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Research Article

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Effect on the Physicochemical and Nutritional Properties of Cookies with the Incorporation of Beetroot Grown with the Application of Poultry Manure

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Abstract

Cookies is a baked item that is beloved by people of all ages. They are mostly made from refined wheat flour, sugar, and butter, resulting in a high amount of carbohydrates and fats. Considering the ever-rising demand of the functional foods, the aim of study was to develop cookies enriched with beetroot in order to improve their nutritional, physico-chemical, polyphenolic, and textural characteristics The beetroot cookies were formulated in five variations which is BC0, BC1, BC2, BC3, and BC4 having a corresponding beetroot content of 0%, 5%, 10%, 15%, and 20%, respectively. The protein, ash, fat, and fiber contents showed a positive correlation with the rise in beetroot content. The highest values were seen in BC4, 10.94% protein, 1.83% ash, 23.25% fat, and 1.73% fiber. The findings of the texture profile analysis indicated that the weight, diameter, and thickness increase in proportion to the beetroot content. The spread-ratio exhibited a negative correlation with the beetroot content in beetroot cookies. The BC0, BC1, and BC2 cookies received better higher scores across all sensory characteristics on a 9-point hedonic scale, with overall acceptability scores of 7.01, 7.62, and 8.35, respectively. As the amount of beetroot in the cookies increase, the levels of polyphenolic compounds, specifically the total phenolic content (GAE) and total flavonoid (QE), also increase. Notably, when the beetroot concentration in cookies increases, the cookies become harder texture, a paler in color, and a bitter aftertaste. Incorporating beetroot into cookies substantially enhanced the nutritious composition of the cookies. It can be concluded that the inclusion of beetroot can be effectively achieved up to a maximum of 10%.

Keywords

Beetroot, Cookies, Mineral profiling, Functional food, Food microencapsulation

Introduction

Bakery products, such as bread, cookies, rolls, pastries, pies, and muffins, are an integral part of the diet that is extensively consumed across the world [1]. Due to their low moisture content and extended shelf life, cookies are different from other baked products [2]. The main ingredients of the cookie, specifically fat, sugar, and wheat flour, as well as its shelf life, give rise to increase the demand of the cookies consumption as a ready to serve high-calorie snack by the majority of people. However, it is deficient in essential nutrients [3, 4]. Regular wheat-based cookies are not acceptable for everyday consumption due to their inadequate nutrient composition. Therefore, it is crucial to improve their nutritional content [3, 5]. Aim of the sustainable development goals-9 (SDG-9) (Industry innovation and infrastructure) is innovation is a fundamental aspect of our business. We depend upon the capacity of human beings to convert knowledge into real

applications, which helps in the identification of sustainable solutions. Our research and development efforts result in revolutionary findings, ranging from organic pest management to innovative technology for monitoring, which encourages sustainable industry.

Beetroot (*Beta vulgaris L.*) is a root vegetable that is known to be beneficial for health. Although the beetroot abundance of beneficial nutritional and phyto-nutritional elements, including protein, vitamins, minerals, fiber, phenolic compounds, and antioxidant activity, it is frequently not included in the human diet [5-10]. Several research have proposed utilizing beetroot as health-enhancing ingredients in food products [5, 9, 11, 12]. However, conventional farming practices in the country have excessively depended on artificial fertilizers, pesticides, and herbicides, resulting in soil deterioration, water contamination, and adverse effects on the health of humans [13]. Therefore, it is essential to shift towards more sustainable and environmentally friendly farming practices [14]. Recently, various studies have investigated the potential of organic farming as an alternate method to enhance agricultural sustainability [15]. Organic fertilizers, such as compost, manure, poultry manure and neem cake, are crucial elements of organic agriculture due to their capacity to improve soil fertility, increase nutrient availability, promote beneficial soil organisms, and increase crop production [16].

As people are attempting to improve their general health and quality of life, and hence there is a growing demand for a healthy diet that includes the consumption of "functional foods." This need is growing on a global scale because of the presence of various components, such as beta-carotenoids, carotenoids, vitamins, dietary fibers, and other phytochemicals, certain fruits and vegetables are functional foods. These components play a pivotal role in the prevention of cardiovascular disease, cancer, type 2 diabetes mellitus, age-related disorders, and hepatic diseases [17, 18]. Because of its nutritional, medicinal, and palatability, beetroot is one of the recognized functional foods that is consumed either in raw or processed form worldwide [18].

Although incorporating beetroot into cookies can be a difficult task in terms of improving their nutritional value, adding non-wheat powder to the cookie formulation can also influence the quality and shelf life of the product [5, 19, 20]. The selection of vegetables and fruits, as well as the proportions of fiber, were determined based on previous study reviews and initial baking experiments [5]. One barrier to implementing this technique is the fact that teens often dislike vegetables. Vegetables have been recognized for their beneficial effects on health, but they rarely appeal to young people and adolescents because of their bitterness, undesirable texture, and their low satiating capacity [21]. An effective strategy to enhance children's vegetable consumption is to include vegetables into a food matrix that corresponds to their preferences. Multiple studies have demonstrated that children highly value cookies, making them an excellent choice to manufacture vegetable enrich food products.

The objective of this study is to provide a detailed and analytical summary of all beetroot processing technologies used for extraction, dehydration, preservation and development of value-added products. This evaluation provides food manufacturers and processors with important information about effective techniques for processing beetroot to create new and improved products which is very beneficial for our day-to-day life to fulfil the needs of the customers which fulfil the SDG-9 which is the “industry innovation and infrastructure”.

Materials and Method

Preparation of the beetroot powder

After collecting raw beetroot from the farm of Lovely Professional University in Phagwara, Punjab, beetroot undergoes the proper cleaning to eliminate the contamination. The beetroot was then sliced into slim/thin slices of thickness 1 - 3 mm using a keen kitchen knife. After that the thin slices of the beetroot were placed in the tray dryer to initiate the drying process at a temperature range of 60 - 70 °C for a duration of 7 to 10 h. The electric grinder was used to grind the dehydrated slices of the beetroot to the powder form. The grinded powder was sieved through 60 - 65 mesh size sieve and sealed in coloured glass bottles or high-density polyethylene bags for later use. The process of preparing beetroot powder is shown in figure 1.

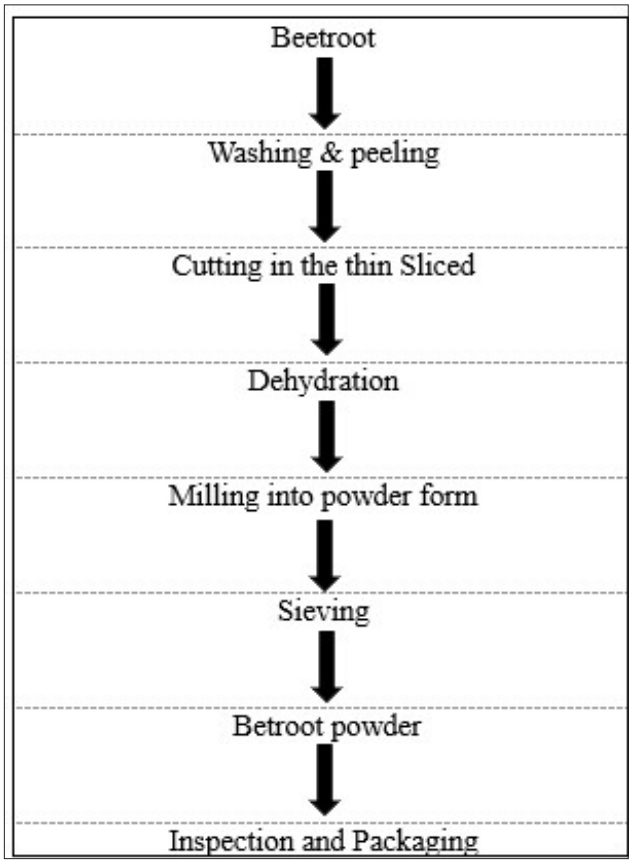

Figure 1: Processing of beetroot powder.

Preparation of cookies

For the preparation of the cookies from the beetroot powder. Beetroot powder and wheat flour were used instead of refined wheat flour. Many different combinations have been

made by mixing wheat flour and beetroot powder in the following ratio: 100:0; 95:5; 90:10; 85:15, and other ingredients are backing powder, backing soda, and butter.

Flow chart of preparation of cookies

Weigh all the ingredients separately according to the table 1, afterwards, note down the weight of the empty bowl, also the weight of mixing bowl along with all the ingredients prior to portioning, the mixing bowl containing unused dough after portioning, and all the baked cookies (later the percentage of waste and yield for the purpose of determining the cost of cookies). The oven is preheated to a temperature of 150 ˚C, and the ingredients are mixed to form the dough. The sugar, shortening, salt and baking soda and baking powder were mixed in a bowl for three minutes, milk and powdered sugar were added, and the mixture was stirred for a few minutes. The flour was added to a dough, kneed until soft dough is prepared. After that, the dough was rolled out to a consistent thickness of 7 mm and then use cookies mould or cookies cutter for cutting cookies, with a diameter of 7.5 cm approx.

The cookies were baked for a duration of 15 min on sheet trays that were covered with parchment paper. The cookies were extracted from the oven after a duration of 15 min, irrespective of their visual appearance, to maintain consistent baking durations for each batch. After that the cookies were placed in the room temperature to cool and then use these cookies for the analysis. For the textural analysis the 3 - 4 cookies are separated and perform the textural analysis.

Determination of physical characteristics

Once all weights were recorded as before, proceed to calculate the weight of cookies, thickness of the cookies and diameter of the cookies for each replication using given below.

Procedures to measure overall spread of cookies

The W/T (Spread ratio) was determined by dividing the mean width of the three cookies by the mean thickness of the three cookies, as shown below.

Determination of physicochemical analysis

The moisture, crude protein, crude fat, and ash content of the cookies were analysed using the AOAC [22] standard procedures.

The calorific values were calculated using given formula

NFE% (Carbohydrate) = 100 - (moisture + crude protein + total ash + crude fat + crude fiber)

Energy (Kcal.100 g^-1) = {Proteins (g) × 4.00} + {Fats (g) × 9.00} + {Carbohydrates (g) × 4.00} [23].

Determination of mineral composition by inductively coupled plasma-mass spectrometer (ICP-MS)

Estimation of mineral elements was performed according to Chhikara et al. [24] and Choi et al. [25]. Accurately 100 mg of powdered sample were transferred to a test-tube. The test-tube contained 1 ml of nitric acid. The test-tube was then placed in a boiling water container on a hot plate set at a temperature of 95 ˚C. This entire process was carried out inside a fume hood.

Table 1: Ingredients used in the preparation of cookies.

Ingredients	Amount (g)				
	T_0	T_1	T_2	T_3	T_4
Wheat flour	100	95	90	85	80
Beetroot powder	0	5	10	15	20
Sugar	50	50	50	50	50
Salt	2	2	2	2	2
Backing powder	0.5	0.5	0.5	0.5	0.5
Backing soda	0.5	0.5	0.5	0.5	0.5
Butter	50	50	50	50	50
Milk (ml)	10 ml	10 ml	10 ml	10 ml	10 ml

After a duration of 4 h, the samples were removed from the boiling water and allowed to cool to the ambient temperature. After that, a volume of 1 ml of hydrogen peroxide was added to the sample and again boiled at a temperature of 95 ˚C for 10 more min. Subsequently, the sample tubes were filled with distilled water to reach a final volume of 10 ml. Finally, the sample mixture was transferred to a 15 ml falcon tube that had been cleaned beforehand and treated with acid. This tube was then used to analyse the mineral elements.

The above approach was used as well to prepare soil samples for the determination of mineral components content, utilizing 100 mg of soil sample. Throughout the entire process, any contact between metal and the samples was prevented, and glassware was immersed in a 10% nitric acid (v/v) solution for a duration of one day. The biological samples were measured three times each.

The mineral elements were analysed using ICP-MS apparatus model 7900 by agilent. The analysis was conducted at the Citrus Estate Laboratory Hoshiarpur. The instrument was operated under the specified conditions and parameters. Nebulizer gas-flow: ~1 L min^{-1}, auxiliary gas-flow: ~1 L min^{-1}, Plasma gas-flow: ~15 L min^{-1}, helium gas-flow in reaction cell: ~0.2 ml min^{-1}, reflected power: ~45 W, forward power: ~1500 W, analyzer vacuum: ~6 × 10^{-5}, detector: EM, replicates: 3, and sweeps/replicate: 100.

Determination of the polyphenolic compounds

Determination of total phenolic compounds (TPC)

The Folin-Ciocalteu colorimetric technique was used to measure the total phenolics in cookies. The solution is composed of 7.9 ml of distilled water, 0.5 ml of Folin-Ciocalteu solution, and 1.5 ml of 20% Na_2CO_3. The solution was allowed to incubate for 2 h at a temperature of 25 ˚C, in the absence of light. The absorbance of the samples was measured at a wavelength of 760 nm using a UV–Vis spectrophotometer. The results are quantified in mg of gallic acid equivalents per liter (mg GAE/L) according to Singleton and Rossi's method.

Determination of antioxidant 2,2-Diphenyl-1-picrylhydrazyl (DPPH)

The DPPH free radical scavenging activities of each sample were evaluated using the method described by Do et al. [26]. Approximately 0.1 ml of each sample was transferred into a test tube, and the make the final volume to 1 ml by adding methanol. Subsequently, add volume of 5 ml of 0.1

mm DPPH reagent to each test tube. After that, the test tubes containing each sample were vigorously mixed and placed in a controlled environment at a temperature of 27 °C for a duration of 20 min. The spectrophotometric measurements of each sample were taken at a wavelength of 517 nm, and the findings were reported as follows:

$$\text{Radical scavenging activity (\%)} = \frac{(\text{control Abs.}) - (\text{sample Abs})}{(\text{control Abs.})} \times 100$$

Sensory evaluation

A panel of 10 semi-trained members evaluated several specific characteristics of cookies (i.e., color, taste, texture, aroma as well as overall acceptability). The system of 9-point-hedonic-scale was used, whereas the score of 1 represented dislike extremely, 2 represented dis like very much, 3 represented dis-like moderately, 4 represented dis like slightly, 5 represented neither like nor dis-like, 6 represented like slightly, 7 like moderately, 8 represented like very much and 9 represented like extremely. The panellist members were semi-trained in order to be acquainted with sensory parameters of cookie and the aforementioned ranges of nine scores in the sensory analysis.

Statistical analysis

Each analysis was conducted in triplicate, involving a total of three participants. The mean values were represented as the mean plus the standard error. The mineral and nutritional profile, physicochemical analysis, antioxidant test, and antimicrobial activities of beetroot powder and enriched hard candies were assessed using the analysis of variance (ANOVA) technique. The OPSTAT software tools were utilised to conduct this analysis. The least significant difference was used as the evaluation technique to determine the level of significance among all the mean values at a 5% confidence interval.

Results and Discussion

Proximate composition of beetroot powder supplemented in cookies

Based on the data collected, it was discovered that the nutrient profile of cookies containing 20% of beetroot powder exhibited significantly greater levels of ash, protein, and dietary fibers, specifically 1.83, 10.94, and 1.73%, respectively, as indicated in figure 2. On the other hand, the addition of beetroot powder to cookies at a percentage ranging from 0 to 20% led to a significant ($p < 0.05$) increase in the amount of ash (0.69 - 1.83 %), protein (8.87 - 10.94%), and fibers (0.65 - 1.73%), respectively. The rich nutrient profile of Beetroot powder itself is responsible for the higher magnitudes of these nutrients that are found in the cookies that have been supplemented. For a long time, people have believed that phyto-proteins have a beneficial impact on human health. This is because phyto-proteins are readily available from a variety of plants, including beetroot [27].

The moisture content of the control cookies was 2.38% and it increased from 3.19% to 4.21% in cookies incorporated with beetroot powder. The moisture content showed a significant increase, ranging from 3.19% (BC1) to 4.21% (BC4),

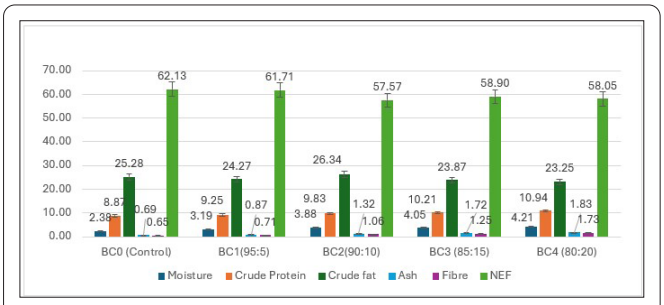

Figure 2: Proximate composition of beetroot powder supplemented in cookies.

with intermediate values of 3.88% (BC2), 4.05% (BC3), and 4.21% (BC4). The treatment (BC4) had the highest moisture content, measuring 4.21%, whereas the treatment (BC0) had the lowest moisture level, 2.38%. The variation in moisture levels could be attributed to the elevated fibre content present in beetroot powder.

Crude fat and carbohydrates contents were decreased from 24.27 to 23.25%, 62.98 to 62.65% respectively with addition of beetroot powder.

A greater number of hydroxyl groups of cellulose in the fibre were able to form hydrogen bonds with molecules of free water, which led to an increase in the fiber's capacity to store water increasing the amount of beetroot powder that was substituted into the formulation led to an increase in the amount of protein and fibre that was present in the cookies, as demonstrated by the findings with the findings of Alshehry et al. [28].

Mineral profile of beetroot powder supplemented cookies

Many micro and macro nutrients present in the beetroot, such as sodium, magnesium, calcium, potassium, iron, and zinc, which have the potential to assist in the improvement of micronutrient deficiencies among individuals. Youngsters are among most of the diseased members of the population. The daily dietary recommendations for sodium, magnesium, calcium, iron, and zinc for children are as follows: 300 mg, 130 mg, 650 mg, 3000 mg, 10 mg, and 3 mg, respectively [29].

Sodium: The sodium content was found lowest in control treatment BC0 (5.01 ± 0.066 mg/100 g) and found highest in treatment BC4 (6.58 ± 0.137 mg/100 g).

Iron: It was discovered that the amount of iron that was present in cookies increased from 1.22 mg/100 g to 2.55 mg/100 g. The iron concentration increased by a considerable amount, going from 1.55 mg/100 g (BC1) to 1.83 mg/100 g (BC2) to 2.13 mg/100 g (BC3) to 2.55 mg/100 g (BC4).

Zinc: It was discovered that the zinc content of cookies dropped from 0.83 mg/100 g to 0.45 mg/100 g. The zinc concentration dropped from 0.83 mg/100 g (BC0) to 0.74 mg/100 g (BC1) to 0.65 mg/100 g (BC2) to 0.54 mg/100 g (BC3) to 0.45 mg/100 g (BC4).

Magnesium: The magnesium content was found lowest in control treatment BC0 (1.36 ± 0.063mg/100 g) and found highest in treatment BC4 (2.23 ± 0.117 mg/100 g) as indicated in the figure 3.

The findings of Awasthi in the year of 2014 consistent with our data, indicating that the concentrations of Fe^{+3}, Ca^{+2},

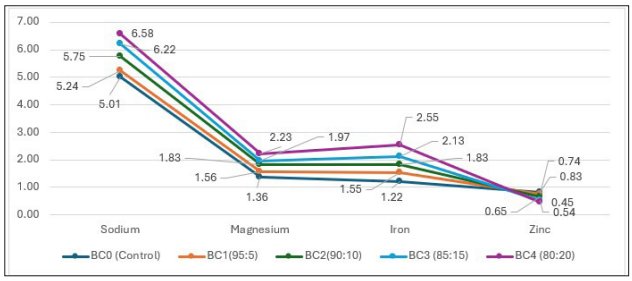

Figure 3: Mineral profile of BRP supplemented cookies.

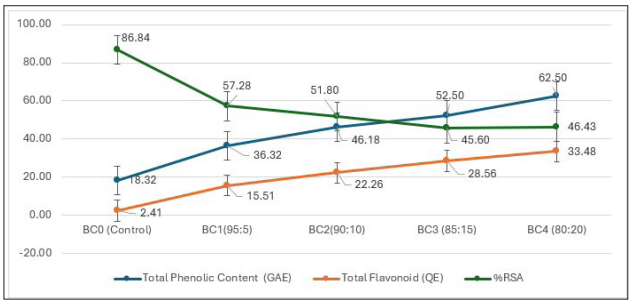

Figure 4: Polyphenolic activities of beetroot powder supplemented cookies.

and P^{+5} ranged from 0.1 to 2.7, 32.0 to 64.0, and 310 to 532 mg/100 g, respectively. Additionally, the concentration of Zn^{+2} in beetroot powder ranged from 0.35 to 0.96 mg/100 g [28].

Polyphenolic activities of beetroot powder supplemented cookies

Phenolic compounds, which are found in beetroot powder, are thought to exert their favourable health of the supplemented cookies about 5 - 20%. The results for TPC demonstrated the presence of TPC at its highest level, which was 62 mg GAE/100 g. in BC4 (20% supplementation level). On the other hand, the lowest TPC was recorded for BC0 (0%) supplementation level, which was 18.32 mg GAE/100 g. Alshehry et al. [28] stated appreciable magnitudes of total polyphenolic content, which includes total phenolics and flavonoids, as well as the antioxidant components, which include ABTS, DPPH, and FRAP, are shown in figure 4 as 137, 190, and 181 mg/100 g, respectively. During examination, we discovered that the concentrations of TFC in cookies incorporation with beetroot powder were much higher, specifically 33.48 mg QE/100 g (Figure 4). The results obtained from the cookies that were treated with beetroot powder demonstrated significant increases in total flavonoid content (TFC) from 2.41 to 33.48 mg QE/100 g at levels ranging from 0 to 20% beetroot powder supplementation. Flavonoids are known to possess a wide range of health-promoting qualities, such as antibacterial, anti-inflammatory, and antioxidant activities [4]. There is a possibility that the release of bound phenolics, also known as flavonoids, could be a consequence of thermal lysis of cellular components in beets. This phenomenon could be linked to the increased levels of TFC in beetroot powder. In a study conducted by Kaur et al. [30], comparable results were observed for total TFC in value-added hard candies. The TFC was measured to be 46 mg QE/100 g. This was achieved by supplementing beetroot and sucrose in a ratio of 1:1 weight-to-weigh.

Antioxidant in the beetroot cookies scavenge free radicals was determined by measuring their ability to reduce DPPH radicals. The results presented in figure 4 show that the highest antioxidant activity was observed in the BC4 sample that is 55.89%, with 20% beetroot powder, which is associated with beetroot itself, which has an exceptional antioxidant activity. The samples BC1 which do not contain beetroot powder, exhibited the lowest antioxidant activity, 23.93%. A trend of decreasing antioxidant activity was observed in the decrease in the proportion of beetroot in the biscuit sample in each series. The lowest antioxidant activity was observed in biscuits without beetroot powder and the highest activity in biscuits with 20% of beetroot powder. The baking temperature show significantly affect the DPPH radical activity of beetroot cookies. Literature results have also shown the effect of temperature on their antioxidant activity. Furthermore, the study conducted by Eswaran et al. [31] demonstrated that cookies prepared by substituting 15% of wheat flour with banana peel powder exhibited DPPH inhibition of 70.30% [32]. Additionally, cookies with cranberry [33], acai berry [34] and blueberry powder [35] showed a similar increase in the antioxidant capacity [36-38].

Noticeable effect of beetroot powder on the physical profiling of the cookies

The cookies containing beetroot powder up to 10% exhibit significant variations in diameter and thickness when compared to the control group. This is clear from the data provided in figure 5. However, significant differences were observed when higher levels of beetroot powder were present. With an increase in the substitution of beetroot powder, there was a corresponding increase in diameter and a decrease in thickness values.

The data on the mean thickness of the cookies revealed that the maximum value (11.53 mm) was observed in BC4, while the lowest value (9.50 mm) was observed in BC0.

The data on the average diameter of the cookies revealed that the maximum value (48.27 mm) was observed in BC4, while the lowest value (43.57 mm) was observed in BC0.

The results showed gradual increase in weight as the level of beetroot powder increased. The mean values of cookies weight showed that control treatment BC0 showed lowest value (31.67 g) while highest (37.67 g) by treatment BC4.

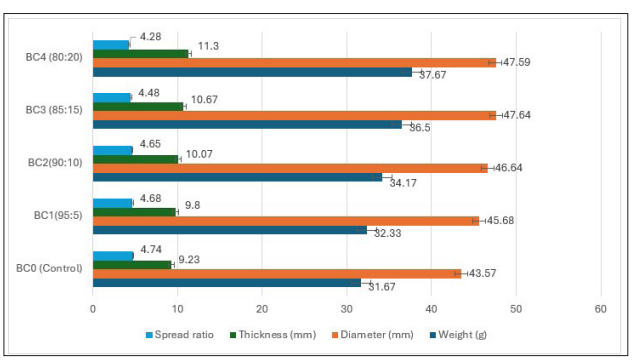

Figure 5: Noticeable effect of beetroot powder on the physical profiling of the cookies.

The findings indicated that there was no statistically significant difference in the spread ratio of the cookies among the treatments. The spread ratio of cookies across all treatments varied between 4.19 and 4.80.

Incorporating beetroot powder led to a decrease in gas retention and thus resulted in less cookie expansion as compared to the control. The cookies prepared with beetroot powder exhibited a difference in spread ratio compared to the control. Alshehry et al. [28] discovered that using beetroot powder at a concentration of 20.0% in the cookies led to an increase in their weight.

On the other hand, the cookies resulted in a reduction in volume and density as the quantity of beetroot increased, probably due to a drop in gluten protein in the dough and a significant amount of raw fibre in the beetroot [39]. Development and quality evaluation of pasta incorporated with beetroot powder.

Effect on the sensory observation of the cookies supplemented with the beetroot powder

The incorporation of confectionery items that contain innovative ingredients is a potential strategy that has the potential to dramatically impact the sensory appeal of functional food products. For developing value-added cookies, the beetroot powder was taken into consideration because it possesses a significant nutrient-dense and antioxidant-rich profile. BC2 was found to have the greatest sensory score for color, as shown in figure 5.

The colour and appearance evaluation of cookies enhanced with the addition of beetroot powder up to a concentration of 10%. However, beyond this level, the colour and appearance of the cookies decreased. The score for colour and appearance was recorded as 7.83 for the control treatment BC0, followed by 8.40 for BC1, 8.70 for BC2, then reduced to 7.33 for BC3 and 6.97 for BC4. The cookies prepared with BC2 had the maximum score of 8.70, while the cookies made from BC4 received the lowest score of 6.97. The light brown shade of the cookies is attained by including 10% of beetroot powder. The texture score of cookies improved with the addition of beetroot powder up to a concentration of 10%. However, beyond this level, the texture score decreased. The texture score for the control treatment BC0 was first recorded as 7.93. Subsequently, the scores for treatment BC1, BC2, were 8.10, 8.83 respectively. However, the score declined to 8.63 for BC3 and further dropped to 7.13 for BC4. The flavour score increased with the increase in beetroot powder concentration increases up to 10% for cookies. Treatment BC2 shown highest score of 7.53, while treatment BC4 showed lowest score of 5.87. There were significant differences in flavour scores across all the treatments.

This improvement was statistically significant ($p < 0.05$). In a comparable way, the findings of the sensory evaluation showed that the highest sensory scores for taste were awarded to BC2 (8.67), followed by BC1 (8.03), BC3 (7.47), BC0 (6.77), and BC4 (5.80), in that order. Tannins, geosmin, and isothiocyanates are examples of astringent chemicals that can be found in beets, which may be responsible for the drop in the sensory scores for taste [40]. Table 2 is a tabular representation of organoleptic evaluation of cookies. An increase in the substitution level of sugar beet powder in wheat-sugar beet powder composite flour cookies resulted in a substantial and significant fall in the scores. When compared to the control, the values of each parameter for sensory qualities were found to be highest for the BC2 (10%) treatment and lowest for the BC4 (20%) treatment [41-43].

Conclusion

In terms of the ever-increasing burden of micronutrient deficiencies, nutritional scarcities, and food insecurity difficulties brought on by the growing population, there is a critical requirement for innovative interventions that might help improve these health-related challenges in the modern era. Consumers' preferences for normal vegetable consumption in their diets are currently evolving toward more complex and nutritious finished food products in an effort to support a better way of life. In today's world, the use of dehydrated vegetables in the process of producing novel food compositions is preferred. In summary, beetroot, a nutrient-rich vegetable, serves as a valuable source of inorganic micronutrients, photoproteins, dietary fibers, and bioactive compounds. These components have the potential to assist in treating a variety of health conditions and deficiencies in micronutrients. According to the current investigation's findings, the addition of beetroot powder in the range of 5 to 20% did not have any negative impact on the sensory quality or acceptance of confectionery food products. The sensory panellists assigned sensory scoring concludes that a beetroot powder supplementation of 10% or less is an appropriate concentration for use as an ingredient in manufactured novel food products.

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Table 2: Effect on the sensory observation of the cookies supplemented with the beetroot powder.

	Appearance	Colour	Texture	Flavour	Taste	Overall acceptability
BC0 (Control)	6.03	7.83	7.93	6.47	6.77	7.01
BC1 (95:5)	7.33	8.40	8.10	6.23	8.03	7.62
BC2 (90:10)	8.03	8.70	8.83	7.53	8.67	8.35
BC3 (85:15)	6.37	7.33	8.63	7.03	7.47	7.37
BC4 (80:20)	5.50	6.97	7.13	5.87	5.80	6.25

throughout this research on the "Effect on the Physicochemical and Nutritional Properties of Cookies with the Incorporation of Beetroot Grown with the Application of Poultry Manure." I am also thankful to the faculty and staff of Lovely Professional University or providing the necessary resources and facilities, and the farmers who helps in providing the poultry manure. Lastly, I am deeply grateful to my family and friends for their constant encouragement.

Conflict of Interest

None.

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