Anti-oxidative, physico-chemical and sensory attributes of *burfi* affected by incorporation of different herbs and its comparison with synthetic anti-oxidant (BHA)

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Abstract Six different herbs, viz., turmeric, ginger, clove, curry leaves, basil leaves and small cardamom, were incorporated (@1% of *khoa*) into *burfi*, a heat desiccated-sweetened milk product, for their ability to act as natural anti-oxidant and were compared against butylated hydroxyanisole (BHA). Anti-oxidative potential of *burfi* significantly increased with herbs incorporation, which was in the order of clove > turmeric > basil leaves > curry leaf > ginger > cardamom. However, it was lower when compared to BHA added samples. Gross compositional attributes of *burfi* remained unaffected upon herb incorporation, however, significant lowering in water activity was observed upon cardamom and clove addition. Hunter color analysis revealed that cloves decreased lightness and increased redness, turmeric increased yellowness, and basil and curry leaves increased greenness in *burfi*. Texture attributes viz., hardness, springiness and gumminess were significantly higher for clove and cardamom *burfi*. Sensory evaluation revealed that among the different herbs, cardamom is highly preferred in *burfi* followed by ginger, turmeric, clove, curry leaves and basil leaves. However, no significant difference in sensory attributes were observed between control, cardamom and BHA added *burfi* samples.

Keywords Herbs · *Burfi* · Anti-oxidative activity · TPA · Sensory evaluation

Introduction

Plants have been used since ancient times to cure diseases and improve human health. Irrespective of ancient origin, medicinal plants still form the basis of traditional health-care systems. Phytochemicals are described as chemicals from plant origin which confers health benefits, but are not included in essential nutrients as like carbohydrates, proteins and fats (Taher et al. 2017). Chemically, polyphenols are compounds having large number of phenol structural units. The number and characteristics of these phenol structures forms the basis for their unique physical, chemical, and biological properties (Quideau et al. 2011).

Burfi, a sweetened dairy dessert prepared by atmospheric moisture removal from milk to semi-solid consistency, is reported to contain 20% (weight basis) of fat of which around 60% exist as free form (Palit and Pal 2005). Prabha (2006) reported lipid oxidation in *burfi* led to fatty acids degradation which reduced its sensory attributes to unacceptable levels. Patel et al. (2013) reported lipid oxidation can adversely affect the nutritional value, sensory quality and shelf life of foods.

Heat desiccation of milk imparts desirable sensorial characteristics in *burfi* (Aneja et al. 2002) but, the effect of heat on herbs' anti-oxidant activity is rather contradictory. Khatun et al. (2006) reported an increase in total phenolic content and subsequent anti-oxidant activity of herbs after heat processing. Goswami et al. (2013) suggested a reasonable heat treatment could increase the solubility of active components by decomposition of cell wall and penetration of solvent into the cell. Shobana and Naidu

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(2000) reported bound anti-oxidants might be released due to heat treatment, resulting in higher anti-oxidant activity of thermally processed spices. On the other hand contrary results were obtained for milk or for milk based components as a vehicle for herbs utilization. Takamura et al. (2002) reported decrease in the radical scavenging activity of curry leaves as it was heated with butter.

All these literature suggests increasing utilization of herbs into different food systems but their incorporation into sweetened heat desiccated milk based system (e.g., *burfi*) has not been reported so far. Their incorporation into *burfi* seems to provide information about efficacy of herbs as anti-oxidative ingredients in sweetened-concentrated milk based products. Thus, the present work was undertaken with the objective to evaluate the effect of incorporation of various commonly used herbs viz., turmeric, ginger, clove, curry leaves, basil leaves and cardamom on various physicochemical and sensorial attributes of *burfi* and comparing it with that of control and BHA added samples, followed by selection of the most suitable herb.

Materials and methods

Ingredients and chemicals

Fresh buffalo milk was procured from Experimental Dairy of ICAR-National Dairy Research Institute, Karnal, India. Spray dried skimmed milk powder, procured from M/s Modern Dairies Ltd. (Karnal), was used for standardization of milk. Different herbs were procured from local market. All the chemicals were purchased from M/s Hi-Media (P) Ltd., (Mumbai).

Preparation of *burfi*

Burfi was prepared using the standard batch method prescribed by Aneja et al. (2002) with certain modifications. Ground sugar (@30% of *khoa*), mixed with individual herb was added during the final stages of thermal desiccation of milk. The herbs were added @1% of *khoa* because beyond this level the sensorial attributes of the product particularly the flavor was adversely affected. Control *burfi* was not added with any herb or anti-oxidant, while BHA was added @200 ppm of *khoa*.

Total phenolic content

Total phenolic content of different *burfi* samples was analyzed by Folin Ciocalteu's method provided by Zhang et al. (2006) with minor modifications. Twenty microlitre of appropriately diluted sample was taken in a test tube.

100 μ L of diluted Folin–Ciocalteu's reagent was mixed to it. After 3 min, 80 μ L of 20% sodium carbonate solution was added. The mixture was kept undisturbed for 20 min. For blank preparation, 20 μ L of distilled water was taken instead of sample. The absorbance of blank and samples were recorded at 730 nm. Total phenol content of sample was calculated using equation of standard curve and the results are expressed as μ g gallic acid equivalent (GAE) per gram of *burfi*.

Free radical scavenging activity

DPPH (2,2 Diphenyl-1-picryl hydrazyl) free radical scavenging activity in herbal *burfi* was evaluated by the method of Brand-Williams et al. (1995). Methanolic extract (0.1 mL) of herbal *burfi* was mixed with 2.9 mL of 0.1 mM methanolic DPPH solution. Control was prepared by mixing 0.1 mL of methanol with 2.9 mL of 0.1 mM methanolic DPPH solution and methanol was used as blank. The samples were kept in the dark room for 30 min after which absorbance was recorded at 517 nm.

ABTS [2,2'-azinobis (3 ethyl benzothiazoline)-6-sulfonic acid] free radical scavenging activity in herbal *burfi* was evaluated by the method of Re et al. (1999). Methanolic extract (1 mL) of herbal *burfi* was mixed with 3 mL ABTS working solution. Control was prepared by mixing 1 mL of methanol with 3 mL of DPPH solution and methanol was used as blank. The samples were kept in the dark room for 7 min after which absorbance was recorded at 734 nm.

ABTS and DPPH free radical scavenging activity was computed using the following formula.

$$\begin{aligned} \% \text{ Free radical scavenging activity} \\ = \frac{(\text{Control absorbance} - \text{Sample absorbance}) \times 100}{\text{Blank absorbance}} \end{aligned}$$

Composition

Proximate composition of different *burfi* samples was evaluated in terms of moisture content (IS: SP-18 1981), fat content (IS: SP-18 1981), protein content (Menefee and Overman 1940), total ash (AOAC 1995) and titratable acidity (AOAC 1975).

Colour and texture analysis

Colour measurements were conducted using Color Flex (M/s Hunter Associates Laboratory, Inc., Reston VA, USA) color measurement system equipped with dual beam xenon flash lamp and universal software. Textural attributes of *burfi* samples were obtained using TA-XT2i

Texture Analyzer (M/s Stable Micro Systems, UK) equipped with 5 kg load cell. Water activity in the samples was determined using Aqua Lab (Model Series 3TE) water activity-meter supplied by M/s Decagon Devices, USA.

Sensory evaluation

Herbal *burfi* samples prepared during the course of investigation was sensorially evaluated using a 9-point hedonic scale by a panel of trained judges selected from Faculty of Dairy Technology Division.

Statistical analysis

Data obtained from various experiments was recorded as mean $\pm$ standard error (SE). Data obtained was statistically analyzed using one way analysis of variance (ANOVA) followed by Tukey's comparison test to establish the significance of differences among the mean values at 5% level of significance ($p < 0.05$) using SPSS software of M/s IBM Corporation. Dendrogram was used for selection of herb.

Results and discussion

Effect of herb incorporation on anti-oxidant capacity of *burfi*

Total phenolic content (TPC) of *burfi* incorporated with turmeric was 0.725 (μg GAE/g), with cardamom was 0.552 (μg GAE/g), with ginger was 0.643 (μg GAE/g), with curry leaf was 0.630 (μg GAE/g), with cloves was 1.562 (μg GAE/g) and with basil leaves was 0.658 (μg GAE/g). ABTS and DPPH free radical reducing capacity of *burfi* incorporated with turmeric was 55.51 and 19.90%, with cardamom was 11.87 and 5.90%, with ginger was 16.98 and 7.63%, with curry leaf was 19.96 and 7.78%, with cloves was 89.34 and 21.79% and with basil leaves was 47.70 and 17.81%, respectively (Table 1). All the samples added with herbs had significantly ($p < 0.05$) higher anti-oxidative activity than that from control *burfi*, which could be attributed to polyphenolic compounds contributed by these herbs. There are many reports which emphasize direct relation between phenolic content and anti-oxidative activity due to the presence of hydroxyl groups in their chemical structure (Tawaha et al. 2007). Various scholars working on similar herbs employed in present study have reported presence of different polyphenols. Eugenol, acetyleugenol and humulenes have been reported in cloves;

6-gingerol and shagols in ginger; cyclomahanimbine, tetrahydromahanimbine, 3-carene and caryophyllene in curry leaves; p-coumaric acid, protocatechuic acid, 1,8-cineol and α -terpineol acetate in cardamom; curcumin (diferuloyl methane) in turmeric (Parthasarathy et al. 2008) and apigenin, eugenol and thymol in basil (Sharafati et al. 2015).

Further, it was also observed that even though no herb or polyphenolic substrate was added to *khoa* for control *burfi* preparation, yet it showed some extent of anti-oxidative activity, viz., TPC of 0.408 (μg GAE/g), ABTS and DPPH free radical inhibition of 10.83 and 10.83%, respectively. This could be associated with free sulphahydral groups and Maillard browning products which were formed during thermal desiccation of milk. Gélinas and McKinnon (2006) reported Maillard reaction products could react with the Folin-Ciocalteu reagent and contribute to TPC. Similarly, Oh et al. (2013) reported Maillard browning products have ABTS and DPPH free radical reducing activity.

Upon comparison of different herbs in increasing anti-oxidative activity in *burfi*, clove was found to have highest anti-oxidant activity and the least was obtained for cardamom, but all these herbal *burfi* samples had anti-oxidant activity lower ($p < 0.05$) than that of synthetic anti-oxidant (BHA) added *burfi*. Although, basil leaves, ginger and curry leaf showed no significant difference ($p < 0.05$) in terms of TPC, but significant ($p < 0.05$) difference in their free radical reducing activity was observed. Total phenolic content in herbal *burfi* was found to be in the order of clove > turmeric > basil leaves $\sim$ ginger $\sim$ curry leaf > cardamom. Free radical (ABTS) reducing activity was found to be in the order of clove > turmeric > basil leaves > curry leaf > ginger > cardamom, while (DPPH) free radical reducing activity was found in the order of clove > turmeric > basil leaves > curry leaf $\sim$ ginger > cardamom (Table 1). Przygodzka et al. (2014) classified clove as high anti-oxidant capacity (AC) herb, and ginger cardamom as low AC herb. Embuscado (2015) classified herbs based on their decreasing TPC content in the order of: cloves > basil > turmeric > ginger > cardamom. Goswami et al. (2013) reported the order of effectiveness of spices in inhibiting free radicals as: turmeric > clove > ginger > cardamom > coriander. Khatun et al. (2006) observed that clove showed the highest DPPH free radical scavenging activity, followed by allspice, ginger, coriander, turmeric and cardamom. Bandyopadhyay et al. (2007) reported ABTS free radical reducing activity of herb incorporated *sandesh* decreased in the order of TBHQ > turmeric $\sim$ curry leaf.

Results obtained were in partial agreement with the above reported works and the differences from other

Table 1 Effect of addition of herb (@1% of *khoa*) on anti-oxidative and compositional parameters of *burfi*

Parameters	Herbal <i>burfi</i>			BHA (@200 ppm)		
	Control <i>burfi</i>	Turmeric	Cardamom	Ginger	Curry leaf	Basil leaf
TPC (μg GAE/g)	0.408 $\pm$ 0.061 ^a	0.725 $\pm$ 0.047 ^b	0.552 $\pm$ 0.050 ^c	0.643 $\pm$ 0.059 ^d	0.630 $\pm$ 0.065 ^d	0.658 $\pm$ 0.046 ^d
ABTS activity#	10.83 $\pm$ 0.21 ^a	55.51 $\pm$ 0.53 ^b	11.87 $\pm$ 0.88 ^c	16.98 $\pm$ 0.31 ^d	19.96 $\pm$ 0.29 ^e	47.70 $\pm$ 0.57 ^e
DPPH activity#	4.33 $\pm$ 0.11 ^a	19.90 $\pm$ 0.20 ^b	5.90 $\pm$ 0.53 ^c	7.63 $\pm$ 0.28 ^d	7.78 $\pm$ 0.43 ^d	17.81 $\pm$ 0.48 ^f
Moisture content (% w/w)	14.68 $\pm$ 0.78	14.38 $\pm$ 0.45	14.35 $\pm$ 0.83	14.72 $\pm$ 0.85	14.56 $\pm$ 0.73	14.53 $\pm$ 0.51
Fat (% w/w)	19.85 $\pm$ 0.52	19.95 $\pm$ 0.65	19.82 $\pm$ 0.70	19.70 $\pm$ 0.45	19.79 $\pm$ 0.62	19.82 $\pm$ 0.63
Protein (% w/w)	13.88 $\pm$ 0.65	14.05 $\pm$ 0.72	14.05 $\pm$ 0.63	14.04 $\pm$ 0.81	14.01 $\pm$ 0.75	13.88 $\pm$ 0.61
Ash (% w/w)	2.95 $\pm$ 0.22	3.02 $\pm$ 0.17	3.01 $\pm$ 0.21	2.99 $\pm$ 0.16	3.02 $\pm$ 0.14	2.95 $\pm$ 0.15
Acidity (%lactic acid)	0.23 $\pm$ 0.02	0.23 $\pm$ 0.02	0.23 $\pm$ 0.03	0.22 $\pm$ 0.03	0.22 $\pm$ 0.02	0.24 $\pm$ 0.03

(ABTS, DPPH activity) = % inhibition of free radicals

Values are mean $\pm$ standard deviation ($n = 3$)Means with different superscripts within a row differ significantly ($p < 0.05$)

studies could be due to differences in the materials utilized viz., utilization of different form of herb, different solvents used and plausibly due to the natural variation in herbs by difference in the location where these herbs were grown, etc.

Effect of herb on hunter color values of *burfi*

Hunter color values of herb incorporated *burfi* are presented in Fig. 1. The L^* (lightness) values for different *burfi* samples were 65.87 for turmeric, 55.36 for cardamom, 67.19 for ginger, 52.99 for curry leaf, 50.62 for cloves and 50.55 for basil leaves. The a^* values were 3.88 for turmeric, 3.94 for cardamom, 4.26 for ginger, -1.10 for curry leaf, 6.06 for cloves and -1.15 for basil leaves added samples. The b^* values were 38.84 for turmeric, 22.68 for cardamom, 27.16 for ginger, 29.54 for curry leaf, 25.99 for cloves and 30.33 for basil leaves added samples. It was observed that with incorporation of different herbs, the hunter color values varied significantly ($p < 0.05$) from one another and from control *burfi*, which could be attributed to the pigments imparted by these herbs into *burfi*. Yellow color of turmeric is due to the presence of curcuminoids viz., curcumin, demethoxycurcumin and bis-demethoxycurcumin (Anandaraj and Sudharshan 2011) and that of ginger is due to curcumin, demethoxycurcumin, and 6-dehydrogingerdione (Balestra et al. 2011). Less intensity of yellowness in ginger as compared to turmeric is attributes to 6-dehydrogingerdione, which contains only a single aromatic ring forming conjugated double bond in the molecule (Parthasarathy et al. 2008). Green color of curry leaves (Parthasarathy et al. 2008) and basil leaves (Kopsell et al. 2005) is primarily due to the presence of chlorophyll in them. Parthasarathy et al. (2008) reported eugenin, eugenitin, iso-eugenetin and iso-eugenitol as the prime pigments in clove, while cyanidin 3-glucoside and cyaniding-3,5-diglucoside in cardamom.

Scholars working on herb incorporation in food products have reported similar results. Lim et al. (2011) replaced wheat flour with turmeric powder to utilize bread as a carrier of phytochemicals from turmeric. The authors reported increasing levels of turmeric resulted in lower L^* value and higher a^* and b^* values in bread. Bandyopadhyay et al. (2007) reported herbs incorporation in *sandesh* led to the color shift towards the respective herb, such as turmeric incorporation resulted into yellow coloured *sandesh* and curry leaves led to dark green coloured *sandesh*. Balestra et al. (2011) reported increasing ginger powder incorporation into bread significantly reduced the lightness (L^*) and hue angle and increased chroma value.

Fig. 1 Hunter color values of *burfi* samples. Values are mean $\pm$ standard error ($n = 3$). Values with different superscript for same parameter differ significantly ($p < 0.05$)

Effect of incorporation of herbs on compositional attributes of *burfi*

Results obtained for various compositional analysis of *burfi* samples are presented in Table 1. Moisture content in *burfi* ranged from 14.22 to 14.72%, fat content from 19.70 to 20.01%, protein content from 13.88 to 14.05%, ash content from 2.95 to 3.09% and titratable acidity from 0.22 to 0.24% lactic acid for *burfi* added with different herbs. Upon analysis of variance of obtained means for different compositional parameters, it was found that no significant ($p > 0.05$) difference exists between the control, BHA and different herbs added samples. No significant ($p > 0.05$) difference in chemical characteristics among *burfi* samples was observed which could be due to small amount of herb application. Sivakumar et al. (2014) reported 0.5% of betel leaves incorporation into *khoa* did not result into any significant change in compositional parameters, which the authors ascribed to addition of small quantity of betel leaves. Similarly, Lim et al. (2011) reported similar results for turmeric added bread.

Effect of herb on instrumental textural attributes of *burfi*

Instrumentally measured textural parameters and water activity of different *burfi* samples are presented in Table 2. Hardness value in *burfi* ranged from 39.59 to 43.67 N, adhesiveness from (−)2.77 to (−)2.93 Ns, springiness (mm) 0.11 to 0.14, cohesiveness from 0.12 to 0.14, gumminess from 4.92 to 6.11 and chewiness from 0.66 to 0.74. It was observed that herb or synthetic anti-oxidant incorporation did not result into significant ($p > 0.05$) modification in adhesiveness, cohesiveness and chewiness, while hardness, springiness and gumminess differed significantly ($p < 0.05$) for samples added with clove and cardamom, in comparison to other *burfi* samples. Water activity in *burfi*

samples ranges from 0.742 to 0.754. Significant ($p < 0.05$) difference was observed in water activity of samples added with herbs in comparison to control or BHA added samples. The observed trend could have been primarily due to fiber imparted by these herbs (Parthasarathy et al. 2008; Anandaraj and Sudharshan 2011). Balestra et al. (2011) reported increased elasticity and hardness in bread dough with incorporation of ginger powder due to increased cross-linking in dough with the presence of ginger powder. Lim et al. (2011) reported increased hardness of cake when turmeric powder was incorporated into it. Foda et al. (2007) reported decreased whey syneresis and increased firmness of yoghurt when added with turmeric.

Effect of herb on sensory attributes of *burfi*

Burfi obtained with incorporation of 1% herb (on *khoa* basis) were presented to the panelist for evaluation of sensory attributes. The samples were evaluated on 9-points hedonic scale rating for four sensorial attributes, viz., flavour, color and appearance, body and texture, and overall acceptability. The results obtained by sensory evaluation of herb incorporated *burfi* are presented in Fig. 2.

Effect of herb on flavour scores of *burfi*

It was observed that different herbs were liked differently by the panelist, as it could be seen that the lowest flavor score of 5.20 was obtained for basil leaves incorporated *burfi*, while highest score was obtained by cardamom added *burfi* (7.50), which was significantly ($p > 0.05$) not different from the control sample (Fig. 2). Samples scoring less than 6 were often marked bitter and unacceptable by the panelists. Phenolic compounds imparted by these herbs could have led to alteration in the flavor scores of *burfi*. Parthasarathy et al. (2008) reported polyphenols could contribute to astringency and bitter taste in the organoleptic properties of foods. Astringency is perceived upon the

Table 2 Effect of addition of herb (@1% of *khoa*) on Instrumental texture profile and water activity of *burfi*

Parameters	Control <i>burfi</i>	Herbal <i>burfi</i>				BHA (@200 ppm)			
		Turmeric	Cardamom	Ginger	Curry leaf	Clove	Basil leaf		
Hardness (N)	40.96 ± 2.95 ^a	42.33 ± 2.40 ^{ab}	43.35 ± 1.55 ^{ab}	42.38 ± 2.10 ^{ab}	41.22 ± 2.92 ^{ab}	43.67 ± 1.84 ^b	41.58 ± 1.40 ^{ab}	41.02 ± 2.20 ^a	
Adhesiveness (N.s)	−2.90 ± 0.15	−2.95 ± 0.17	−2.77 ± 0.19	−2.90 ± 0.12	−2.78 ± 0.12	−2.80 ± 0.14	−2.93 ± 0.12	−2.79 ± 0.15	
Springiness (mm)	0.15 ± 0.02 ^a	0.13 ± 0.03 ^{ab}	0.12 ± 0.05 ^{ab}	0.13 ± 0.04 ^{ab}	0.14 ± 0.03 ^a	0.11 ± 0.03 ^b	0.13 ± 0.04 ^{ab}	0.14 ± 0.04 ^a	
Cohesiveness	0.12 ± 0.03	0.13 ± 0.05	0.14 ± 0.05	0.12 ± 0.04	0.12 ± 0.06	0.14 ± 0.05	0.12 ± 0.05	0.13 ± 0.05	
Gumminess	4.92 ± 0.99 ^a	5.50 ± 0.57 ^{ab}	6.06 ± 0.64 ^b	5.06 ± 0.72 ^a	5.07 ± 0.73 ^a	6.11 ± 0.68 ^b	4.92 ± 0.47 ^a	5.33 ± 0.69 ^a	
Chewiness	0.74 ± 0.19	0.66 ± 0.18	0.73 ± 0.10	0.72 ± 0.12	0.71 ± 0.17	0.74 ± 0.19	0.72 ± 0.15	0.74 ± 0.15	
Water activity	0.754 ± 0.003 ^a	0.745 ± 0.003 ^b	0.743 ± 0.002 ^b	0.747 ± 0.003 ^b	0.745 ± 0.005 ^b	0.742 ± 0.004 ^b	0.745 ± 0.003 ^b	0.755 ± 0.004 ^a	

Values are mean ± standard error ($n = 3$)Means with different superscripts within a row differ significantly ($p < 0.05$)

interaction of salivary proteins with polyphenols, which results in the formation of insoluble aggregates that interferes with palate lubrication and causes an unpleasant sensation (Baxter et al. 1997). Contrary to this, cardamom added sample was not significantly ($p > 0.05$) different from that of control *burfi*, which could have been due to the presence of sweet flavor compounds in cardamom. Anandaraj and Sudharshan (2011) reported major chemical constituents that impart sweet flavour in cardamom extract are α -terpinyl acetate and α -terpineol.

Results obtained were in agreement with studies on sensorial attributes of food products incorporated with polyphenols. Axten et al. (2008) reported bitterness in milk when polyphenols from apple were incorporated into it and this resulted in decreased acceptability of apple-polyphenol fortified milk as compared to control milk samples. Similarly, cinnamon yogurt was considered by the panelist as undesirable in taste in comparison to control-yogurt (Yadav et al. 2013). Sawale et al. (2015) reported increasing concentration of *Pueraria tuberosa* extract from 0.2 to 0.5% in milk led to significant reduction in sensory attributes.

Effect of herb incorporation on color and appearance of *burfi*

Color and appearance scores of the herb incorporated *burfi* ranged from 5.10 for clove added *burfi* to 7.30 for ginger added *burfi*. Significant ($p < 0.05$) difference in color and appearance attribute was observed for herbal *burfi* as compared to control *burfi*, which is also supported by hunter color values (Fig. 1). As like sensorially perceived flavor scores, the difference in color attributes could be contributed by the added herbs into *burfi* as discussed before.

It could be observed from Figs. 1 and 2 that the samples obtained less sensorial score than control samples also had higher differences in instrumental (L^* , a^* , b^*) values. Similar results were obtained by Tepper (1993) while working on variation in the acceptability of orange juice with variation in juice color, who reported that a departure from orange to light green color tended to reduce the color preference for the product even though all the products had same flavour profile. Similarly, Bandyopadhyay et al. (2007) reported variation in sensory color scores for *sandesh* when herbs were incorporated into it.

Effect of herb incorporation on textural scores of *burfi*

Texture scores of herb incorporated *burfi* ranged from 7.26 for cardamom incorporated *burfi* to 7.33 for turmeric added *burfi* (Fig. 2). No significant ($p > 0.05$) difference was observed in the sensory textural scores of *burfi* upon addition of different herbs into it.

Fig. 2 Sensory attributes of *burfi* samples. Values are mean $\pm$ standard error ($n = 3$). Values with different superscript for same parameter differ significantly ($p < 0.05$)

Fig. 3 Dendrogram showing clusters of different *burfi* samples

Effect of herb on overall acceptability of *burfi*

Overall acceptability scores of the herb incorporated *burfi* ranged from 5.27 for basil leaves added *burfi* to 7.39 for cardamom added *burfi* (Fig. 2). The overall acceptability scores obtained for different herb incorporated *burfi* could be due to departure from the sensory attributes of control *burfi* and their level of liking towards these herbs in *burfi*.

Selection of suitable herb for incorporation into *burfi*

Figure 3, showed that, BHA added sample had the most outstanding of physico-chemical and sensorial attributes but it has issues pertaining to negative health implications (Bandyopadhyay et al. 2007). Further, the objective of this

study was to utilize herbs as an alternative to synthetic additives, thus the most suitable *burfi* sample i.e. cloves, were found to be most suitable for incorporation into *burfi*.

Conclusion

The incorporation of herbs into *burfi* significantly increased the anti-oxidative activity. Among the herbs studied, clove exhibited maximum anti-oxidative activity followed by turmeric, basil leaves, curry leaves, ginger and cardamom. Herb addition affected the instrumental color profile of the *burfi* samples. Only clove and cardamom addition affected a few instrumental textural attributes of *burfi*. The herb incorporated samples were sensorially acceptable but

inferior as compared to control or BHA added *burfi*. Though herb addition negatively affected sensorial attributes, however cardamom added samples was preferred most followed by ginger, turmeric, clove, curry leaves and basil leaves.

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