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Development of value added fig toffee from fresh fig (*Ficus carica*) fruit

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Abstract
Fig (*Ficus carica* L.) is having a great importance in nutrition as it is a good source of antioxidants along with iron and carbohydrates however, fresh figs are very perishable in nature. In order to reduce the postharvest losses of fresh fig, the present study had been conducted where in fresh fig fruits were processed to obtain dehydrated fig powder and utilized in the formulation of fig toffee. Confectionery products are highly popular among children throughout the world due to their taste and flavor. The toffees were prepared from dehydrated fig powder and skim milk powder at different proportions *viz*. (100:0, 75:25, 50:50, 25:75, 0:100) with sugar, liquid glucose and butter. It was observed that toffees prepared with dehydrated fig powder and skim milk powder at 75:25 ratio were superior compare to other combinations with respect to organoleptic parameters. The proximate composition of fig toffee indicated protein (2.4g/100 g), fat (6.45 g/100 g), Carbohydrate (79.9 g/100 g) and 387 Kcal. The crude fibre content was found to be higher than the control (milk toffee) due to the incorporation of dehydrated fig powder. There was no significant difference for color and flavor throughout the storage period in both types of toffee. Hence, dehydrated fig powder can be utilized in the formulation of confectionary products to upscale the nutritional profile.

Keywords: Fig, dehydrated fig powder, toffee

Introduction
Fruits and vegetables being perishable in nature undergo spoilage at various stages of their harvesting, handling, transport, storage, marketing, processing. The spoilt produce is not fit for marketing and is a virtual loss (Bhatnagar 1991) [4]. Fig (*Ficus carica* L) belonging to the family Moraceae is a deciduous tree popularly known as Anjir in Hindi. Fig is native of Southern Arabia and is grown in most of the countries bordering the Mediterranean climate. Botanically fig is not a fruit but a fleshy receptacle containing numerous flowers (Indura, 2003) [8]. In India fig fruit is considered to be a minor fruit crop and the commercial cultivation of fig is mostly confined to Western parts of Maharashtra, Uttar Pradesh, Gujarat, Karnataka and Tamil Nadu. Maharashtra is the largest producer of fig (7894 million tonnes) with largest area under cultivation (2242 ha) out of total acreages in India (2899 ha) (Anushree *et al*., 2018) [3]. In Karnataka, it is largely cultivated in Bellary, Raichur, Sreerangapatna and Chitradurga districts (Indura, 2003) [8]. Figs have a great importance in nutrition due to being an important source of carbohydrates. They are an excellent source of vitamins, minerals, amino acids and phenolic compounds.
The confectionery products are highly popular among the children throughout the world due to their taste and flavor. Toffee is one of the sugar based product which is largely consumed by the children (Sakhale *et al*., 2012) [14]. The conventional toffees are generally made from sugar, skim milk powder and other synthetic colors and flavors. Fruit toffee is a nutritional product, has the chewy texture and is a good source of dietary fiber and natural sugar. The toffees can be better utilized as a vehicle to promote consumption and utilization of such fruits that have otherwise less market demand and quite limited shelf life (Thanusan *et al.*, 2018) [16]. Based on the nutritional and health benefits of fig fruit in the present investigation, efforts have been made to incorporate the dehydrated fig powder in the development of value added fig toffee from fresh fig fruit".

Material and Methods
The current study was carried out at Department of Food Science and Nutrition, University of agricultural Sciences, GKVK, Bengaluru.

Collection of sample
Fully matured, firm, ripe and healthy fig fruits were procured from the local markets of Bengaluru, Karnataka, India.

Physico-chemical analysis of fresh fig fruit
Physic-chemical characteristics like shape, color, weight, length, diameter, volume, shape index and fullness index, moisture, protein, fat, ash, crude fiber, TSS, TA, TSS: Acid ratio, pH, ascorbic acid were studied in detail. The recorded data was subjected to statistical analysis.

Processing and dehydration
Fig fruits were washed, cleaned and blanched for 3-5 minutes at 87-89 ºC. After blanching fruits were cut into small uniform size pieces and kept for dehydration in tray drier at 60 ºC. The dried fig fruits were ground into powder by using an electric drier and sieved through a 60 mesh size sieve. Then the dehydrated fig powder was packed and stored for further use.

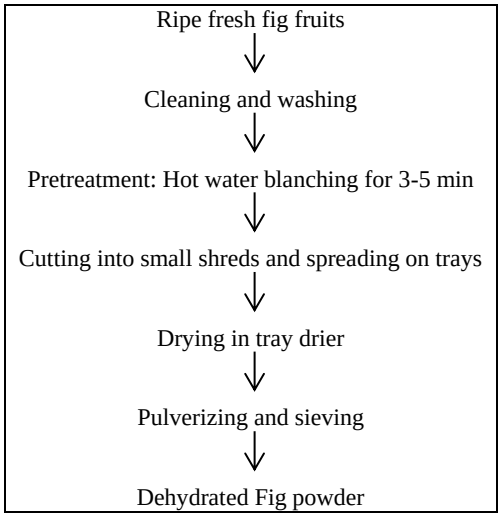

Fig 1: Procedure for the preparation of dehydrated fig powder

Physico-chemical and proximate composition of dehydrated fig fruit powder
Physico-chemical parameters like TSS, pH, TA and ascorbic acid were analyzed. Proximate analysis includes the determination of the major components of food such as moisture, crude protein, crude fat, ash, crude fiber and carbohydrate according to AOAC (2005) methods [2].

Formulation of fig powder enriched toffee
The ingredients like Skim milk powder, sugar, liquid glucose and butter were obtained from local market and used as ingredients for preparation of fig toffee. Four variations of toffees were formulated by substituting dehydrated fig powder with skim milk powder at 25%, 50%, 75% and 100% levels and compared with control. Dehydrated fig powder and skim milk powder were mixed with little amount of water to obtain paste. Other ingredients were added to the mixture and mass was heated in stainless steel container till the TSS content reached 80-82º brix. The heated mass was spread into a thin sheet of 1 to 2 cm thickness in stainless steel plate that was already smeared with butter. The mass was cooled to room temperature and cut into desired size and wrapped in butter paper and stored in metalized polyester polyethylene pouches under ambient condition for 30 days.

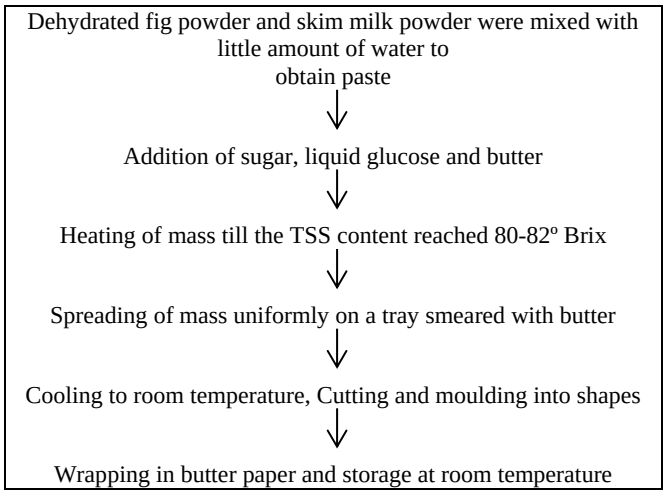

Fig 2: Flowchart for the preparation of fig toffees

Organoleptic evaluation of the developed fig toffee
The developed toffees were subjected to sensory evaluation of various sensory parameters like appearance, color, texture, taste, flavor and overall acceptability by a panel of 21 semi-trained members on a 9-point Hedonic scale (Amerine *et al*., 1965) [1].

Proximate analysis of fresh fig toffee
Best accepted toffee along with control (milk toffee) was analyzed for moisture, protein, fat, ash and crude fiber content according to the standard methods of AOAC (2005) [2].

Shelf-life study of best accepted fig toffee
Among all the four variations, the best accepted fig toffee (FTF3) and control milk toffee (MTF) were enclosed with butter paper and packed in metallized polyester polyethylene pouches and kept for shelf-life study under room temperature (33 ± 2 ºC). The samples were evaluated for variations in moisture content, sensory properties and microbial profile up to 30 days at an interval of 15 days (Tate, 1995) [15].

Statistical analysis
The data were subjected to analysis of variance (ANOVA) for testing the significance of variance by using the statistics, software Statistical Package for Social Sciences (SPSS) version 12.0 (Sabine and Brian, 2004) [13].

Results and Discussion
Physico-chemical composition of fresh fig fruit
Results shows that the exterior color of fig fruit was reddish green, whereas the interior flesh was found to be pinkish in color with pear shape. The results seem to agree with the results reported by Gawade and Waskar (2005) [7].
As per the observations recorded average weight, length, diameter and volume of fruits were found to be 30.94 g, 4.42 cm, 3.9 cm and 32.98 ml respectively. The shape index, fullness index and percent waste of fruit was 1.13, 7.93 and 2.85. These values seem to agree with values reported by Mhalaskar and Satwadhar (2016) [11] who reported that average weight, length, diameter, volume, shape index, fullness index and percent waste of fig fruit (*Var* Dinakar) were 27.27 g, 3.9 cm, 3.97 cm, 28.9 ml, 0.98, 6.86 and 3 percent respectively.

Table 1: Physico-chemical composition of fresh fig fruit

Parameters	Value
Shape	Pear shape
Color (a) External (b) Flesh	 Reddish green Pinkish
Average weight (g)	30.94
Average length (cm)	4.42
Average diameter (cm)	3.90
Average volume (ml)	32.98
Shape index of fruit	1.13
Fullness index of fruit	7.93
Waste%	2.85
Moisture (%)	81.53
Protein (g/100 g)	1.40
Fat (g/100 g)	0.28
Ash (g/100 g)	1.24
Crude fiber (g/100 g)	0.99
Total soluble solids (ºBx)	17.64
TA (%)	0.21
TSS: Acid ratio	84.00
pH	5.01
Ascorbic acid(mg/100 g)	15.28

The results from present study indicate that fresh fig fruits contain 81.53 percent moisture on fresh weight basis. The protein, fat, ash and crude fiber content of fresh fig fruits were 1.40, 0.28, 1.24 and 0.99 g per 100 g respectively.

Fresh fig fruit had 17.64ºBx TSS and 15.28 mg ascorbic acid. The fig fruit was found to be acidic and recorded value for acidity was 0.21 against the pH value of 5.01. TSS: Acid ratio is used as an index of fruit quality since the perceived sweetness of ripened fruits depends on it. Fresh fruits had TSS: Acid ratio of 84. Similar observations with respect to chemical parameters of Brown Turkey fig fruits were reported by Kaul (2017) [9]. Results revealed that fig fruits had 80.70 percent moisture, 2.48 percent protein, 0.62 percent fat, 9.03 percent crude fiber, 17ºBx TSS, 0.29 percent TA, 58.6 TSS: Acid ratio, 5 mg ascorbic acid.

Physico-chemical and proximate composition of dehydrated fig fruit powder

The Results shows that dehydrated fig powder contains 36º Brix TSS (Total Soluble Solids), 5.34 pH. Acidity of dried fig fruit powder as citric acid content was found to be 0.55 percent Ascorbic acid content decreased significantly by drying process. Ascorbic acid content of dehydrated fig powder was 4 mg. Similar findings were obtained by Piga *et al.* (2004) [12] for dehydrated fig (*Ficus carica* L.) fruits treated with blanching and sulphitation. The results showed that dehydrated fig fruits pretreated with blanching had 4.87 pH, 0.66 percent titrable acidity and 3.24 mg per 100 g ascorbic acid.

From proximate analysis it was found that dehydrated fig fruit powder has 10.2 percent moisture, 74.73 g carbohydrate, 3.67 g protein, 1.34 g fat, 3.78 g ash, 5.28 g crude fibre and 325 Kcal energy. The nutritional profiling of the dehydrated fig fruit powder indicates that it is a good source of carbohydrates. It has average protein and dietary fiber content with very low amount of fat.

Similar proximate composition was obtained by Verma and Gupta (2015) [17] who reported that oven dried fig fruit powder had 68.33% carbohydrates, 0.14% fat, 8.48% protein, 8.8% moisture, 4.44% ash and 302 Kcal energy.

Table 2: Physico-chemical and proximate composition of dehydrated fig fruit powder

Parameters	value
TSS(ºBrix)	36.00
pH	5.34
TA (% Citric acid)	0.55
Ascorbic acid (mg/100 g)	4.00
Moisture (%)	10.2
Carbohydrate (g/100 g)	74.73
Protein (g/100 g)	3.67
Fat(g/100 g)	1.34
Ash (g/100 g)	3.78
Crude fibre(g/100 g)	5.28
Energy (Kcal)	325

Standardization of ingredient levels for preparation of toffees: Four variations of toffees containing different levels of dehydrated fig powder were developed. Dehydrated fig powder was substituted in toffee at 25%, 50%, 75% and 100% level. Toffee prepared without dehydrated fig powder was considered as control. The toffee prepared using 75% dehydrated fig powder (FTF 3) was found superior than other combinations (Table 4).

Table 3: Ingredient composition of different variations of fig toffee

Ingredients (g/100 g)	MTF (Control)	FTF 1	FTF 2	FTF 3	FTF 4
Skim milk powder	20	15	10	5	-
Fig powder	-	5	10	15	20
Sugar	50	50	50	50	50
Liquid glucose	25	25	25	25	25
Butter	5	5	5	5	5

*MTF- Milk toffee (Control), FTF1- Fig toffee 1, FTF2- Fig toffee 2, FTF3- Fig toffee 3, FTF4- Fig toffee 4

Sensory evaluation of fig toffee

Sensory evaluation of toffees were carried out by 21 semi-trained panelists on a nine point hedonic scale. Sensory attributes like appearance, color, texture, taste, flavor and overall acceptability were scored based on its intensity scaled. The toffee prepared from a blend of dehydrated fig powder

and skim milk powder at 75:25 ratio resulted in highest score in all the sensory quality parameters followed by a blend of 50:50. The scores for color and appearance of toffees ranged from 7.90 to 8.64 and 7.52 to 8.59 respectively. Incorporation of dehydrated fig powder changed the color of toffee from whitish to dark brown which was more appealing than control. The texture scores for toffees ranged from 6.47 to 8.23 incorporation of dehydrated fig powder at higher levels in toffees resulted in decreased scores for texture. Flavor scores for toffee ranged from 7.61 to 8.09. Mean scores for flavor increased with higher levels of dehydrated fig powder in toffee. Taste scores for toffees ranged from 7.69 to 8.09. Toffee formulated with 75:25 blend of dehydrated fig powder and skim milk powder scored highest score for taste compare to other blends. Higher levels of dehydrated fig powder in 75:25 blend might be responsible for giving good taste scores to the toffee. There were significant differences among the treatments for overall acceptability. The toffee of treatment 75:25 blend scored maximum for overall acceptability. Scores for overall acceptability ranged from 6.92 to 8.26. Variations in the scores might be due to better color, appearance, texture, flavor, taste and combination of mixed toffee formulated from dehydrated fig powder and skim milk powder. The difference in all sensory characteristics among the variations was found to be statistically significant at 5 percent level of significance (p<0.05). The results of the present study were in par with the study conducted by Sakhale *et al*. (2012) [14] who prepared mixed fruit toffee from fig and mango pulp at different proportions *viz*.,(100:0, 80:20, 60:40, 40:60, 20:80 and 0:100) with sugar, liquid glucose, hydrogenated fat and khoa. Sensory results revealed that the toffee prepared by blending fig and mango pulp at 80:20 proportions was superior with respect to all organoleptic quality parameters than control.

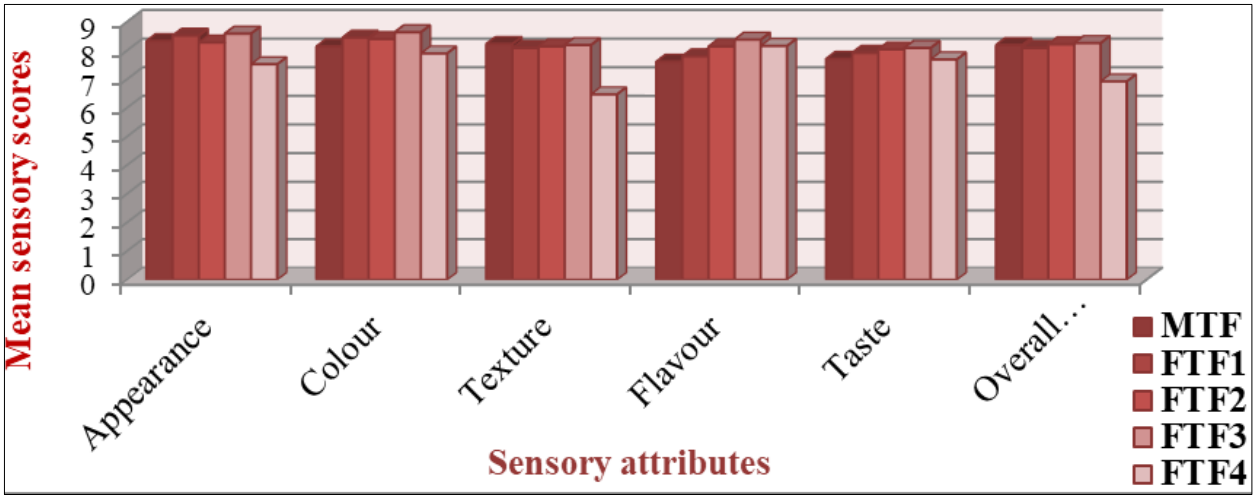

Fig 3: Sensory scores of fig toffee

Proximate composition of best accepted fig toffee (per 100 g) *

The moisture content of control and best accepted fig toffee was 8.81 and 9.44 percent, respectively. Incorporation of dehydrated fig powder might be responsible for increased moisture content in fig toffee than control. Protein content of control toffee (3.69 g) was higher compared to fig toffee (2.40 g). higher levels of protein in control toffee indicates presence of higher levels of skim milk powder than to fig toffee where skim milk powder is replaced by dehydrated fig powder at 75 percent level. Fat content of fig toffee was lower compared to control toffee. Fat content of control and fig toffee was 7.5 g and 6.4 g respectively. Replacement of skim milk powder with dehydrated fig powder might be the reason for decreased fat content in fig toffee. Ash content of both control and fig toffee was 0.73 g and 0.61 g respectively. Compared to control toffee with no crude fibre content fig toffee contains 1.16 g crude fibre. Incorporation of dehydrated fig powder in toffee is the main reason for increased crude fibre content of fig toffee. Carbohydrate content of control and fig toffee was 79.26 g and 79.91 g respectively. Energy value for control toffee (399 Kcal) was higher compared to fig toffee (387 Kcal).

Table 4: Proximate composition of control and best accepted fig toffee

Nutrients	MTF (Control)	FTF3	T test
Moisture (%)	8.8	9.4	3.05^{NS}
Protein (g)	3.7	2.4	9.87*
Fat (g)	7.5	6.4	2.22^{NS}
Ash (g)	0.7	0.6	3.04^{NS}
Crude fiber (g)	-	1.2	27.54*
Carbohydrate (g)	79	80	1.14^{NS}
Energy (g)	399	387	4.70^{NS}

#Best accepted ** highly significant@1% *significant@5% NS-non significant MTF-Milk toffee FTF3-Fig toffee (75%)

The results of the present study were at par with Khapre *et al*. (2011) [10] who reported that fig toffee contains 15.55 percent moisture, 4.1 percent ash, 8.93 percent protein, 9.1 percent fat and 4.3 percent dietary fiber. Similar results were observed with the study conducted by Kaul (2017) [9] and the results showed that that fig toffee had 9.87 percent fat, 3.97 percent protein, 1.77 percent ash, 2.89 percent crude fiber.

Changes in sensory profile of toffee on storage

Significant decrease in mean sensory scores for appearance 8.47 to 7.26 and 8.66 to 7.59 with respect to control and fig toffee was observed. While scores for color showed no significant difference in control and fig toffee throughout the storage period. Scores for texture decreased gradually in both control and fig toffee throughout the storage period from 8.11 to 5.76 and 8.16 to 5.80 respectively. The decreased rate of texture scores was faster in both control and fig toffee. This is due to the temperature effect during storage conditions. No significant differences were observed for flavor scores in both control and fog toffee throughout the storage period. There was a decrease in taste scores for both control and fig toffee from 7.54 to 6.57 and 7.54 to 7.00, respectively. A gradual decrease in overall acceptability scores was observed in both control and fig toffee from 8.19 to 5.90 and 8.19 to 5.90 respectively at the end of 30 days of storage period. Effect of temperature and surrounding conditions during storage period might be responsible for decreased overall acceptability scores of both control and fig toffee.

Table 5: Effect of storage on sensory quality of fig toffee

Products	Duration	Appearance	Color	Texture	Flavor	Taste	Overall acceptability
MTF (Control)	Initial	8.47	8.14	8.11	7.80	7.54	8.19
	15th day	7.97	8.07	7.02	7.76	7.21	7.28
	30th day	7.26	8.02	5.76	7.71	6.57	5.90
	F value	*	NS	*	NS	*	*
	SEm±	0.171	0.208	0.120	0.176	0.141	0.149
	CD@5%	0.343	-	0.241	-	0.282	0.299
FTF3	Initial	8.66	8.28	8.16	7.80	7.54	8.19
	15th day	8.09	8.23	7.02	7.76	7.14	7.28
	30th day	7.59	8.16	5.80	7.73	7	5.90
	F value	*	NS	*	NS	*	*
	SEm±	0.171	0.169	0.137	0.189	0.172	0.149
	CD@5%	0.343	-	0.274	-	0.346	0.299

Best accepted NS- Non significant and *- Significant at 5% level FTF3-Fig toffee (75%)

Similar results were observed with the study conducted by Chavan *et al*. (2015) [6] who studied the effect of storage period on sensory profile of guava-strawberry mixed toffee and the results showed a gradual decrease in the mean scores of appearance (8.1 to 7.7), flavor (8.05 to 7.48), texture (8.0 to 7.6), taste (8.1 to 7.6) and overall acceptability (8.1 to 7.7) of guava-strawberry mixed toffee throughout the storage period. The results of the present study were also at par with the study conducted by Kaul (2017) [9] where he reported a gradual decrease in appearance (8.4 to 6), color (8.2 to 6.9), flavor (8.4 to 6.5), texture (8.1 to 6.2) and overall acceptability (8.23 to 6.25) of fig toffee throughout the storage period.

Changes in moisture content of toffee during storage

Decrease in moisture content of toffee was observed throughout the storage period. Moisture content of control was 8.78% initially and 8.12%, 7.75% on 15th and 30th day. Moisture content of fig toffee was 9.63% and it decreased to 8.04%. The rate of loss of moisture was rapid due to ariation in temperature in storage condition (Fig 4).

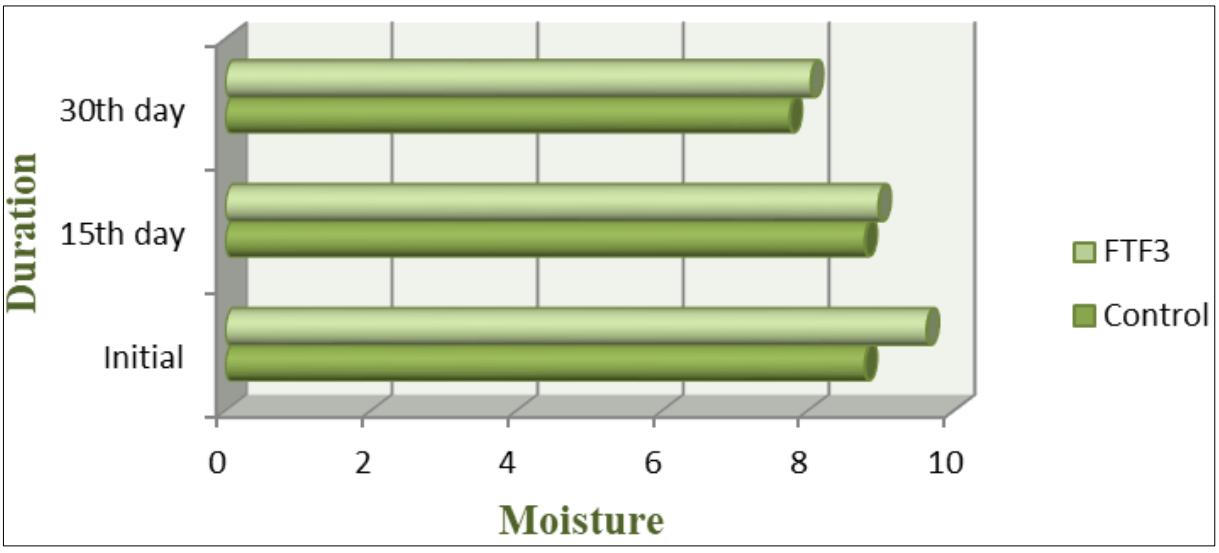

Fig 4: Effect of storage on moisture content of best accepted fig toffee

Microbial profile of fig toffee during storage:

Microbial profile was analyzed on initial, 15th and 30th day. At initial days no microbial growth was observed for both control and fig toffee. Bacterial population of 2×10^1 CFU/ g in control and 3×10^1 CFU/ g in fig toffee was observed on 30th day. Mould counts were observed after 15 days of storage and it was found to be 3×10^1 CFU/ g in control and 5×10^1 CFU/ g in fig toffee. There were no coliforms colonies reported till 30 days of storage in both control and fig toffee (Table 4).

Table 7: Effect of storage on microbial profile of fig toffee

Products	Duration	Bacteria (× 10^1 CFU/ g)	Moulds (× 10^1 CFU/ g)	Coliforms (× 10^1 CFU/ g)
Control	Initial	ND	ND	ND
	15th day	ND	ND	ND
	30th day	2	3	ND
	F value	*	*	NS
	SEm±	0.00	0.00	0.00
	CD@5%	-	-	-
FTF3	Initial	ND	ND	ND
	15th day	ND	ND	ND
	30th day	3	5	ND
	F value	*	*	NS
	SEm±	0.00	0.00	0.00
	CD@5%	-	-	-

NS- Non significant and *- Significant at 5% level FTF3-Fig toffee (75%).

Conclusion

It can be concluded from the results that the incorporation of dehydrated fig powder can improve the nutritional and sensory quality of toffee and also adds variety to the product. The formulated toffees were found to be acceptable in both sensory and nutritional quality even after 30 days of storage period. Thus toffee formulated from dehydrated fig powder was found to be a best novel product providing good nutritional profile with high fibre and less calories compared to the conventional toffee. Also the study addresses an option to preserve the fresh fig fruits thereby reducing the postharvest losses.

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