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Studies on utilization of jaggery extracted from sugar beet (*Beta vulgaris*) in cookies

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Abstract
In the present study, efforts have been made to utilize the jaggery extracted from sugar beet in bakery products such as cookies. The cookies were prepared by varying the levels of jaggery @ T_c (0%), T_1 (5%), T_2 (10%) and T_3 (15%). The prepared cookies were analyzed for its sensory, physical and chemical characteristics. The weight and thickness were found in increasing while diameter and spread ration in decreasing trends with increase in concentration of jaggery. The cookies T_2 (10%) were found to be organoleptic ally accepted over other treatments. The cookies (T_2) were found to contain moisture (2.46%), ash (1.51%), crude protein (4.10%), fat (22.34%) and carbohydrate (69.56%). The cookies were techno-economically feasible to be exploited in the market.

Keywords: Jaggery, sugar beet, sweetening agent, cookies, sensory characteristics

Introduction
Sugar beet (*Beta vulgaris*), a genus of the family *Amaranthaceae* (formerly *Chenopo diaceae*), is one of the diverse and useful group of cultivars from the same species that includes Swiss chard, fodder beet, and red beet (McGrath, 2011) [1]. Sugar beet is the most important of several crops, including spinach beet, swiss chard, garden beet (beetroot) and fodder beet, within *Beta vulgaris* species (Gill and Vear, 1980) [2]. With various technical developments and favorable government policies, the beet sugar industry has expanded and the crop is cultivated and processed in Europe, North and South America, Asia and Africa (FAO, 2009) [3]. Sugar beet producing roots in first year and seeds in second year is a biennial herb grown in different countries of the world, and provides about 25% of world's sugar requirement. The crop is a major source of sugar in temperate countries (Winner, 1993) [4].

The conventional technology of sugar extraction from beetroot includes thermal denaturation of sliced beetroot tissue followed by aqueous diffusion in hot water at 70–75 °C. The thermal treatment leads to the breakage of cellular membranes and tissue denaturation. However, thermal extraction results in a number of undesirable processes. Not only the cell membranes are destroyed, but the cell walls also change their inner chemical structure through reactions of hydrolytic degradation (molecular chain breakages and detachment of polysaccharide fragments. Besides sucrose, other cell components (e.g. hydro soluble pectins) penetrate through the cell wall and pass into the juice. These pectins and other impurities deteriorate the juice quality and complicate tremendously the subsequent process of juice purification. Moreover, thermal diffusion promotes formation of some colorants like melanins, which results in a brownish yellow near black colour of the extracted juice. The thermally induced degradation of beet tissue, extraction of non-sucrose cell components and formation of colorants decrease the juice purity and it requires further purification (Poel van der *et al*., 1998) [5].

"Cookie" is chemically leavened product, also known as "biscuit". Generally the term biscuit is used in the European countries and cookies in the USA. Biscuits and biscuit like products have been made and eaten by man for centuries. Cookies are ideal for nutrient availability, palatability, compactness and convenience. They differ from other baked products like bread and cakes because of having low moisture content, ensure comparatively free from microbial spoilage and confer a long shelf life of the product (Wade, 1988) [6]. Cookies are the most popular bakery product and are consumed by the majority of the population because of their ease of consumption, variety and affordable price, which enables access by most consumers (Park *et al.*, 2015) [7]. The objective of the present research was to utilize sugar beet sugar in cookies. In the present study, the jaggery were extracted from sugar beet has been used to

substitute as a sweetening agent the cane sugar which will help to improve nutritional value.

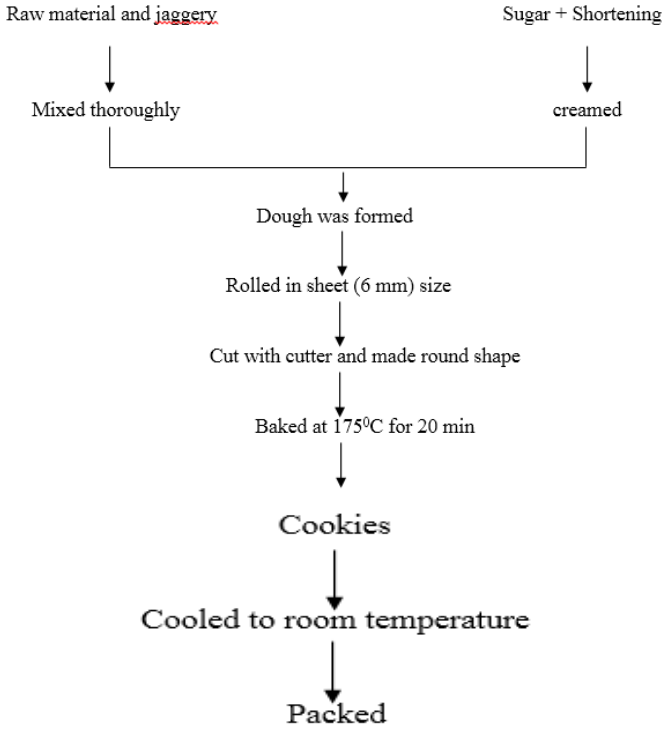
Materials and methods

Materials

Refined wheat flour, edible oil and baking powder were obtained from local market of Parbhani. Sugar beet (PA 86-2530) was obtained from fruit and vegetable research station Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Preparation of Cookies

The process for preparation of cookies was summarized in Flow sheet-1.



Flow sheet 1: Flow sheet for preparation of Cookies

Recipe for cookies preparation

Table 1: Recipe for cookies preparation

Ingredient	Quantity (g)
Refined wheat flour	100.0
Sugar	60.00
Shortening	45.0
Baking powder	1.5
Ammonium bicarbonate	1.5
Sodium bicarbonate	1.5
Distilled water	As per requirement

Formulation of sugar beet jaggery incorporated cookies

Table 2: Formulation of sugar beet jaggery incorporated cookies

Treatments	Sugar (g)	Sugar beet extracted sugar (g)
T_0	60	00
T_1	55	05
T_2	50	10
T_3	45	15

Physicochemical properties of prepared cookies

Proximate composition of prepared cookies such as moisture, crude protein, fat, ash, carbohydrate were analysed by A.A.C.C. (2000) [8].

Sensory evaluation of sugar beet incorporated cookies

Prepared cookies were evaluated for organoleptic Characteristics like color, texture, flavor, taste and overall acceptability by a panel of semi trained judges based on 9-point hedonic scale.

Statistical analysis

The data obtained was analyzed statistically by Completely Randomized Design (CRD) as per the procedure given by Panse and Sukhatme (1967) [9]. The analysis of variance revealed at significance of $P< 0.05$ level, S.E. and C.D. at 5% level is mentioned wherever required.

Result and Discussion

Physical properties of cookies incorporated with sugar beet sugar

The data regarding weight, diameter, and thickness and spread ratio of cookies are presented in Table 3.

Table 3: Physical properties of cookies prepared with different incorporation levels of sugar beet sugar

Treatment	Weight (g)	Diameter (mm)	Thickness (mm)	Spread ratio
T_c	14.88	56.93	10.15	5.60
T_1	14.95	56.05	10.60	5.33
T_2	15.38	55.38	11.02	5.02
T_3	15.86	54.59	11.56	4.72
SE+	0.04472	0.03651	0.0511	0.04472
CD at 5%	0.13462	0.10992	0.15382	0.13462

*Each value is a mean of three determinations.

It could be observed from the Table 3 that, the weight of cookies increased as the concentration of sugar beet sugar increased. The range of cookies weight was 14.88 to 15.86 g with maximum value in 15% sugar beet sugar cookies. The increase in weight of the sugar beet sugar incorporated cookies might be due to water binding capacity of fibres in sugar beet. Highest score for diameter was observed in treatment T_c (56.93 mm) whereas lowest score was observed in treatment T_3 (54.59 mm). Decrease in diameter might be due to the protein present in sugar beet which has more binding power and it binds water and restricts the spread of cookies. The results of decrease in diameter of peanut butter incorporated cookies are in close agreements with the result of Siddiqui *et al.* (2003) [10] who reported that decrease in diameter with increasing level of soy flour in biscuits.

The thickness of cookies ranged from 10.15 to 11.56 mm. The thickness increased with the incorporation of sugar beet sugar. Increase in thickness of cookies may be due to the decrease in diameter. The changes in diameter and thickness were reflected in spread ratio of cookies. The spread ratio of treatment T_c was 5.60 whereas it was decreased to 4.72 in treatment T_3. Jayasena and Nasar-Abbas, (2011) [11] reported that significant decrease in the spread ratio of biscuits were found due to the incorporation of lupin flour.

Sensory evaluation of cookies incorporated with sugar beet sugar

Table-4 summarizes the effects of addition of different levels of sugar beet sugar on sensorial quality parameters of cookies.

Table 4: Sensory evaluation of cookies incorporated with sugar beet sugar

Treatment	Color and Appearance	Texture	Taste	Flavor	Overall Acceptability
T_c	8.3	8.4	8.3	8.0	8.1
T_1	8.0	7.5	7.9	7.7	7.7
T_2	7.6	7.2	8.4	8.5	8.1
T_3	7.3	7.0	8.0	7.9	7.6
SE+	0.06055	0.07638	0.05	0.05477	0.0639
CD at 5%	0.18228	0.22992	0.1505	0.16488	0.19236

*Each value is a mean of ten determinations.

The data presented in Table 4, the color and appearance were decreased with increase in concentration in jaggery which was highest in Tc (8.3) and lowest in T_3 (7.3). The texture scored highest for control cookies (8.4) and lowest for T3 (7.0). In terms of taste and flavour cookies (T_2) had highest score over all treatments i.e. 8.4 and 8.5. The overall acceptability of control and T_3 cookies scored same (8.1). Hence, it showed the cookies with jaggery (10%) were organoleptically accepted over all other treatments.

Proximate composition of sugar beet sugar based cookies

Proximate composition of food products gives the picture on the major nutrients in the product. The proximate compositions 10 per cent sugar beet sugar incorporated cookies is compared with the samples prepared with sugar addition i.e. controls samples and the results are presented in Table-5.

Table 5: Proximate composition of sugar beet sugar based cookies (control cookies and cookies with 10% sugar beet sugar incorporated cookies)

Parameter	Cookies (T_c)	Cookies (T_2)
Moisture content (%)	2.16	2.46
Total ash (%)	1.17	1.51
Crude protein (%)	5.80	4.10
Total fat (%)	21.88	22.34
Carbohydrate (Calculated)	68.96	69.56

* Each value is an average of three determinations

The moisture content and ash content in control cookies were 2.16 and 1.17 per cent, respectively. The crude protein fat and carbohydrate content in control cookies were found to be 5.80, 21.88 and 68.96%. It was observed that the T_2 (2.46%) remained relatively more moisture than the control sample. It may be due to increased water absorption capacity by the sugar beet sugar, which are hydrophilic in nature. In terms of ash, protein, fat and carbohydrate, the T_2 cookies had 1.51, 4.10, 22.34 and 69.56% respectively. The nutritional VALUES were found to be increased due to incorporation of jaggery extracted sugar beet.

Conclusion

Due to the good presence of sucrose in sugar beet it has the potential to be used as sweetening agent in cookies. As results indicated that formulations with up to 10% of sugar beet jaggery give better nutritional value and maintained them during the storage.

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