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Physico-chemical and Nutritional Assessment of Toffees Developed from Figs

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ABSTRACT

Background: Fig is emerging as an important functional food because it is considered to be an important source of dietary fiber, vitamins and various useful minerals like Iron, calcium, magnesium, *etc.* Fruit toffees contain nutrients like vitamins and minerals present in the original fruit and are nutritionally superior to milk based toffees. The present study was carried out to develop and standardize technology for preparation of fig toffees.

Methods: Six types of toffee blends were prepared with the replacement of fig in the amount of 0%, 10%, 20%, 30%, 40% and 50%. The desired blend was kept for shelf-life analysis at a 30 days interval, under the storage period of three months.

Result: It was found that toffee containing 30% fig pulp was most desirable and was kept for storage studies. Fig toffee contained crude fiber 2.890%, protein 3.973%, phenolic compounds 153.253 GAE mg per 100 g, antioxidants 60.6% inhibition activity per 100 g and flavonoids 15.110 mg per 100 g. Fig toffee was also found to be a good source of minerals like calcium, Iron, potassium, magnesium, sodium and phosphorus. Storage studies revealed that the product was stable during three months of storage study period.

Key words: Figs, Pulp, Storage, Toffee.

INTRODUCTION

Fig an ancient crop belongs to the mulberry family Moraceae. It is also known as 'Anjir' in Asia, 'Fiege' in German, 'Figue' in French and 'Higo' in Spanish (Imran *et al*., 2011). Turkey is the world's largest producer of figs with annual production of 274,535 Metric Tonnes followed by Egypt, Algeria, Morocco, Iran, Syrian Arab Republic, USA, Brazil, Albania and Tunisia (Anonymous, 2017). Few areas in India like Maharashtra, Gujarat, Uttar Pradesh, Karnataka, Punjab and Tamil Nadu cultivate fig as a minor fruit (Naikwadi *et al*., 2010) and "Poona Fig" is the most popular variety grown and consumed in fresh form (Marpudi *et al*., 2013). Fig is one of the most important medicinal fruits available worldwide and is often referred to as the 'fitness fruit'. It consists of 84% pulp and 16% skin (Guvenc *et al*., 2009).

Figs are a great source of minerals, vitamins, amino acids, crude fibres, carotenoids, antioxidants, phenolic compounds and various other compounds like arabinose, β-amyrins, glycosides *etc* (Soni *et al*., 2014). Besides being consumed in its fresh form, figs are also enjoyed as dried, canned in syrups and candied. In Europe, figs are used in preparation of coffee while wine and alcohol are produced from figs in the Mediterranean region (Naikwadi *et al*., 2010). Larger sized fruit could be consumed in fresh form whereas small sized fruit could be used for preparation of jams and marmalade (Gozlekci, 2011).

Toffee is one of the chewable confectionery products made from milk solids, sugar, vegetable oil or butter, artificial flavours and colours. Conventional toffees lack nutritional components and thus by incorporating a fruit pulp, a regular milk toffee can be transformed into a nutritionally rich processed product. Fruit toffee can be prepared either from a single fruit or combination of fruits.

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Various studies have prepared fruit toffees from nipa palm, aonla and papaya, strawberry and apple ber, guava and mango, cocoa-mulhati and guava (Supaking, 2019; Kumar *et al*., 2019; Deshmuskh and Thorat, 2018; Sucheta *et al*., 2018; Pawar *et al*., 2017).

There is a growing interest to consume figs owing to its high nutritional status but the major constraint is its perishability due to which its availability is only for a short period. Processed and convenient products like toffee will help in making it available round the year in a palatable form. The rich mineral content of the fig fruit will also help in combating anaemia in the target consumers. So, there is a dire need to develop this value-added convenience product to increase its consumption.

MATERIALS AND METHODS

The research work related to the present study was carried out in the Department of Food Science and Technology, Punjab Agricultural University, Ludhiana during the year 2017-18. Fully matured and ripe fig fruit variety Brown Turkey was obtained from Department of Fruit Science, Punjab

Agricultural University, Ludhiana. Chemicals of analytical grade were used in the investigation and other raw materials were procured from the local market.

Standardization of toffee recipe

Fig toffees were prepared by using six combinations of toffee blends by mixing fig pulp and other ingredients like butter, liquid glucose, sugar, milk powder, pectin, starch and water in different ratios such as 0:100, 10:90, 20:80, 30:70, 40:60, 50:50 (fig: other ingredients). Ripe fruits were washed and de-stemmed manually. Pulping was done by macerating fruit in a mixer until a uniform pulp was obtained. The flow diagram enumerating the steps in the preparation of fig toffee are given in Fig 1.

Chemical analysis of toffees

The toffees were chemically analysed for moisture, acidity, ascorbic acid, crude fat, crude protein, flavonoids, antioxidants, phenols, peroxide value and free fatty acids as per the standard (AOAC, 2000) and (AOCS,1997) methods.

Texture profile analysis

Texture measurements of fig toffee samples were performed using the texture analyzer (TA-Hd*i*), (Stable Micro systems, UK) were sample was compressed twice to 50% of the original height with a probe P/75 (Bhatt and Verma, 2016) with the load cell of 250 kg, pre-test speed 2.00 mm/s, Test speed 2.00 mm/s, post-test speed 5.00 mm/s, Distance 5.00 mm, Time 5.00 sec. From the resulting curve, hardness, cohesiveness, springiness, chewiness and gumminess were determined.

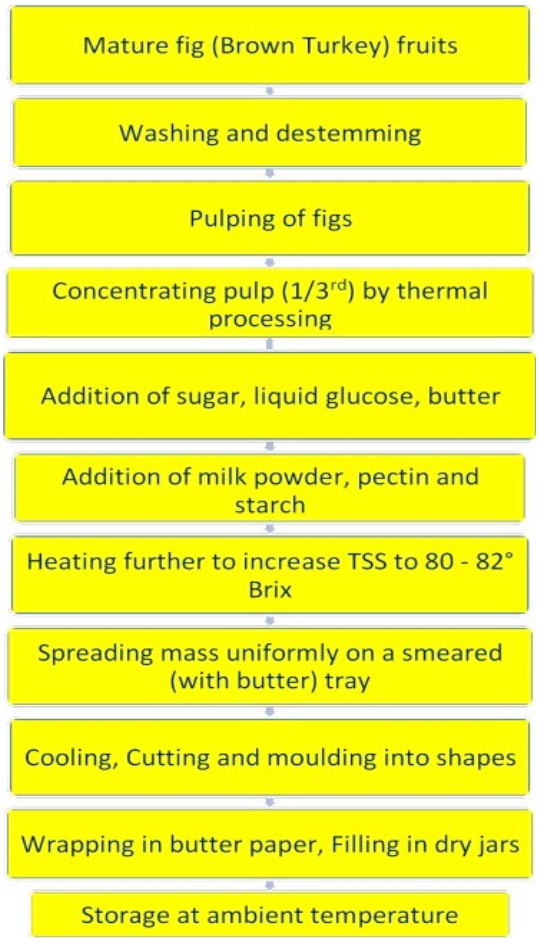

Fig 1: Flow sheet for preparation of fig toffee.

Sensory evaluation of toffees

Prepared fig toffee blends were evaluated by sensory evaluation to obtain the most acceptable and desirable toffee blend on the basis of appearance, colour, flavour, texture and overall acceptability by a panel of semi-trained judges (Larmond, 1970). The desirable blend obtained was checked for the sensorial attributes for three months with the interval of 30 days.

Statistical analysis

The data in the present investigation was subjected to analysis of variance (ANOVA) and thus analysed according to three factorial completely randomized designs.

Results and Discussion

Physico-chemical composition of toffees

Physico-chemical analysis of the toffee blends (Table 1) show that the blend with the highest percentage of fig content exhibited the highest nutritional content. Toffee blend containing no fig pulp was found to be containing higher amounts of total solids, fat, protein, free fatty acid and peroxide value. Low moisture content leads to high total solids content and high amounts of fat, protein, free fatty acids and peroxide value are due to the presence of 100% milk component. Other parameters like ascorbic acid, fiber, anthocyanins, carotenoids, antioxidants, phenols and flavonoids were found to be non- detectable in control due to absence of fig pulp.

Sensory analysis of toffee blends

Sensory analysis data from Table 2 shows that toffee blend containing 30% fig pulp scored highest for all the parameters and had an overall acceptability of 8.237 which was significantly higher than the control but had non-significant difference with all other blends. None of the blends were found to be undesirable as all of them got sensory rating of above 5 on a 9-point hedonic scale.

Nutritional composition of most desirable fig toffee (30:70)

Nutritional profile of fig toffee containing 30% fig pulp is summarized in Table 3. It can be seen that fig toffee contains appreciable amount of total solids (90.493%), total soluble solids (81°Brix), pH (5.967), titrable acidity (0.0087%), ascorbic acid (4.493 mg per 100 g), crude fiber (2.890%), protein (3.973%), fat (9.877%) phenolic compounds (153.253 GAE mg per 100 g), antioxidants (60.6% inhibition activity per 100 g) and flavonoids (15.110 mg per 100 g) which provide numerous health benefits. Fig toffee is also a good source of various macro and micro minerals such

as calcium (235.4 mg per g), Iron (2.945 mg per g), potassium (356.5 mg per g), magnesium (41.93 mg per g), sodium (157.1 mg per g), phosphorus (171.3 mg per g) and sulphur (105.0 mg per g) as given in Table 4. These minerals will help to meet the requirements of these micronutrients in diet which have established implications in various metabolic processes and health benefits.

Texture profile analysis (TPA) of fig toffee

Texture profile analysis of the desirable toffee blend that is containing 30% fig pulp was done using stable micro system texture analyzer TAXT2i and the data was compared with the control that is milk toffee. From the curve data evaluated given in Table 5 and it can be seen that fig toffee has better textural properties that ordinary milk toffee.

Changes in chemical constituents of fig toffee during storage

Various changes during three months can be compared from Table 6 and it was found that pH of the fig toffees ranged from 5.967 to 5.660 which shows that fig toffee is a low acid food product. No significant change in pH was observed during the first month but it decreased significantly during the second and third month. In case of titrable acidity a significant decrease was noticed from 0.087% to 0.045%. The results were found to be in line with Pawar *et al*. (2017); Divya *et al*. (2014) and Nath *et al*. (2005). Total solids decreased significantly from 90.493% to 90.423% and then the trend became non-significant as no change was seen throughout the storage period. The ascorbic acid content decreased significantly during the third month which might be due to light and heat sensitivity, as vitamin C gets lost during thermal processing as well as the oxidation of ascorbic acid to de-hydro ascorbic acid. Loss in ascorbic acid content in guava leather from 176-104 mg/g was observed by Jain and Nema (2007). Similar results have been reported by Divya *et al*. (2014) in sapota candy and Shakoor *et al*. (2015) in guava bar. Crude fibre content showed non-significant decrease because of thermal processing which significantly reduces the crude fiber content.

A significant decrease in the protein content from 3.973% to 3.037% was observed during storage. This decrease might be due to the maillard reaction where protein gets combined with sugar and leads to the formation of melanoidins (brown nitrogenous compound) (Anisa *et al*., 2016). Total carotenoids were found to decrease significantly with increasing storage period. This trend could be due to non-oxidative changes like isomerisation

Table 1: Physico-chemical analysis of various toffee blends.

Parameters	Toffee blends						C.D 5%
	0:100	10:90	20:80	30:70	40:60	50:50	
Total solids (%)	96.650^{a}	95.140^{b}	93.717^{c}	90.500^{d}	87.357^{e}	84.213^{f}	0.240
pH	6.007^{c}	1.983^{f}	3.983^{e}	5.967^{d}	7.980^{b}	9.977^{a}	0.021
Titrable acidity (%)	0.127^{b}	0.026^{f}	0.059^{e}	0.087^{d}	0.112^{c}	0.149^{a}	0.005
Fat (%)	13.844^{a}	12.510^{b}	11.199^{c}	9.877^{d}	8.542^{e}	7.234^{f}	0.052
Protein (%)	4.612^{a}	4.399^{b}	4.186^{c}	3.973^{d}	3.759^{e}	3.546^{f}	0.027
Ascorbic acid (mg per 100 g)	ND	1.460^{e}	2.963^{d}	4.493^{c}	5.327^{b}	7.583^{a}	0.429
Crude fiber (%)	ND	0.907^{e}	1.937^{d}	2.890^{c}	3.813^{b}	4.893^{a}	0.017
Total carotenoids (mg per 100 g)	ND	0.410^{e}	0.797^{d}	1.244^{c}	1.688^{b}	2.111^{a}	0.002
Antioxidants (% inhibition activity per 100 g)	ND	36.6^{e}	52.5^{d}	60.6^{c}	68.6^{b}	85.2^{a}	51.6
Total phenols (GAE mg per 100 g)	ND	49.4^{e}	100.6^{d}	153.2^{c}	204.8^{b}	260.4^{a}	1.5
Total flavonoids (mg per 100 g)	ND	4.990^{e}	11.263^{d}	15.110^{c}	19.593^{b}	27.013^{a}	0.048
Free fatty acids (% oleic acid)	0.045^{a}	0.036^{b}	0.025^{c}	0.020^{d}	0.011^{e}	0.006^{f}	0.001
Peroxide value (meq per kg)	5.173^{a}	4.133^{b}	3.463^{c}	3.090^{d}	1.507^{e}	0.990^{f}	0.031

ND= Not detectable.

All values are mean of three replicates; values with same superscript in a row do not differ significantly.

Table 2: Sensory analysis of various toffee blends.

Parameters	Toffee blends (Figs: Other ingredient mix)						C.D (5%)
	0:100	10:90	20:80	30:70	40:60	50:50	
Appearance	7.300^{b}	7.000^{b}	7.500^{b}	8.400^{a}	7.000^{b}	6.600^{c}	0.943
Colour	7.400^{b}	7.100^{c}	7.100^{c}	8.200^{a}	7.000^{c}	6.900^{c}	0.800
Flavour	7.100^{c}	7.100^{c}	7.400^{b}	8.400^{a}	7.300^{c}	6.700^{c}	0.985
Texture	6.800^{d}	6.600^{e}	7.500^{b}	8.100^{a}	6.900^{c}	6.500^{f}	1.024
Overall acceptability	7.150^{b}	6.975^{b}	7.412^{b}	8.237^{a}	7.062^{b}	6.862^{b}	0.809

All values are mean of three replicates; values with same superscript in a row do not differ significantly ($p<0.05$).

Table 3: Nutritional profile of fig toffee containing 30% fig pulp.

Parameters	Amount
Total solids (%)	90.493
pH	5.967
TSS (°Brix)	81°
Titrable acidity (%)	0.087
Fat (%)	9.877
Protein (%)	3.973
Ascorbic acid (mg per 100 g)	4.493
Crude fiber (%)	2.890
Total carotenoids (mg per 100 g)	1.244
Antioxidants (% inhibition activity)	60.6
Total phenols (GAE mg per 100 g)	153.253
Total flavonoids (mg per 100 g)	15.110
Free fatty acids (% oleic acid)	0.020
Peroxide value (meq per kg)	3.090

Table 4: Mineral composition of fig toffee.

Minerals	Amount
Calcium (mg per 100 g)	235.4
Potassium (mg per 100 g)	356.5
Magnesium (mg per 100 g)	41.93
Iron (mg per 100 g)	2.945
Phosphorus (mg per 100 g)	171.3
Sodium (mg per 100 g)	157.1

Table 5: Parameters of TPA curve.

Parameter	Control	Fig toffee
Hardness (N)	1621.6^{b}	2667.2^{a}
Cohesiveness	0.0642^{a}	0.0689^{a}
Springiness (s)	0.400^{a}	0.407^{a}
Gumminess (N)	104.1^{b}	183.7^{a}
Chewiness (N.s)	41.6^{b}	74.7^{a}

All values are mean of three replicates; values with same superscript in a row do not differ significantly.

of trans-carotenoids to the cis-forms promoted by acids, heat treatment and exposure to light which reduces the color and the vitamin A activity of carotenoids; epoxide formation of thermal degradation or oxidative changes is stimulated by light, heat, some metals, enzymes and peroxides. Similar trend was observed in conformity with papaya toffee by Attri *et al*. (2014). Total flavanoid content was found to decrease significantly during storage. This might be due to oxidation of the compounds. Ramesova *et al*. (2012) reported that naturally occurring flavonoids like quercetin and luteolin when come in contact with atmospheric oxygen become unstable and gets degraded. Flavonoids are also pH and light sensitive and get degraded easily under sunlight and extreme pH conditions (Bohm, 1999).

The trend in antioxidant activity was found to decrease significantly from 60.6% to 40.8%. Similar trend was observed in phenolic compounds where a significant decrease was observed from 153.253 mg to 74.013 mg. The decrease in total phenols during storage might be due to their condensation into brown pigments. Similar observations were recorded by Waskar and Khurdiya (1987) in phalsa beverages. Kim and Zakour (2004) reported that this decrease may be due to destruction of anthocyanins (flavonoids), browning reactions and exposure to light. Zafrilla (2000) also determined the similar trend of decrease in total phenolics and antioxidants.

Effect of storage on sensory evaluation of fig toffee

From Table 7 it can be inferred that the sensory score for appearance of the product decreased significantly from 8.40 to 6.00 during three months of storage while colour scores decreased initially but no significant change was observed during the preceding months. This might be due to the temperature effect on the parameters as well as on surrounding atmosphere. The scores for flavour decreased significantly from 8.40 to 6.50 during three months storage.

Table 6: Effect of storage on constituents of fig toffee.

Parameters	Storage period (months)				CD (5%)
	0	1	2	3	
pH	5.967^{a}	5.967^{a}	5.843^{b}	5.660^{c}	0.025
Titrable acidity %	0.087^{a}	0.072^{b}	0.058^{c}	0.045^{d}	0.001
Total solids %	90.4^{a}	90.4^{b}	90.4^{b}	90.4^{b}	0.042
Ascorbic acid %	4.493^{a}	4.203^{b}	4.183^{b}	4.000^{c}	0.021
Crude fiber %	2.890^{b}	2.850^{b}	2.863^{b}	2.930^{a}	0.057
Fat %	9.877^{a}	9.390^{b}	9.303^{c}	8.887^{d}	0.037
Protein %	3.973^{a}	3.827^{b}	3.557^{c}	3.037^{d}	0.026
Anthocyanin (mg/100 g)	2.592^{a}	2.310^{b}	1.192^{c}	0.962^{d}	0.013
Total carotenoids (mg/100 g)	1.244^{a}	1.030^{b}	0.657^{c}	0.294^{d}	0.003
Antioxidants (% inhibition activity)	60.6^{a}	52.9^{b}	50.8^{c}	40.8^{d}	50.19
Total phenols (mg/100 g)	153.2^{a}	151.9^{b}	111.1^{c}	74.0^{d}	0.237
Total flavonoids (mg/100 g)	15.1^{a}	14.5^{b}	10.1^{c}	8.4^{d}	0.033
Free fatty acids (% oleic acid)	0.020^{d}	0.027^{c}	0.047^{b}	0.055^{a}	0.001
Peroxide value (meq/ kg)	3.090^{d}	3.203^{c}	4.207^{b}	4.587^{a}	0.051

(All values are mean of three replicates; values with same superscript in a row do not differ significantly ($p<0.05$).

Table 7: Effect of storage on sensory evaluation of fig toffee.

Parameters	Storage period (months)				C.D (5%)
	0	1	2	3	
Appearance	8.400[a]	7.300[b]	6.600[c]	6.000[d]	0.453
Colour	8.200[a]	7.600[b]	7.300[b]	6.900[b]	0.626
Flavour	8.400[a]	7.700[b]	7.300[c]	6.500[d]	0.458
Texture	8.100[a]	7.400[b]	7.000[c]	6.200[d]	0.413
Overall acceptability	8.237[a]	7.900[b]	7.250[c]	6.150[d]	0.309

All values are mean of three replicates; values with same superscript in a row do not differ significantly.

A gradual decrease in texture score from 8.10 to 6.20 was observed. This could be due to change in atmospheric conditions (difference in moisture content). Statistical analysis showed a significant decrease in overall acceptability scores of fig toffee. This was due to decreased scores for appearance, colour, flavour and texture. The overall acceptability scores decreased from 8.23 to 6.15. These findings were in accordance with Domale *et al*. (2008) for aonla pulp toffees, Sivakumar *et al*. (2007) for guava toffee and Ingle *et al*. (2016) for sugar free aonla candy.

Conclusion

Toffee blend containing 30% pulp was most acceptable than the other blends. Shelf-life studies for 3 months showed that prepared toffees could be stored well for 90 days at ambient temperature. Trend in the storage stability of the toffees with time could be checked further by carrying out the physico-chemical and organoleptic evaluation of the toffees at monthly intervals. Economics of the toffee revealed that price of fig toffee and milk toffee is approximately same but fig toffee has an advantage over other milk-based toffees that it is nutritionally enhanced and target consumer can derive health benefits like high antioxidant levels, high mineral content and all the necessary nutrients in the same price as that of milk-based toffee.

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Conflict of interest

All authors declare that they have no conflict of interest.

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