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Fig (*Ficus carica*): A Potential Functional Ingredient for Developing Value Added Products

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Abstract. To increase the intake of fruits and vegetables, especially among young people, the food industry is trying to develop new, ready-to-eat products, such as snacks and breakfast spreads. Nowadays, consumers are choosing their foods based not only on sensory attributes but also on nutritional/functional properties. Fig is the one of the oldest plants cultivated on the earth which is rich in phytochemicals and minerals. The present study was designed to analyze three sun-dried Fig varieties named Afghani, Irani and Turkish for nutritional composition including proximate and minerals (mg/100 g) content and to develop value-added products such as Fig rolls and honey to increase the utilization of Figs in the daily routine. For this purpose, the Fig roll was prepared by filling Fig paste (which was changed gradually from 0 g, 2 g, 3 g, 4 g and 5 g in different treatments) in the chickpea-based dough. Whereas Fig honey was prepared by gradually replacing honey (commercially available) with prepared Fig liquid (from 0%, 20%, 40%, 80%, 100%) in different treatments. Results revealed that the Afghani Fig has the highest protein (4.96%), ash (5.29%), potassium (1148.13), magnesium (198.37) calcium (122.80) and zinc (2.80), whereas the Turkish Fig has a high fiber content (9.38%). However, Fig rolls have 3 g Fig paste filling and the Fig honey prepared with 60% Fig liquid paste was well accepted by consumers for their appearance (8.30, 8.07), flavour (8.53, 7.43), and overall acceptability (8.42, 7.80 respectively) assessed by 9-hedonic scale. The nutrition fact of Fig rolls and honey was also calculated.

Keywords: *Ficus carica*, functional food, rolls, honey, minerals, nutrition fact

Introduction

Ficus carica Linn. belongs to the genus Ficus (Moraceae) and is one of the most popular fruits consumed globally and is recognized by more than 135 different names such as *Anjir* (Urdu), *Figari* (Hindi) and *Tian* (Arabic). According to the United Nations Food and Agriculture Organization (FAO), annual Fig production is about 1.1 million tons. Turkey is the major producing country with a 27% share of the global market. Additionally, Algeria, Egypt, Iran and Morocco are also among the leading producers of Figs and their products (Deepa *et al*., 2018). Fig fruit is famous for its pleasant, sweet taste as well as nutritional and therapeutic potential. Figs are energy-dense and nutritious fruits with appreciable amounts of fiber and minerals. It is cholesterol and sodium-free. The fresh Fig fruit has nearly 80% water, 17.3% carbohydrate, 1.7% fiber, 1.2% protein, 0.6% ash and 0.3% fat along with 76 Kcal per 100 g (GOP, 2001). Fig is rich in fatty acids, aliphatic alcohols, hydrocarbons, volatile components and some secondary metabolites such as flavones, steroids, triterpenoids and coumarins (Veberic and Mikulic-Petkovsek, 2016).

Fig is concentrated with various polyphenols such as catechins, epicatechin, epicatechin gallate, epigallocatechin, gallocatechin and epigallocatechin gallate. Fig fruit (mg/100 g) has a good amount of rutin (28.7), catechin (4.03), chlorogenic acid (1.71), epicatechin (0.97) and gallic acid (0.38) and syringic acid (0.10) (Veberic *et al*., 2008). The dried Fig is sodium and cholesterol-free with 0.9% fat and 9.8% fiber content. About 28% of the fiber is soluble which is good for controlling blood glucose levels, cholesterol and body weight. One serving of dried Fig provides recommended daily intake (RDA) of thiamin (7.1%), riboflavin (6.2%), potassium (7%), iron (6%) and calcium (6%) (Vinson, 1999). Fructose and glucose are the chief core sugars in the fruits of Figs (Aljane *et al*., 2007). The glucose content ranges from 2.53 to 15.9 g and fructose 1.9 to 11.9 g per 100 g in different cultivars (Slatnar *et al*., 2011). Fig fruit has essential (isoleucine, phenylalanine,

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threonine, tryptophan and valine) as well as non-essential amino acids (glutamine, aspartic acid, asparagine, alanine and serine) along with their derivatives such as α-ketoglutarate, β-alanine, cyanoalanine, O-acetylserine and oxoproline (Allegra *et al*., 2018).

Fig is one of the few fruits mentioned in the Holy Quran and Ahadith. In the Holy Quran, the first verse of Surat At-Tin illustrates the benefits of this fruit as it says "*(I swear),* by the Fig and the olive" (Quran, 95:1). In an Ahadith, the Holy Prophet (PBUH) said "Eat Fig, if a certain type of fruit was sent down to us from the heavens and say it's a Fig because it has no seeds. It ends (cures) the piles and is useful for rheumatism". In traditional medicines including Siddha, Unani and Ayurveda, Figs are used extensively for the cure and prevention of numerous health ailments. It has been utilized for the treatment of disorders related to the cardiovascular system, endocrine system, gastrointestinal tract, infectious diseases, inflammation, liver, reproductive system and respiratory system (Badgujar *et al*., 2014; Mawa *et al*., 2013). The Fig fruit is used in both dried and fresh forms. Depending on the variety and type. Dried Figs can be commercialized for diverse uses, such as table consumption or to prepare other commercial products like canned Figs and Fig paste. Mission variety is used as dried fruit and to make juices and paste, however, Adriatic and Kadota varieties are specifically utilized for paste production. In California Fig is used to make energy bars and cookies. Fig is also used in baked products like pastries, pies and cooked dishes. Low-quality dried Figs are used mostly to flavor coffee and to prepare concentrated juices (Crisosto *et al*., 2011). Fresh unpeeled and peeled Figs are used in several ways in bakery products including cakes, Fig pies and puddings. Numerous products like Fig ice cream, Fig jams, Fig marmalade, Fig Newtons, Fig paste and Fig rolls are commercially available. The addition or filling of Fig paste in wheat and corn flour, along with other ingredients such as oil and syrup, results in the production of delicious bakery products. Moreover, sugar syrup from the whole Fig is also prepared at the household level (Chawla *et al*., 2012).

Functional ice cream has been formulated using dry Fig along with stevia leaf extract (Gençdag *et al*., 2021). Fig fruit powder has been prepared and utilized in the preparation of bakery products like cookies to enhance its nutritional profile. Fig fruit powder is also utilized in traditional sweets like burfi (Khapre *et al*., 2015a and b). A chocolate-coated snack containing dried Fig powder is commercially available in supermarkets (Yeganehzad *et al*., 2020). Jam, a shelf-stable product from Fig is also popular nowadays. Fig jam is prepared by mixing it with other fruit like apples to enhance the nutrition of the product and better different tastes (Reddy *et al*., 2014). Fresh wild Himalayan Fig has been used to produce jam with good anthocyanin content (17.05 mg/100 g) (Kumari *et al*., 2018; Rababah *et al*., 2011). A mixture of Fig honey has been developed with three different varieties for better aroma, fatty acids, sterols, terpenes and antioxidants. The cultivar San Francesco had better flavonoid and phenolic content whereas, Dottato has more anthocyanin concentration as evidenced by the highest antioxidant activity. Thus, dried Figs can be used in convenient food to produce quality products (Loizzo *et al*., 2014). Other than these items nuggets, noodles, muffins and buns have also been prepared (Chauhan and Tanwar, 2016). Fig by-products from the wine and jam industries can be utilized as an important source of phenolic compounds. An optimized solid-state fermentation extracted a significant amount of total phenolic compounds (TPC; 10.37 mg) that have a high antioxidant capacity (Buenrostro-Figueroa *et al*., 2017).

Fig fruit purée along with other fruit has been used to prepare fruit smoothies. The addition of fig puree and other fruits in the ratio of 40:60 significantly increased the TPC, total flavonoid content (TFC) and anthocyanins (Cano-Lamadrid *et al*., 2018a). Fig smoothies are rich in anthocyanins (Cano-Lamadrid *et al*., 2018b). Moreover, the addition of Figs also elevated the sensory attributes of fruit smoothies by imparting a sweet flavor (Issa-Issa *et al*., 2020). Being a rich source of antioxidants, phenolic compounds and dietary fiber, the Fig seed could be a valuable health-promoting food ingredient. Replacement of wheat flour with Fig seed powder in biscuits significantly improves the fiber (56%) and phenolics (665 mg/100 g). Moreover, the addition of seed powder (10%) improved the sensory characteristics of the biscuits (Bölek, 2020). Milk-based dessert named 'Shir Anjir' has also been developed with the addition of dried Figs to replace added sugar (Jahromi and Niakousari, 2018).

For children, confectionery is one of the most consumed products and continuous efforts are made to improve the nutritional profile of such products. Papaya pulp, ragi powder, soy protein isolate and many other fruit pulps are used to prepare toffees. Fig toffee has been developed using Fig pulp along with other components

including fat, glucose, skim milk powder and sucrose. This developed product claims to be cheaper compared to other similar available toffees (Mhalaskar *et al*., 2012). Fig fruit powder is also utilized to prepare toffee (Khapre *et al*., 2011), cake, coconut burfi and lassi (Makeshwari and Bhuvaneswari, 2019). An isolated proteolytic enzyme from Fig latex, Ficin which is used for the removal of sausages casing, as a chill proofing compound, meat tenderizer and milk coagulant (Aksoy, 1998). Pullulan (polysaccharide) is used in food science, pharmaceutical and cosmetic industries but cost-effective production of pullulan is difficult. Fig fruit syrup has been used to produce pullulan and results revealed that pullulan production (14.06 g/L) from Fig was higher than the production from other sources (5.01 g) (Marvdashti *et al*., 2018). As Fig fruit is rich in bioactive components, the main objective of the study was the development and evaluation of Fig-based and value-added food products to increase the utilization of Fig in daily routine.

Materials and Methods

Procurement of materials. Three dried Fig fruit varieties named Afghani Fig, Irani Fig and Turkish Fig, white flour, chickpea flour, sugar, vegetable ghee, baking powder, eggs, salt and food-grade colour required for research and product development were purchased from the local market of Faisalabad, Pakistan. Alloxan monohydrate and all reagents of HPLC analytical grade were procured from Sigma-Aldrich (Sigma Aldrich, Tokyo, Japan) and Merck (Merck KGaA, Darmstadt, Germany).

Analysis of dried Fig fruits. Dried Fig fruits were converted into fine pieces using the domestic grinder and analyzed in triplicate for their preliminary proximate analysis *i.e.*, moisture, crude protein, fat, fiber, ash, nitrogen-free extract and minerals *i.e.*, sodium, potassium, iron, zinc, calcium, magnesium, copper, manganese by respective methods in (AOAC, 2019; AACC, 2010) respectively.

Development of Fig-based functional product. Fig rolls and Fig honey were prepared using modified methods described by Dhankhar *et al*. (2019) and Costa *et al*. (2019), respectively.

***Preparation of Fig rolls*.** 100 g of dried Fig fruit was cleaned and washed for the removal of dirt then soaked in 100 mL water for 2 h. After draining water, the Figs were converted into paste. The additional water was removed by heating the paste at a gentle fire. Subsequently, the sheath's dough of Fig rolls was prepared with white flour (42%), chickpea flour (5%), sugar (21%), egg (2), baking powder (1.5 g), salt (2 g) and vegetable ghee (31%). First, dry ingredients were mixed and then blend with eggs and vegetable fat until a smooth dough was obtained. The dough was rolled out with a rolling pin into two flat bases having 10 mm thickness. Fig pasted was spread over one sheet and then another sheet was placed on it. The dough was rolled out again with a rolling pin and cut into a rectangular shape (width 2.5 cm and length 6 cm) with the help of the cutter. Fig pastes filling was changed gradually (0 g, 2 g, 3 g, 4 g and 5 g) in different the treatments. Following treatment plan was adopted to develop different formulation Fig rolls.

T_0=No Fig paste filling; T_1=Rolls having 2 g of Fig paste filling; T_2=Rolls having 3 g of Fig paste filling; T_3=Rolls having 4 g of Fig paste filling; T_4=Rolls having 5 g of Fig paste filling.

The rolls were baked in a laboratory oven at 180 ºC for 30 min. Fig rolls were cooled and kept in an airtight package for further studies. The net weight of 1 roll is 14-17 g.

***Preparation of Fig honey*.** 100 g of dried Fig fruit was cleaned and washed for the removal of visible dirt then soaked in 100 mL of water for 2 h. Afterward, was blended with an additional 200 mL of water. The obtained mixture was heated at 60 ºC till the volume remained at 250 mL having 26 Brix. Fig honey was prepared by gradually replacing honey with obtained Fig liquid (0%, 20%, 40%, 80% and 100%). Following treatment plan was adopted to develop different formulations of Fig honey.

T_0*=100% commercially available honey; T_1=80% commercially available honey and 20% Fig paste; T_2=60% commercially available honey and 40% Fig paste; T_3=40% commercially available honey and 60% Fig paste; T_4=20% commercially available honey and 80% Fig paste; T_5=10% commercially available honey and 100% Fig paste

The obtained Fig honey was poured into glass jars and cooled to room temperature. Then jars were subsequently sealed and stored at refrigeration temperature.

Analysis of Fig rolls and Fig honey. Sensory evaluation of Fig rolls and Fig honey along with control was performed for various attributes like appearance, colour, flavour (aroma, taste), texture and consumer

acceptability. A panel of semi-trained judges (teachers + postgraduate students) was selected from the NIFSAT, UAF. The test was employed using a 9-hedonic scale where 9 points represent "Like Extremely" and 1 point indicated "Dislike Extremely" (Meilgaard *et al*., 2007).

Statistical analysis. The data recorded for each parameter were assessed statistically by analysis of variance (ANOVA) and Tukey test to determine significant differences among the groups as described by Montgomery (2008).

Results and Discussion

Analysis of dried Fig. Three commercially available varieties of dried Figs available in Pakistan *i.e.*, Afghani Fig, Irani Fig and Turkish Fig available were analyzed for proximate and minerals composition. Statistical analysis for the proximate composition of Fig varieties showed significant differences concerning moisture, crude fat, crude fiber, ash and nitrogen-free extract whereas crude protein content remained non-significant. Likewise, the mineral contents of Fig varieties showed significant differences concerning sodium, potassium, iron, zinc, calcium, magnesium, copper and manganese. Means for the proximate composition and mineral contents of Fig varieties are given in Table 1.

Proximate analysis. The moisture content of the Fig ranged from 12.88±0.41 to 16.88±0.18%. Among the different varieties, the Turkish Fig has the highest moisture content (16.88±0.18%) followed by the Afghani Fig (14.12±0.38%) and Irani Fig (12.88±0.41%). The highest crude fat content was found in the Irani (4.01±0.23%) followed by the Turkish Fig *i.e.*, 3.42±0.19% and then the Afghani Fig (2.79±0.14%). Likewise, the highest crude fiber content was found in the Turkish Fig *i.e.*, 9.38±0.16%, followed by the Irani Fig (6.57±0.42%) and then the Afghani Fig (2.49±0.32%). The total ash was highest in the Afghani Fig (5.29±0.19%), while the Turkish and Irani Figs have similar ash content (3.62±0.23 and 3.68±0.24%, respectively). However, the highest NFE was observed in the Afghani Fig (70.36±0.44%), followed by Irani (68.48±0.27%) and Turkish (62.24±0.35%). The crude protein ranged from 4.38±0.44 to 4.96±0.25%. The compositional analysis of Fig fruit has shown the presence of a variety of nutrients. It's considered a good source of energy owing to the richness of carbohydrates and a moderate amount of protein and minerals. Dried Fig fruit from Panipat's market (India) was analyzed for nutritional and phytochemical contents. The results revealed the presence of carbohydrates (73.50%), moisture (16.63%), protein (4.67%), ash (4.65%), fiber (3.68%) and fat content (0.56%) (Soni *et al*., 2014). In another study, seven Figs cultivated from different areas of Pakistan were analyzed for their nutritional profile. The results revealed that the moisture content of the dried Fig fruits varied between 12.89 to 17.50% whereas ash contents were between 1.39 to 2.80% (Khan *et al*., 2011). In another study, Fig fruit powder was utilized for the development of confectionary *i.e.*, toffee. The powder was prepared from the fresh Dinkar variety that contained 61.52% total sugars, 10.43% moisture, 5.26% protein, 2.48% fat and 3.9% ash (Khapre *et al*., 2011).

Table 1. Proximate composition (%) and mineral content (mg/100g) of commercially available Figs in Pakistan

Compositional analysis (%)	Fig varieties		
	Afghani	Irani	Turkish
Moisture	14.12±0.38^{b}	12.88±0.41^{c}	16.88±0.18^{a}
Crude protein	4.96±0.25	4.38±0.44	4.46±0.26
Crude fat	2.79±0.14^{c}	4.01±0.23^{a}	3.42±0.19^{b}
Crude fiber	2.49±0.32^{c}	6.57±0.42^{b}	9.38±0.16^{a}
Total ash	5.29±0.19^{a}	3.68±0.24^{b}	3.62±0.28^{b}
NFE	70.36±0.24^{a}	68.48±0.27^{b}	62.24±0.35^{c}
Sodium	504.47±2.32^{a}	414.07±1.63^{b}	337.87±2.41^{c}
Potassium	1148.13±3.81^{a}	1064.53±3.52^{b}	1103.33±1.97^{ab}
Iron	5.87±0.11^{c}	7.29±0.23^{a}	6.67±0.16^{b}
Zinc	2.80±0.12^{a}	0.60±0.09^{b}	0.67±0.04^{b}
Calcium	122.80±1.06^{a}	88.670±1.04^{b}	85.150±0.85^{c}
Magnesium	198.37±1.10^{a}	131.69±0.99^{b}	112.38±1.03^{c}
Copper	1.83±0.03^{a}	1.28±0.06^{b}	0.55±0.07^{c}
Manganese	6.69±0.19^{a}	0.48±0.03^{b}	0.59±0.02^{b}

Mean ± SD = mean values within a row, bearing a different superscript are statistically significant

Fresh Figs were dried using various drying techniques including sun drying, freeze-drying and microwave drying and were evaluated to check their nutritional, phytochemical and physico-chemical changes. Sun and microwave-dried Fig fruit was found to contain approximately 65% carbohydrates, 4.42% ash and 3% protein (Chauhan *et al*., 2015). Likewise, Nagaraja *et al*. (2016), observed the changes in the quality of dried Figs during storage using various drying methods *i.e.*, microwave oven drying, sun drying and solar cabinet drying. Results revealed the lowest moisture content in microwave oven-dried Figs (15.30%) and the highest was found in sun-dried samples (16.48%). Similarly, the lowest protein was found in microwave oven drying (4.11%) whereas the highest was found in solar cabinet

drying (4.65%). The difference in the values may be attributed to geographical origin, climate, environmental factors, agronomic practices, genotypic variation, time of harvest, temperature, light and rainfall. Moreover, processing techniques *i.e.*, drying temperature, drying method and duration may also affect the composition of the fruit.

***Minerals analysis*.** The sodium content of Fig fruit ranged from 337.87±2.41 to 504.47±2.32 mg/100 g of dried Fig fruit. The Afghani Fig has the highest sodium content (504.47±2.32 mg) followed by the Irani Fig (414.07±1.63 mg) and Turkish Fig (337.87±2.41 mg). The potassium content of dried Fig fruit ranged from 1064.53±3.52 to 1148.13±3.8 mg/100 g of dried Fig fruit. The Afghani Fig has the highest potassium content (1148.13±3.8 mg) followed by the Turkish Fig (1103.33±1.97 mg) and Irani Fig (1064.53±3.52 mg). The iron content of dried Fig fruit ranged from 5.87±0.11 to 7.29±0.23 mg/100 g of dried Fig fruit. The Irani Fig has the highest calcium content (7.29±0.03 mg) followed by the Turkish Fig (6.67±0.16 mg) and Afghani Fig (5.87±0.13 mg). The zinc content of dried Fig fruit ranged from 0.60±0.10 to 2.80±0.12 mg/100 g of dried Fig fruit. The Afghani Fig has the highest zinc content (2.80±0.12 mg) followed by the Turkish Fig (0.67±0.04 mg) and Irani Fig (0.60±0.09 mg). The calcium content of dried Fig fruit ranged from 85.15±0.85 to 122.80±1.06 mg/100 g of dried Fig fruit. The Afghani Fig has the highest calcium content (122.80±1.06 mg) followed by the Turkish Fig (88.670±1.04 mg) and Irani Fig (85.150±0.85 mg). The magnesium content of dried Fig fruit ranged from 112.38±1.03 to 198.37±1.01 mg/100 g of dried Fig fruit. The Afghani Fig has the highest magnesium content (198.37±1.01 mg) followed by the Turkish Fig (131.69±0.99 mg) and Irani Fig (112.38±1.03 mg). The copper content of dried Fig fruit ranged from 0.55±0.07 to 1.83±0.04 mg/100 g of dried Fig fruit. The Afghani Fig has the highest copper content (1.83±0.03 mg) followed by the Irani Fig (1.28±0.06 mg). The manganese content of dried Fig fruit ranged from 0.48±0.03 to 6.69±0.19 mg/100 g of dried Fig fruit. The Afghani Fig has the highest manganese content (6.69±0.19 mg) followed by the Turkish Fig (0.59±0.02 mg) and Irani Fig (0.48±0.03 mg). It is evident from mean values for minerals content that the Afghani Fig has the highest minerals content as well as ash content. Similarly, the mineral content of different Fig varieties has been reported by other researchers.

Vinson (1999) reported sodium, potassium and iron (12.26, 609, 3.07 mg/100 g) in dried Fig. Fresh Fig fruit was compared for antibacterial, antioxidant activity and phytochemicals content after microwave drying, sun drying and freezing. Results revealed that iron content ranged between 11.51-13.20 mg/100 g. After drying mineral content improved due to an increase in dry matter content (Chauhan *et al*., 2015). In another study, 14 Tunisian fresh Figs were analyzed for mineral content. The results showed that sodium, potassium and zinc ranged from 12.33-57.52, 541.27-875.95 and 0.72-2.03 mg/100 g of dry matter (Aljane *et al*., 2007). The seven Fig types from Pakistan analysis cobalt, calcium, iron, copper, sodium, nickel, magnesium, potassium, phosphorus and zinc content which is reported by Khan (2011). Results revealed Figs as a good source of potassium (611.5 mg/100 g), magnesium (202.40 mg/100 g) and calcium (132.8 mg/100 g). In another study, the analysis of Figs revealed 1545.46 ppm calcium, 5.02 ppm copper, 29.49 ppm iron, 679.04 ppm magnesium, 4.75 ppm manganese, 9.87 ppm zinc (Soni *et al*., 2014). The differences in mineral content of Figs reported in different studies might be due to various factors, *i.e.*, origins of Figs cultivars, plants' nutrients, differences in ripening, etc. Recommended Dietary Allowances (RDAs) of copper range from 700-900 mcg, iron range from 8-18 mg, zinc range from 8-11 and potassium range from 4.5-4.7 g for both genders aged between 9->70 years. However, Adequate intake (AIs) of manganese is ranged from 1.2-2.3 mg and sodium ranges from 1.2-1.5 g for both genders aged between 9->70 years (Mahan and Raymond, 2017). If 100 g is considered as one serving of Figs, then Afghani Figs can provide upto 200% of copper, 39-53% of iron, 371-400% of manganese, 33% of sodium, 242% of potassium and zinc of 25-31% daily requirement.

Consumer acceptability of Fig-based products. *Fig rolls.* Results depicted that the appearance, flavor, texture and overall acceptability of the Fig rolls differ significantly among the various treatments (Table 2). Appearance and colour are the first sensory characteristics perceived by the consumer and play a vital role in the selection of food products. The appearance and colour of the product predict consumer acceptance and significantly influence purchasing behaviour. It is usually the first score given to the food commodity. The mean values of appearance and colour of different treatments showed that the highest score of 8.30 was found in rolls having 3 g of Fig paste filling (T_2), followed by 7.77 in the rolls having 2 g of Fig paste filling (T_1), and 7.33 in the rolls having 4 g Fig

paste filling (T_3). The lowest was scored (6.87) by rolls having 5 g of Fig paste. The mean values of flavour (including aroma and taste) of the different treatments showed the highest score was 8.53 by T_2, followed by T_1 (8.03) and by T_3 (7.37). The lowest value (7.26) was scored by rolls with no Fig paste filling (T_0). The mean values of the texture of the different treatments showed that the highest score was 8.43 by T_2, followed by T_1 (7.50) and by T_3 (7.30). The lowest value (6.79) was scored by rolls with no Fig paste filling (T_0). The mean values of the overall acceptability of the different treatments showed that the highest score was 8.42 by T_2, followed by T_1 (7.77) and by T_3 (7.33). The lowest value (6.98) was scored by rolls with 4 g Fig paste filling (T_4). The rolls with 3 g Fig pasted were liked more because they have a standard blend of fruit paste and crispy crust. However, rolls prepared with 5 g paste were a little moist and make the crust soggy. However, rolls prepared with 2 g paste were a little dry and hard as Fig paste was caramelized because of the thin layer of paste and high temperature applied for baking.

Table 2. Means for the effect of different treatments on sensory attributes of the Fig roll

Treatments	Parameters			
	Appearance	Flavour	Texture	Overall acceptability
T_0	6.93±0.25^{bc}	7.26 ±0.35^{c}	6.79±0.12^{d}	7.00±0.17^{c}
T_1	7.77±0.12^{ab}	8.03±0.21^{ab}	7.50±0.17^{b}	7.77±0.13^{b}
T_2	8.30±0.17^{a}	8.53±0.12^{a}	8.43±0.23^{a}	8.42±0.15^{a}
T_3	7.33±0.25^{bc}	7.37±0.29^{bc}	7.30±0.17^{bc}	7.33±0.11^{c}
T_4	6.87±0.28^{c}	7.30±0.36^{bc}	6.83±0.21^{cd}	6.98±0.09^{c}

Mean ± SD = mean values within a column, bearing a different superscript are significant

T_0= No Fig paste filling; T_1= Rolls having 2 g of Fig paste filling; T_2= Rolls having 3 g of Fig paste filling; T_3= Rolls having 4 g of Fig paste filling; T_4= Rolls having 5 g of Fig paste filling

Fig honey. Appearance and colour are the first sensory characteristics perceived by the consumer immediately. The appearance and colour of the product predict consumer acceptance and significantly influence purchasing behavior. It is the first score given to the food commodity. Results depicted that the appearance, flavour, texture, spreadability and overall acceptability of the Fig honey differ significantly among various treatments (Table 3). The mean values of appearance of different treatments showed that the highest score of 8.53 was found in Fig honey prepared with 40% honey and 60% Fig paste (T_3) followed by 8.07 in Fig honey prepared with 60% commercially available honey and 40% Fig paste and 8.03 in Fig honey prepared with 80% commercially available honey and 20% Fig paste (T_1) due to the light brown colour Table 4. The lowest value (6.57) was scored by the Fig honey prepared with 10% commercially available honey and 100% Fig paste (T_5) due to its dark brown colour. The mean values of the flavour of different treatments showed that the highest score was 8.60 in (T_4) followed by 7.57 in T_3 and 7.43 in T_2. The lowest value (6.77) was scored by T_0. The mean values of the texture of different treatments showed that the highest score was 8.30 in (T_2) followed by 7.77 in T_3 and 7.33 in T_4. The lowest value (6.53) was scored by T_0. The formulation with higher Fig pastes content has a more viscous texture with higher Fig seed content which was considered a negative texture character. The formulation of upto 60% replacement of honey was well accepted. The mean values of the spreadability of different treatments showed that the highest score was 8.37 by (T_1) followed by 7.93 in T_2 and 7.33 by T_0. The lowest value (6.90) was scored

Table 3. Means for the effect of different treatments on sensory attributes of Fig honey

Treatments	Parameters				
	Appearance	Flavour	Texture	Spreadability	Overall acceptability
T_0	7.57±0.32^{bc}	6.77±0.15^{d}	6.53±0.22^{d}	7.33±0.19^{b}	6.77±0.24^{c}
T_1	8.03±0.21^{ab}	7.07±0.32^{bcd}	6.93±0.37^{cd}	8.37±0.23^{a}	7.60±0.33^{ab}
~~T_2~~	~~8.07±0.15^{ab}~~	~~7.43±0.23^{bc}~~	~~8.30±0.17^{a}~~	~~7.93±0.35^{a}~~	~~7.80±0.15^{ab}~~
T_3	8.53±0.42^{a}	7.57±0.49^{b}	7.77±0.44^{ab}	7.30±0.51^{b}	7.93±0.41^{a}
T_4	7.23±0.35^{cd}	8.60±0.16^{a}	7.33±0.55^{bc}	7.13±0.47^{b}	7.58±0.27^{b}
T_5	6.57±0.25^{d}	7.03±0.56^{cd}	6.57±0.21^{cd}	6.90±0.77^{b}	7.05±0.57^{c}

Mean ± SD = mean values within a column, bearing a different superscript are significant

T_0*= 100% Commercially available honey; T_1=80% commercially available honey and 20% Fig paste; T_2=60% commercially available honey and 40% Fig paste; T_3=40% commercially available honey and 60% Fig paste; T_4= 20% commercially available honey and 80% Fig paste; T_5= 10% commercially available honey and 100% Fig paste

by T_5. The mean values of the overall acceptability of different treatments showed that the highest score was 7.93 by (T_3) followed by 7.80 in T_2 and 7.60 by T_1. The lowest value (6.77) was scored by T_0.

Nutrition facts of Fig rolls and Fig honey. The nutrition fact of Fig rolls (per 100 g) having 3 g of Fig paste and Fig honey (per 100 g) prepared with 40% commercial honey and 60% Fig paste is given in Table 4 and 5. respectively. Percent daily value (per 100 g) is also presented in the table for an adult aged 20-30 years consuming 2000 kcals per day described by Mahan and Raymond (2017).

Table 4. Nutrition fact of Fig rolls (per 100 g) having 3 g of Fig paste

Parameter	Value per 100 g	Value per serving (60 g)	Percent daily value per 100 g
Protein (%)	7.64	4.58	~ 8%
Fat (%)	31.8	19.08	~ 40%
Fiber (%)	2.2	1.32	~ 57%
Carbohydrates (%)	66.25	39.75	~ 23%
Sodium (mg)	1271	762.6	~ 84%
Potassium (mg)	376.64	225.98	~ 8%
Iron (mg)	2.87	1.72	~ 15%
Zinc (mg)	1.77	1.06	~ 2%
Calcium (mg)	35.96	21.58	~ 3%
Magnesium (mg)	87.94	52.78	~ 22%
Copper (mg)	0.32	0.192	~ 100%
Manganese (mg)	1.20	0.612	~ 63%

~ = Approximately

Table 5. Nutrition fact of Fig honey (per 100 g) prepared with 40% commercial honey and 60% Fig paste

Parameter	Value per 100 g	Value per serving (15 g)	Percent daily value per 100 g
Water	18.86	2.83	-
Protein (%)	3.77	0.56	~ 4%
Fat (%)	1.67	0.25	~ 3%
Fiber (%)	1.50	0.23	~ 6%
Carbohydrates (%)	74.2	11.13	~ 26%
Sodium (mg)	302.68	45.40	~ 20%
Potassium (mg)	688.8	103.32	~ 15%
Iron (mg)	3.52	0.528	~ 19%
Zinc (mg)	1.68	0.25	~ 10%
Calcium (mg)	73.68	11.05	~ 6%
Magnesium (mg)	119.02	17.86	~ 30%
Copper (mg)	1.09	0.16	~ 100%
Manganese (mg)	4.01	0.60	~ 100%

~ = Approximately

Conclusion

After sun drying and dehydration, whole and fruit paste can be used in numerous food products such as ice cream, puddings, marmalade, pies, jam, cakes and many bakery products. Fig fruit and Fig-based products should be included in the regular diet to prevent oxidative stress-related diseases. Snack manufacturers should be motivated to utilize Figs in food formulations to improve the nutritional profile of products.

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References

AACC. 2010. International Approved Methods of Analysis, 11th Ed., Method no 975.03B., American Association of Cereal Chemists, International Press, St. Paul, MN, USA.

Allegra, A., Gallotta, A., Carimi, F., Mercati, F., Inglese, P., Martinelli, F. 2018. Metabolic profiling and post-harvest behaviour of "Dottato" Fig (*Ficus carica* L.) fruit covered with an edible coating from *Ficus indica*. *Frontiers in Plant Science*, **9:** 1-10.

Aljane, F., Toumi, I., Ferchichi. A. 2007. HPLC determination of sugars and atomic absorption analysis of mineral salts in fresh Figs of Tunisian cultivars. *African Journal of Biotechnology*, **6:** 599-602.

AOAC. 2019. Official Methods of Analysis, 21st Ed., Association of Official Analytical Chemists International, Arlington, VA, USA.

Aksoy, U. 1998. 'Why Figs? an old taste and new perspective. In: *Proceeding of First International Symposium of Fig ISHS Acta Horticulturae*, **480:** 25-26.

Badgujar, S.B., Patel, V.V., Bandivdekar, A.H., Mahajan, R.T. 2014. Traditional uses, phytochemistry and pharmacology of *Ficus carica*: a review. *Pharmaceutical Biology*, **52:** 1487-1503.

Bölek, S. 2020. Effects of waste Fig seed powder on quality as an innovative ingredient in biscuit formulation. *Journal of Food Science*, **86:** 55-60.

Buenrostro-Figueroa, J.J., Velázquez, M., Flores-Ortega, O., Ascacio-Valdés, J.A., Huerta-Ochoa, S., Aguilar, C.N., Prado-Barragán, L.A. 2017. Solid state fermentation of Fig (*Ficus carica* L.) by-products using fungi to obtain phenolic compounds with antioxidant activity and qualitative evaluation of phenolics obtained. *Process Biochemistry*, **62:** 16-23.

Cano-Lamadrid, M., Hernández, F., Nowicka, P., Carbonell-Barrachina, A.A., Wojdylo, A. 2018a. Formulation and storage effects on pomegranate smoothie phenolic composition, antioxidant capacity and colour. *LWT-Food Science and Technology*, **96:** 322-328.

Cano-Lamadrid, M., Nowicka, P., Hernández, F., Carbonell-Barrachina, A.A., Wojdy łło, A. 2018b. Phytochemical composition of smoothies combining pomegranate juice (*Punica granatum* L.) and Mediterranean minor crop purées (*Ficus carica, Cydonia oblonga* and *Ziziphus jujube*). *Journal of the Science of Food and Agriculture*, **98:** 5731-5741.

Chauhan, A., Tanwar, B. 2016. Development of value-added products (bun, muffin, noodles and nuggets) by substitution with *Carissa spinarum* and *Ficus carica* powder. *Asian Journal of Pharmaceutical and Clinical Research*, **9:** 130-136.

Chauhan, A., Tanwar, B., Intelli. 2015. Influence of processing on physico-chemical, nutritional and phytochemical composition of *Ficus carica* (Fig) fruit. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, **6:** 1474-1489.

Chawla, A., Kaur, R., Sharma, A. 2012. *Ficus carica* Linn.: a review on its pharmacogenetic, phytochemical and pharmacological aspects. *International Journal of Pharmaceutical and Phytopharmacological Research*, **1:** 215-232.

Costa, E.A., Sousa, P.H.M., Siqueira, A.C.P., Figueiredo, E.A.T., Gouveia, S.T., Figueiredo, R.W., Maia, C.S.C., Gomes, D.S. 2019. Fruit pastes with organic honey texturized with gellan gum: bioaccessibility of antioxidant activity and sensory analysis fruit pastes with gellan and organic honey. *Food Science and Technology (Campinas)*, **39:** 667-676.

Crisosto, H., Ferguson, L., Bremer, V. 2011. Fig (*Ficus carica* L.) In: *Postharvest Biology and Technology of Tropical and Subtropical Fruits*, Yahia, E.M. (ed.), vol. **3**, Woodhead Publishing, Philadelphia, USA.

Deepa, P., Sowndhararajan, K., Kim, S., Park, S.J. 2018. A role of *Ficus* species in the management of diabetes mellitus: a review. *Journal of Ethnopharmacology*, **215:** 210-232.

Dhankhar, J., Vashistha, N., Sharma, A. 2019. Development of biscuits by partial substitution of refined wheat flour with chickpea flour and date powder. *Journal of Microbiology, Biotechnology and Food Sciences*, **8:** 1093-1097.

Gençdag, E., Görgüç, A., Aylan, F., Arı, G., Bilgin, O. and Yılmaz, F.M. 2021. Techno-functional effect of stevia extract substitution on dry Fig-fortified ice cream. *Journal of Food Processing and Preservation*, **45:** e15578.

GOP (Government of Pakistan). *2001*. Food composition table of Pakistan. Ministry of Planning, Development and Reform, Islamabad, Pakistan.

Issa-Issa, H., Cano-Lamadrid, M., Calín-Sánchez, A., Wojdyło, Á., Carbonell-Barrachina, A.A. 2020. Volatile composition and sensory attributes of smoothies based on pomegranate juice and mediterranean fruit purées (Fig, Jujube and Quince). *Foods*, **9:** A19.

Jahromi, M., Niakousari, M. 2018. Development and characterization of a sugar-free milk-based dessert formulation with Fig (*Ficus carica* L.) and carboxymethylcellulose. *International Journal of Dairy Technology*, **71:** 801-809.

Khan, M.N., Sarwar, A., Adeel, M., Wahab, M.F. 2011. Nutritional evaluation of *Ficus carica* indigenous to Pakistan. *African Journal of Food, Agriculture, Nutrition and Development*, **11:** 5187-5202.

Khapre, A.P., Satwadhar, P.N., Deshpande, H.M. 2015a. Studies on standardization of Fig fruit (*Ficus carica* L.) powder enriched cookies and its composition. *Asian Journal of Dairy and Food Research*, **34:** 71-74.

Khapre, A.P., Satwadhar, P.N., Syed, H.M. 2015b. Studies on processing technology and cost estimation of Fig (*Ficus carica* L.) fruit powder enriched burfi (Indian cookie). *Journal of Applied and Natural Sciences*, **7:** 621-624.

Khapre, A., Satwadhar. P., Deshpande, H. 2011. Development of technology for preparation of Fig (*Ficus carica* L.) fruit powder and its utilization in toffee. *Journal of Dairying Foods & Home Sciences*, **30:** 267-270.

Kumari, K., Sharma, S., Joshi, V.K., Sharma, S. 2018.

Adding value to wild Himalayan Fig (*Ficus palmata*): composition, functional and sensory characteristics of jam. *The Journal of Phytopharmacology*, **7:** 13-18.

Loizzo, M.R., Bonesi, M., Pugliese, A., Menichini, F., Tundis, R. 2014. Chemical composition and bioactivity of dried fruits and honey of *Ficus carica* cultivars Dottato, San Francesco and Citrullara. *Journal of the Science of Food and Agriculture*, **94:** 2179-2186.

Mahan, L.K., Raymond, J.L. 2017. *Krause's Food & The Nutrition Care Process*, pp. 1069-1087, 14th Ed., Elsevier, St. Louis, Missouri, USA.

Makeshwari, R., Bhuvaneswari, D. 2019. Processing and value addition of Fig fruit. *International Journal of Research and Analytical Reviews*, **6:** 157-162.

Marvdashti, L.M., Abdolshahi, A., Hedayati, S., Sharifi-Rad, M., Iriti, M., Salehi, B., Sharifi-Rad, J. 2018. Pullulan gum production from low-quality Fig syrup using *Aureobasidium pullulans*. *Cellular and Molecular Biology*, **64:** 22-26.

Mawa, S., Husain, K., Jantan, I. 2013. *Ficus carica* L. (Moraceae): Phytochemistry, traditional uses and biological activities. *Evidence-Based Complementary and Alternative Medicine*, **2013:** 1-8.

Meilgaard, M., Civile, G.V., Carr, B.T. 2007. *Sensory Evaluation Techniques*, pp. 276-293, 4th Ed., CRC Press, Florida, USA.

Mhalaskar, S.R., Lande, S.B., Satwadhar, P.N., Deshpande, H.W., Babar, K.P. 2012. Development of technology for fortification of Fig (*Ficus carica* L.) fruit into its value-added product-Fig toffee. *International Journal of Postharvest Technology and Innovation*, **3:** 176-179.

Montgomery, D.C. 2008. *Design and Analysis of Experiments*, pp. 162-264, 7th Ed., John Wiley & Sons. Inc., Hoboken, NJ, USA.

Nagaraja, K., Sunil, C.K., Chidanand, D.V., Ramachandra, M. 2016. Changes in quality of dried Fig (*Ficus carica* L.) cv. Poona; Ambient storage. *International Advanced Research Journal in Science, Engineering and Technology*, **2:** 126-130.

Rababah, T.M., Al-Mahasneh, M.A., Yang, I.W., Alhamad, M.N., Ereifej, K., Aludatt, M. 2011. Effect of jam processing and storage on total phenolics, antioxidant activity and anthocyanins of different fruits. *Journal of the Science of Food and Agriculture*, **91:** 1096-1102.

Reddy, D.K., Jangabelli, M., Singh, J.K. 2014. Utilization of an underexploited fruit Fig (*Ficus carica*) as a preserved product. *Journal of Agroecology and Natural Resource Management*, **1:** 78-81.

Slatnar, A., Klanchar, U., Stampar, F., Veberic, R. 2011. Effect of drying Figs (*Ficus carica* L.) on the contents of sugars, organic acid and phenolic compounds. *Journal of Agricultural and Food Chemistry*, **59:** 11696-11702.

Soni, N., Mehta, S., Satpathy, G., Gupta, R.K. 2014. Estimation of nutritional, phytochemical, antioxidant and antibacterial activity of dried *Ficus carica*. *Journal of Pharmacognosy and Phytochemistry*, **32:** 58-165.

Veberic, R., Mikulic-Petkovsek, M. 2016. Phytochemical composition of common Fig (*Ficus carica* L.) cultivars. In: *Nutritional Composition of Fruit Cultivars*, Preedy, V.R., Simmonds, M., (eds.), Academic Press, London, UK.

Veberic, R., Colaric, M., Stampar, F. 2008. Phenolic acids and flavonoids of Fig fruit (*Ficus carica* L.) in the northern Mediterranean region. *Food Chemistry*, **106:** 153-157.

Vinson, J.A. 1999. The functional food properties of Figs. *Cereal Food World*, **4:** 82-87.

Yeganehzad, S., Kiumarsi, M., Nadali, N., Ashkezary, M.R. 2020. Formulation, development and characterization of a novel functional fruit snack based on fig (*Ficus carica* L.) coated with sugar-free chocolate. *Heliyon*, **6:** e04350.