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Optimization and Shelf-Life Studies of Beetroot-Coconut *Burfi* Fortified with Cinnamon Oil

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ABSTRACT
Burfi, an Indian traditional dairy dessert is highly popular, however, it's low nutritive value and poor shelf-life limits commercial viability. Essential oils are used as food additives due to their anti-oxidative and anti-microbial properties. Cinnamon oil coating was utilized for improving the anti-oxidative and shelf stability of burfi. Burfi is prepared using the ingredients with different ratios of beetroot-coconut. The combination T2 was superior than T1 or T3 with a rating as the best with the mouth feel. Cinnamon oil prepared as the coating ingredient was applied at different concentrations are compared with the control. The prepared burfi was subjected to various analysis like proximate analysis, anti-oxidant activity (DPPH) and shelf-life stability. The proximate analysis of the coated burfi sample T2 showed the optimum concentration of ingredients involving beetroot-coconut. The moisture, protein and fat content in the coated sample exhibited a better result due to the effect of cinnamon oil. The results indicated that EOEC burfi was evident to scavenge free radicals and inhibited the growth of micro-organisms compared to control. Hence, the present study thereby indicated the use of cinnamon oil on burfi which increased anti-oxidant activity and shelf-life period by preventing the growth of micro-organisms.
Keywords: anti-oxidant; burfi; cinnamon; free radicals; micro-organisms; shelf-life; growth

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INTRODUCTION

Burfi is one of the most popular khoa-based sweets all over India, made from heating a mixture of fresh milk, grated coconut, grated beetroot and sugar with homogenous consistency [1]. The growing interests of health-conscious consumers now demand for more conscious, appropriate, healthy and natural food options without any artificial or synthetic food ingredients [2]. Around 50-55% of milk produced in India, is converted into traditional sweets like *burfi, peda, kalakand, Gulab jamun and milk cake* [3]. In fact, several varieties of *burfi* are available in market based on additives, viz; besan *burfi*, plain *burfi*, groundnut *burfi*, raw *burfi*, cashew nut *burfi*, coconut *burfi*, moong dhal *burfi* and fruit flavoured *burfi*. [4] Beetroot (*Beta vulgaris*) is also known as garden beet that is known to mankind from ancient days in India mainly cultivated in states of Haryana, Tamil Nadu and Maharashtra due to its potent anti-oxidant properties [5]. It is a rich source of phytochemical compound called betalains which opens up on new opportunity in the dairy and food industry to developed natural coloured based functional dairy and food product [6]. Patel *et al.* [7] reported that lipid peroxidation can significantly affect the nutritional value, sensory quality and shelf life of foods [7]. Especially, in dairy and meat products Betaine is used as a natural food colour [8]. Moreover, coconut (*Cocos nucifera*) is rich in manganese that are essential for bone health and metabolism of carbohydrates, protein and cholesterol. It contains copper and iron which help in the formation of red blood cells [5]. Over the recent years, *Burfi* is gaining an international market owning to its delicacy of flavour and texture. It undergoes several physical, biochemical and microbiological changes during storage making it unfit for human consumption.[2] The main reason for behind lack of commercial manufacturing units in market is poor quality of storage which has unpredictable

shelf life. Mostly, unpacked product shelf life is only about 7-10 days.[4] The edible coatings are a thin layer that contain effective functional and medicinal properties essential for food product.[9] Essential oils used as food additives have gained interest due to their high antimicrobial and antioxidant properties [10]. Moreover, Cinnamon (*Cinnamomum verum*) essential oils are highly beneficial plant extracts used in cosmetic and food industries due to antimicrobial compound present [11]. Moreover, during the recent year's investigators have reported the antimicrobial activity of cinnamon essential oil against food poisoning bacteria *in vitro* [12]. Therefore, the present investigation was planned to investigate the effect of edible coating cinnamon oil in nutrient enriched beetroot-coconut *burfi* by evaluating its proximate analysis, extended shelf-life studies and its anti-oxidant properties.

MATERIAL AND METHODS

Procurement of raw materials

Fresh, fully grown and healthy beetroots were procured from the local Beed market of Coimbatore, India. Coconuts, cinnamon oil, fresh milk and high-quality sugar were purchased locally at a retail store. All the chemicals were purchased from M/s Hi-Media (P) Ltd, Chennai.

Preparation of Ingredients

Beetroots were cleaned, peeled and washed. Both beetroot and coconut were sliced/grated and kept for removal of moisture. Later, they were ground and desiccated to a fine powder and used for development of *burfi*. *Burfi* was prepared using the standard batch method prescribed by Shabbir *et al.* (2022) with slight modifications.[1]

Preparation of Essential oil Edible coating (EOEC)

The coating solutions comprising of Gelatin (10% w/v), Glycerol (1% w/v) Mixture (GGM) and Starch (3% w/v), Glycerol (1% w/v) Mixture (SGM) was prepared as per the procedure. Finally, Essential Oil Edible Coating (EOEC) on *burfi* was performed using dipping method in a mixture containing GGM and SGM at (1:1) ratio. [13]

Formulation and development of *burfi*

The procured ingredients were standardized and incorporated to prepare a nutri-dense *burfi* by standard procedure. Three types of nutri-dense *burfi*'s were formulated using different proportions (Table 1). *Burfi* preparation was done by boiling the sugar till it obtained a single thread. Both the ingredients were then added to the boiling sugar syrup and mixed. The mixed batter was removed from stove and spread on a tray and flattened. It was cut into a desired shape and kept at room temperature for cooling. [14]

Table 1: Major ingredients in the *burfi*

Ingredients	Control (g)	Treatment 1 (g)	Treatment 2 (g)	Treatment 3 (g)
Beetroot	30	20	25	15
Coconut	30	20	35	45
Sugar	20	20	7.5	15
Water	20	20	20	10
EOEC	-	20	12.5	15

*Note: The recipe used in the control was the basic formulae

Proximate analysis

The proximate analysis of the breads was undertaken according to the standard method of AOAC (2005). The crude protein, crude fat, crude fibre, ash & moisture content were determined for the prepared samples. The analysis was done triplicate and the results were calculated and expressed as gram per 100 g of dry matter basis. [15]

Free radical scavenging activity

DPPH (2,2 Diphenyl-1-picryl hydrazyl) free radical scavenging activity in *burfi* was evaluated by the method of Brand-Williams *et al.* [16]. Methanolic extract (0.1 mL) of *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.

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

Shelf-life determination and Microbiological analysis

Burfi pieces (1 slice each) were wrapped in butter paper and packed in polypropylene trays. The samples were stored under room temperature (34±2 ºC) conditions. All the *burfi* samples were analysed for the standard plate count (SPC) and yeast and mould count (YMC) at an interval of 15 days during storage by the methods as described by Farzana *et al.* [17].

RESULT AND DISCUSSION

Formation of burfi

Different combinations of ingredients were taken for the preparation of *burfi* using beetroot and coconut at different ratios with the addition of sugar and water. The treatments consisted of: Control (0.3% Beetroot, 0.3% Coconut, 0.2% Sugar and 0.2% Water), T1 (0.2% Beetroot, 0.2% Coconut, 0.2% Sugar, 0.2% Water and 0.2% EOEC), T2 (0.25% Beetroot, 0.35% Coconut, 0.075% Sugar, 0.2% Water and 0.125% EOEC), T3 (0.15% Beetroot, 0.45% Coconut, 0.15% Sugar, 0.1% Water and 0.15% EOEC). Formulations involving T2 were taken for further studies due to the sensory examination. Figure 1 shows the difference between control and the EOEC (T2). According to Shere *et al.* (2018), burfi formulated using beetroot, coconut and carrot at different ratios showed Sample 3 (beetroot 27%, coconut 10% and carrot 10%) as the best formulation based on sensory activities.[18] In another study Kaur *et al.* (2022), reported that effect of kinnow fruit juice (125 g) enhanced the shelf-life, nutritional quality and storage of the burfi. [2]

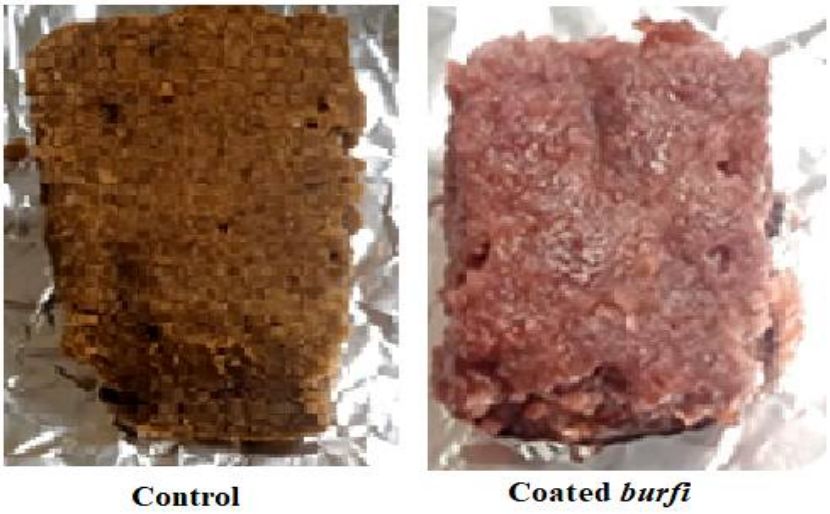

Figure 1: Preparation of *Burfi*

Proximate analysis

Results of proximate composition of coated burfi are compared along with the control as shown in Table 2. The moisture content in the coated sample was significantly lower than the control burfi. Ripnar *et al.* [14] reported that control burfi had the highest moisture content (6%) while the average fat content in the coated burfi showed increased level of about 0.29% higher than the control. [14] According to Kamble *et al.* [19], fat content in the burfi showed lower due to the increase in pineapple pulp when compared to control. This might be due to low fat content in pineapple (0.14%). In this study increased ratio of grated coconut in the burfi (T2) resulted in higher fat content compared to the control. In addition, in a study conducted by Navale *et al.* [20] reported that crude fat and crude protein significantly declined while moisture increased with the increase in the concentration of wood apple pulp in the product. Similarly, in our study indicated that fat and protein content increased with decrease in the moisture due to the incorporation of grated coconut powder in burfi. This might be due to the presence of HDL fatty acids in coconut. Cinnamon essential oil as edible film coated on burfi contains trans-cinnamldehyde which in turn increases shelf-life to nearly 15 days [21]. Pal *et al.* [22] reported that bottle gourd and carrot burfi showed higher fat content in T1 as the best ratio of (80% Khoa, 4% Bottle gourd and 16% Carrot). As the percent of bottle gourd decreases from T1 to T3 the percent fat also decreased.[22]

Table 2: Proximate composition of *burfi*

Burfi Sample	Percentage Composition					
	Moisture (%)	Ash (%)	Protein (%)	Energy (kCal)	Fat (%)	Carbohydrate (%)
Control (/100g)	11.9	0.67	2.07	369	3.81	81.56
Coated (/100g)	7.06	0.65	2.24	386	4.10	86.76

DPPH activity

DPPH (2,2 Diphenyl-1-picryl hydrazyl) is a stable nitrogen centred free radical that can be effectively scavenged by anti-oxidants. Overall, on acceptance of hydrogen from donor, DPPH which is dark purple in colour changes to yellow colour and gets converted into a non-radical form known as 1,1 Diphenyl-2-picryl hydrazine. Methanolic extract of coated burfi exhibited potential free radical scavenging activity when compared to control (Table 3). In this study, Inhibition of about 77.35% was found for coated sample than control (72.10%). Antioxidants are molecules that have the ability to scavenge free radicals before they damage the cells.[23] A significant decrease in DPPH activity of kinnow burfi was observed at 24.40%. [2] In another study Prasad *et al.* (2017) reported that DPPH activity of burfi samples showed 29.2%.[24] According to Wang *et al.* (2009), one-half milli meter of cinnamon leaf and clove bud essential oil showed 96.74% and 96.12% respectively on burfi. It indicated that eugenol consumes free radical which reduces cupric and ferric ions that retard the oxidation process and enhances the shelf-life of burfi. [25]

Table 3: DPPH activity of burfi sample

Burfi sample	Inhibition %	
	Absorbance	Inhibition
Standard	1.563	-
Control	0.436	72.10
Coated	0.354	77.35

Microbial parameters

In the present study, microbiological analysis of the stored beetroot-coconut burfi was carried out till 30 days at room temperature (Table 4). During storage, coated burfi samples showed a decreasing trend in total plate count (TPC), compared to the control however the values were within the acceptable ranges.[26] According to Kaur *et al.* (2022), most of the dairy desserts like burfi, mould growth is reported to be prominent factor in limiting their shelf-life [2]. The yeast and mold count were not detected in coated samples till 15th day but slightly appeared on control burfi. After more than 30 days, the fungal colonies increased rapidly under ambient conditions and exceeded the limit which may be related to higher acidity and FFA content observed during ambient temperature storage.[24] Control burfi was also assessed for microbiological safety during storage which showed too less short life for only 5 days at room temperature. With coating of cinnamon oil, shelf life of burfi was improved due to its high anti-oxidant potential and lower water activity which lowers the growth of micro-organisms. Similarly, Kaur *et al.* (2022) reported that incorporation of kinnow juice, shelf-life of burfi was enhanced when compared to control that lasted only 3 days under room temperature [2].

Table 4: Effect of storage on microbial quality of burfi

Test parameters	Temp.	Storage period (days)					
Microbiological evaluation		**0**		**15**		**30**	
		control	coated	control	coated	control	coated
Total plate count (cfu/g)	RT	**3.6** $\times 10^4$	**2.8** $\times 10^4$	**8.0** $\times 10^4$	**4.5** $\times 10^4$	**22.5** $\times 10^4$	**18.0**$\times 10^4$
Yeast and mold count (cfu/g)	RT	**<10** $\times 10^4$	**<10**$\times 10^4$	**<10** $\times 10^4$	**<10**$\times 10^4$	**<10** $\times 10^4$	**<10** $\times 10^4$

Note: As per FSSAI, (2011); <10 indicate absence of test organisms in 1 g of sample; RT – Room Temperature

CONCLUSION

The present investigation was carried out to optimize the effective concentration of cinnamon oil coated on beetroot-coconut burfi. The developed burfi was unacceptable (T1 and T3) due to the increased texture and sensory profile at different proportions of beetroot-coconut and EOEC of cinnamon. Cinnamon oil (0.125%) reduced the hardness (T2), deterioration and thus extended the shelf-life of burfi. Moreover, the addition of cinnamon oil increased the antibacterial activity and anti-oxidant activity of the product. The shelf-life of burfi

increased till 30th day at room temperature which showed decrease in the growth of micro-organisms compared to control. From the above-mentioned findings, it is concluded that EOEC using cinnamon applied as a novel ingredient produced high quality milk product with an optimum ratio that provided enough stability as well as therapeutic needs. Moreover, further research is needed to identify the GRAS compound in cinnamon oil which impacts colour, firmness, taste and odour of the coated beetroot-coconut burfi.

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Authors' Contribution
Dejaswanth, Hari Prassna and Nivin Hari have performed the experiment in the laboratory and consolidated the results. Gandepalli Pratap Kumar has written the manuscript. Each author mentioned has significantly and directly contributed intellectually to the project and has given their approval for its publication.

Data Availability Statement
The manuscript incorporates all datasets produced or examined throughout this research study.

Ethics Statement
The document accurately and thoroughly presents the author's original research and analysis.

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