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Nutritional, Physicochemical and Organoleptic Evaluation of Low Calorie Muffins Using Natural Sweetener Stevia (*Stevia rebaudiana* Bertoni)

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Abstract

Stevia (*Stevia rebaudiana* Bertoni) natural, safe, non-toxic, non-caloric sugar substitute can be used in the preparation of different food products for diabetes and weight maintaining approaches. In the current study, low calorie muffins were prepared by the substitution of dried stevia leaves powder with sucrose at different levels (25:75, 50:50, 75:25 and 100:0%) as sugar substitute and investigated their nutritional, physicochemical and organoleptic properties. The results demonstrated that stevia is rich source of crude protein (14.87 ± 0.10%), fiber (9.65 ± 0.19 %), K (22000 ± 96.65 ppm), Ca (13300 ± 74.22 ppm), Mg (4500 ± 32.22 ppm), P (3200 ± 23.12 ppm), total phenols (20.3 ± 0.15 (mg GAE/g), total flavonoids (14.32 ± 0.09 mg Catechin/g) and has strong DPPH activity (58.24 ± 0.30 mg Trolox/g). Addition of stevia leaves powder significantly increased the nutritional profile (chemical, mineral and antioxidant properties) of stevia muffins except carbohydrates from T_1 to T_4. Furthermore, stevia leaves powder notably affected the physicochemical (diameter, thickness, spread factor, firmness, springiness and color) and organoleptic parameters (color, flavor, texture, taste, appearances and overall acceptability) of all the treatments. Muffins with 25:75% (stevia: sucrose) were most liked by judges. Conclusively, stevia could be used as natural sweetener in food products.

Keywords: Stevia; Muffins; Physico-chemical; Organoleptic; Nutritional

Introduction

Muffins are the consumer most accepted bakery product. Sugar the main ingredient of muffins is used for better taste and soft texture. Due to high glycaemic index of sugar, sugar containing foods may result in increase of insulin levels and postprandial plasma glucose [1]. Furthermore, increased consumption of sugar may result in high energy intakes and health problems such as obesity, type 2 diabetes, heart disease and dental problems [2]. In order to maintain a healthy body weight and avoid the debilitating diseases associated with excessive sugar consumption, the trend to use non-calorie artificial sweeteners such as saccharin, sucralose and aspartame in bakery products have been increased. Although they have sweetness 50-100 times that of sucrose but are carcinogenic [3]. Nowadays consumers are very conscious about their health that's why they prefer natural non-caloric sweeteners instead of artificial sweeteners. Stevia (*Stevia rebaudiana* Bertoni) popularly known as sugar leaf, honey leaf and candy leaf is natural, safe, non-caloric sweetener with sweetness several hundred times than sugar [4]. Stevia leaves contain a mixture of sweet diterpene glycosides as stevioside, rebaudiosides (A, B, C, D, E, F), steviolbioside, and dulcoside A [5]. Among all the glycosides, stevioside is a major sweetening component having a sweetness of 250 to 300 times that of sucrose [6]. Stevia in the diet has been associated with anti-hyperglycemic, hyperlipidemic, insulinotropic, glucagonostatic, hypotensive, anti-carcinogenic, antiviral, anti-microbial, anti-inflammatory, immunostimulatory and chemopreventative responses due to presence of strong nutritional and antioxidant profile [7].

Several researchers studied the nutritional, physicochemical and organoleptic properties of different bakery products such as muffins, cakes and cookies with stevia as sugar substitute and observed that these food products remained acceptable [8]. Due to increasing demand of bakery products with stevia. Therefore, the aim of this study was to substitute sugar in muffins with different levels of stevia leaves powder and then investigated the nutritional composition, physical, antioxidant and organoleptic properties of the functional muffins.

Material and Methods

Plant material

Stevia (*Stevia rebaudiana* Bertoni) leaves were collected from Ayub Agricultural Research Institute (AARI), Faisalabad. To remove dust, dirt and foreign material on the surface, stevia leaves were properly washed. After washing, stevia leaves were air-dried under shade at room temperature and finely powdered with the help of grinder (MJ-176-NR-3899) [9].

Chemical analysis

Stevia (*Stevia rebaudiana* Bertoni) dried leaf powder was analysed for moisture, protein, fat, fiber, ash and carbohydrates according to the reported official methods [10].

Mineral determination

Concentration of mineral contents including calcium, potassium, phosphorus, magnesium and iron in stevia leaves powder were determined through Atomic Absorption Spectrophotometer (Model: Varian AA-240, Victoria, Australia) using air acetylene flame by the method reported by Tadhani M, Subash R [11].

Stevia extract preparation

Stevioside were extracted from the dried ground leaves of stevia

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plant by using water extraction. The dried ground leaves of stevia were mixed with hot water (65°C) at the ratio of 1:45 (w/v) [12]. The mixture was kept at room temperature for 24 h, after properly shaking. It was stirred 2-3 times a day. Then the mixture was filtered through Whatman No. 1 filter paper after 24 h. Using rotary vacuum evaporator (EYELA N-1110S 115V), the filtrate was evaporated at 40-45°C [9].

Phenolic content determination

The total phenolic contents in extracts were determined by the method described by [13] using Folin-Ciocalteu reagent (Sigma- 132 Aldrich, Germany) and the absorbance was measured by UV-visible spectrophotometer (Model: Varian AA-240, Victoria, Australia) at 760 nm. The total phenolic contents in stevia leaves extracts were expressed as mg of gallic acid equivalent per gram of dry matter.

Flavonoid determination

Flavonoid content was measured by aluminium chloride colorimetric assay as described by [14] by using 10% aluminium chloride solution and 0.5 mL of 1M sodium hydroxide solution and then the samples were run on UV-visible spectrophotometer (Model: Varian AA-240, Victoria, Australia) to measure their absorbance at 510 nm. The quantification of total flavonoids in stevia extracts was expressed as mg of catechin/g dry matter.

DPPH radical scavenging activity

Free radical scavenging capacity of stevia extracts was determined by using DPPH as described by [15] by using 3.9 mL methanolic solution of DPPH and absorbance was measured at 515 nm by using UV-visible spectrophotometer (Model: Varian AA-240, Victoria, Australia). The results were expressed as mg 157 of Trolox /g dry matter.

Product development

Low calorie muffins: The functional muffins were prepared by the substitution of dried stevia leaves powder with sucrose at different levels i.e. 25:75% (T_1), 50:50% (T_2), 75:25% (T_3), 100:0% (T_4) as sugar substitute (1 g of stevia leaves powder = 20 g of sucrose) and T0 (control sample with 100% sucrose) according to the method described by [10] with slight modifications. For the preparation of muffins, the oven was preheated to 55°C. The dry ingredients required for the preparation of control muffins were flour (500 g), sugar (400 g) and baking powder (30 g). While for the preparation of functional muffins all the dry ingredients were same except sugar which was replaced in different levels with sucrose. All the dry ingredients were weighed and then mixed together after putting them into a large mixing bowl. Then the eggs (6), oil (400 mL) milk and water (up to requirement for dough mixing) were beaten together and added into the flour mixture. After that it was mixed properly. The prepared mixture was then poured into greased muffin pan and baked at 185°C for 30 minutes until golden brown.

Analysis of Stevia Muffins

Chemical analysis

Muffins were analysed for moisture, crude protein, crude fat, crude fiber, ash and carbohydrates according to the reported official methods [10].

Mineral determination

Concentration of mineral contents (calcium, potassium, phosphorus, iron, magnesium, sodium and sulphur) in stevia leaves powder were determined in stevia muffins by the procedure described by [11].

Physicochemical analysis

The stevia muffins were analyzed for physical analysis (diameter, thickness, spread factor, firmness, springiness and color).

Diameter, thickness and spread factor

The physical parameters like diameter, thickness and spread factor were analyzed through following the methodology of [16].

Firmness and springiness

Firmness and springiness were conducted by using Texture Analyzer (TA-TX2i Plus, Stable Microsystems, Godalming, UK) provided with Texture Expert software according to method described by [17].

Color measurement

The color of muffins were estimated with CIE-Lab Color Meter (CIE LAB SPACE, Color Tech-PCM, USA) according the method described by [18].

Antioxidant profile

The muffins were analysed for their antioxidant potency through different parameters like total phenolic contents, flavonoids and 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay through the methodologies of [13-15] respectively.

Organoleptic evaluation

Muffins were assessed by a trained panel of judges for various sensory attributes like taste, color, flavor, texture, appearance and overall acceptability according to the method of [19].

Statistical analysis

Data obtained was statistically analyzed using descriptive statistics and interpreted by analysis of variance (ANOVA) using M-Stat C software® package. LSD test was used to determine the level of significance between the mean values of experimental samples [20].

Results and Discussion

Characterization of stevia leaves powder

Chemical composition: The chemical composition of *Stevia rebaudiana* Bertoni leaves powder indicated that moisture, crude protein, crude fat, crude fiber, crude ash and carbohydrates were 9.7 ± 0.04 %, 10.23 ± 0.07 %, 14.87 ± 0.10 %, 4.15 ± 0.16 %, 9.65 ± 0.19 % and 51.4 ± 0.32 % respectively (Table 1). The results are in accordance with the studies of [7,21] who stated that moisture, ash, protein, fat, fiber and carbohydrates in *Stevia rebaudiana* Bertoni dried leaves powder were in the ranges of 7.35-10.73%, 12.06-13.12%, 13.68-16.92%, 0.5-6.13%, 5.03-10.12% and 57.59-63.1% respectively.

Mineral composition: In the current study the minerals including calcium, potassium, magnesium, iron and phosphorous in dried *Stevia rebaudiana* leaves powder are shown in Table 1. The results demonstrated that nutritionally important minerals such as potassium (22000 ± 96.65 ppm), calcium (13300 ± 74.22 ppm), magnesium (4500 ± 32.22 ppm), phosphorous (3200 ± 23.12 ppm) and iron (200 ± 18.77 ppm) were found in reasonable amount in stevia leaves powder. The results are in agreement with the research works of [7,22] who concluded that stevia leaves powder contained high amount of potassium, calcium, magnesium, phosphorous and iron.

Total phenols, flavonoids and DPPH assay: Table 1 showed the

results of total phenolics (20.3 ± 0.15 mg GAE/g), flavonoids (14.32 ± 0.09 mg Catechin/g) and DPPH radical scavenging activity (58.24 ± 0.30 mg Trolox/g) of *Stevia rebaudiana* Bertoni leaves powder. The presence of more phenols and flavonoids in stevia confirmed its strong antioxidant properties [23]. The existing results for total phenols, flavonoids and DPPH assay are in line with findings of [23,24] who confirmed that stevia has strong scavenging activity due to presence of high amount of antioxidants.

Chemical analysis of functional muffins

Results presented in Table 2 indicate that moisture, ash, protein, fat, fiber, and carbohydrates of muffins with stevia leaves powder were significantly affected as a function of treatments. Means for chemical composition (Table 2) showed that moisture, protein, fat, fiber, ash and carbohydrates of control (T_0) muffins were (12.08 ± 1.05%), (9.08 ± 0.12%), (21.92 ± 0.12%), (0.75 ± 0.63%), (0.93 ± 0.02%) and (55.24 ± 0.12%) respectively while in the stevia leaves powder muffins the values of these parameters ranged from (T_1 to T_4) 12.20 ± 0.67-12.63 ± 0.34%, 10.22 ± 0.12-10.69 ± 0.24%, 22.03 ± 0.07-22.14 ± 0.14%, 1.01 ± 0.57-1.30 ± 0.33%, 1.20 ± 0.05-1.51 ± 0.02% and 53.88 ± 0.15-51.73 ± 0.19% respectively. The results showed that by substituting the sucrose with stevia significantly increased the moisture content of stevia muffins due to higher gluten development and water retention in the dough. Furthermore, the protein, fiber and ash contents of muffins with sucrose replacement increased with the addition of stevia leaves powder at different levels (1.5, 3.0, 4.5 and 6.0 g) as compared to T_0 due to abundant amount of protein, ash and fiber in stevia leaves powder [25]. The carbohydrates in stevia leaves powder muffins decreased as compared to control because stevia contained zero calories. The fat content in functional muffins increased than control but the difference was not pronounced because stevia has less amount of fat content as recorded in the previous literature [7,21].

Chemical composition (%)	Moisture	9.7 ± 0.04
	Ash	10.23 ± 0.07
	Crude protein	14.87 ± 0.10
	Crude fat	4.15 ± 0.16
	Crude fiber	9.65 ± 0.19
	Carbohydrates	51.4 ± 0.32
Mineral composition (ppm)	Potassium	22000 ± 96.65
	Calcium	13300 ± 74.22
	Magnesium	4500 ± 32.22
	Phosphorous	3200 ± 23.12
Antioxidant profile	Total phenols (mg GAE/g)	20.3 ± 0.15
	Total flavonoids (mg Catechin/g)	14.32 ± 0.09
	DPPH Assay (mg Trolox/g)	58.24 ± 0.30

Values are expressed as means ± standard deviation

Table 1: Characterization of stevia leaves powder.

The results of present study are in line with the studies of [8,26] who found that moisture, ash, protein, fat, fiber content of stevia containing baked products increased and carbohydrates decreased with increasing the concentration of stevia.

Mineral composition of stevia muffins: The result of mineral composition of functional muffins is shown in Table 3. The results indicated that potassium, calcium, magnesium, phosphorous, sodium and iron of functional muffins significantly increased from T_0 to T_4

Treatments	Moisture content (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Crude ash (%)	Carbohydrates (%)
T_0	12.08 ± 1.05c	9.08 ± 0.12c	21.92 ± 0.12b	0.75 ± 0.63c	0.93 ± 0.02c	55.24 ± 0.12a
T_1	12.20 ± 0.67b	10.01 ± 0.16bc	21.96 ± 0.09b	0.88 ± 0.60bc	1.07 ± 0.04bc	53.88 ± 0.15b
T_2	12.35 ± 0.69ab	10.22 ± 0.12b	22.03 ± 0.07ab	1.01 ± 0.57b	1.20 ± 0.05b	53.19 ± 0.18bc
T_3	12.48 ± 0.47ab	10.46 ± 0.20ab	22.09 ± 0.11ab	1.17 ± 0.44ab	1.37 ± 0.03ab	52.43 ± 0.20c
T_4	12.63 ± 0.34a	10.69 ± 0.24a	22.14 ± 0.14a	1.30 ± 0.33a	1.51 ± 0.02a	51.73 ± 0.19d

Means ± standard deviation (n=3). Means in the same column with different letters are significantly different (P<0.05).
T_0= 100% sucrose
T_1= 25% stevia leaves powder: 75 % sucrose
T_2= 50% stevia leaves powder: 50 % sucrose
T_3= 75% stevia leaves powder: 25 % sucrose
T_4= 100% stevia leaves powder
Where 1g of stevia leaves powder= 20 g of sucrose

Table 2: Chemical analysis of stevia muffins.

Treatments	K (ppm)	Ca (ppm)	Mg (ppm)	P (ppm)	Fe (ppm)
T_0	120.02 ± 0.77e	90.05 ± 0.60e	32.10 ± 0.54e	21.12 ± 0.27e	2.00 ± 0.03e
T_1	250.01 ± 0.67d	140.02 ± 0.62d	64.13 ± 0.66d	46.15 ± 0.57d	3.04 ± 0.04d
T_2	560.04 ± 0.69c	310.03 ± 0.79c	120.05 ± 0.75c	94.16 ± 0.68c	4.11 ± 0.04c
T_3	850.04 ± 0.73b	480.04 ± 0.85b	180.02 ± 0.78b	120.05 ± 0.75b	7.04 ± 0.06b
T_4	1300.03 ± 0.80a	660.04 ± 0.88a	250.03 ± 0.82a	180.04 ± 0.77a	11.07 ± 0.08a

Means ± standard deviation (n=3). Means in the same column with different letters are significantly different (P<0.05).
K=Potassium; Ca=Calcium; Mg=Magnesium; P=Phosphorous; Fe=Iron.
T_0= 100% sucrose
T_1= 25 % stevia leaves powder: 75% sucrose
T_2= 50 % stevia leaves powder: 50% sucrose
T_3= 75 % stevia leaves powder: 25% sucrose
T_4= 100 % stevia leaves powder
Where 1g of stevia leaves powder=20 g of sucrose

Table 3: Mineral composition of stevia muffins.

with mean values as (120.02 ± 0.77-1300.03 ± 0.80 ppm), (90.05 ± 0.60-660.04 ± 0.88 ppm), (32.10 ± 0.54-250.03 ± 0.82 ppm), (21.11 ± 0.27-180.04 ± 0.77 ppm) and (2.00 ± 0.03-11.07 ± 0.08 ppm) respectively. The results proved that stevia leaves powder had high impact on potassium, calcium, magnesium, phosphorous and iron mean values of stevia muffins. The results are in line with the findings of [27,28] according to them mineral contents of muffins increased by the addition of date bran, carissa spinarum and ficus carica powders because these items contained high amount of minerals in them.

Antioxidant profile of stevia muffins: It is evident from Table 4 that mean values for phenols, flavonoids and free radical scavenging activity of control muffins (T_0) are 0.22 ± 0.12 mg GAE/g, 0.17 ± 0.05 mg Catechin /g and 0.32 ± 0.20 mg Trolox/g respectively. The results illustrated that total phenolic contents, flavonoids and free radical scavenging activities of muffins containing stevia increased from T_1 to T_4 (0.28 ± 0.11 mg GAE/g-1.20 ± 0.18 mg GAE/g), (0.20 ± 0.07 mg GAE/g-0.83 ± 0.08 mg Catechin/g) and (0.51 ± 0.24 mg Trolox/g-1.89 ± 0.29 mg Trolox/g) accordingly. The result depicted that with the addition of stevia leaves powder at different levels (1.5, 3.0, 4.5 and 6.0 g) in muffins, the antioxidants concentration increased as compared to control muffins. This increase may be attributed to the reason that *Stevia rebaudiana* Bertoni contain high amount of antioxidants like phenols, flavonoids etc and has strong free radical scavenging activity [23,24]. The strong antioxidant activity of phenols and flavonoids may be due to their ability to alleviate, delocalize the unpaired electrons and chelate the metal ions [23]. The results of current research are confirmed by the [29,30] who found that antioxidants in muffins increased with the addition of sweet lupin flour and apple pomace powder due to their strong antioxidant capacity.

Physicochemical parameters of functional muffins

Diameter, thickness and spread factor: Table 5 illustrated that diameter, thickness and spread factor of muffins containing stevia leaves powder as sugar substitute were significantly affected as a function of their ingredients. Progressive increase in diameter and decrease in thickness of muffins was observed with the addition of stevia leaves powder in functional muffins. Spread factor (D/T) increased with the addition of stevia leaves powder at different levels as (25% =1.5 g, 50% =3.0 g, 75% =4.5 g and 100% =6.0 g of sucrose) (Table 5). Minimum diameter (68.52 ± 0.12 mm) and maximum thickness (64.22 ± 0.05 mm) was observed in T_0 (100% wheat flour), while in the case of stevia leaves powder muffins the diameter increased from (T_1 to T_4) 69.77 ± 0.08 to 75.56 ± 0.18 mm and thickness decreased from 63.52 ± 0.07 to 56.67 ± 0.26 mm. Furthermore, maximum spread factor (1.33 ± 0.24 mm) was observed in T_4 and minimum (1.06 ± 0.14 mm) was recorded in T_0 (Table 5). The increase in diameter and spread factor while decrease in thickness may be due to less air inside the stevia muffins dough, or reduction in the capacity of the dough to retain air inside it when compared with sucrose muffins. The results are in resemblance with research work of [31] who found that the diameter of muffins prepared using maltitol increased and thickness decreased as compared to 100% sucrose containing muffins. Furthermore, [25] concluded that incorporation of stevia leaves powder in biscuits at different levels (15, 30, 60 and 100%) decreased their thickness.

Firmness and springiness: The results presented in Figures 1 and 2 indicate that muffins with sugar substitute with stevia had higher firmness and springiness values than that of control muffins. The highest values of firmness (1132.43 ± 38.98 g) and springiness (66.12 ± 0.55%) were observed in T_4 (muffins with 100% (6.0 g) stevia). T_0 showed lowest values of firmness (246.55 ± 24.56 g) and springiness (57.32 ± 0.25%). The Sweetener with a high dextrose equivalent (DE) like sucrose can help to attract water and cause the softness of the crumb of baked products [32]. The crumb hardness is considerably associated with area and volume of total air cell, so softer crumb structure of the food product was due to increased gas cell size and reduced density [33].

The firmness of muffins is directly related to its specific volume. Stevia has bulking characteristics and reduction of water holding capacity due to which firmness of stevia muffins increased [34].

Treatments	Total phenols (mg GAE/g)	Total flavonoids (mg Catechin/g)	Free radical scavenging activity (mg Trolox/g)
T_0	0.22 ± 0.12e	0.17 ± 0.05e	0.32 ± 0.20e
T_1	0.28 ± 0.11d	0.20 ± 0.07d	0.51 ± 0.24d
T_2	0.56 ± 0.10c	0.39 ± 0.09c	0.89 ± 0.22c
T_3	0.90 ± 0.14b	0.62 ± 0.02b	1.47 ± 0.27b
T_4	1.20 ± 0.18a	0.83 ± 0.08a	1.89 ± 0.29a

Means ± standard deviation (n=3) Means in the same column with different letters are significantly different (P<0.05).

Table 4: Antioxidant profile of stevia muffins.

Treatments	Diameter (mm)	Thickness (mm)	Spread factor (mm)
T_0	68.52 ± 0.12c	64.22 ± 0.05a	1.06 ± 0.14d
T_1	69.77 ± 0.08bc	63.52 ± 0.07a	1.09 ± 0.17c
T_2	70.14 ± 0.10bc	61.29 ± 0.13ab	1.14 ± 0.09b
T_3	72.21 ± 0.14b	58.34 ± 0.22ab	1.23 ± 0.12ab
T_4	75.56 ± 0.18a	56.67 ± 0.26b	1.33 ± 0.24a

Means ± standard deviation (n=3). Means in the same column with different letters are significantly different (P<0.05).
T_0= 100 % sucrose
T_1= 25 % stevia leaves powder: 75% sucrose
T_2= 50 % stevia leaves powder: 50% sucrose
T_3= 75 % stevia leaves powder: 25% sucrose
T_4= 100 % stevia leaves powder
Where 1g of stevia leaves powder=20 g of sucrose

Table 5: Physicochemical parameters of stevia muffins.

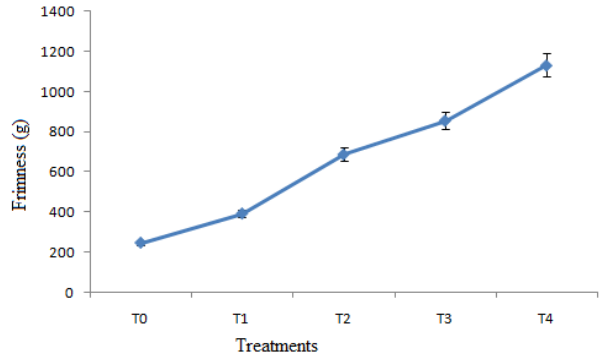

Figure 1: Graphical presentation of Firmness (g) of stevia muffins. *Values represent mean ± S.E.R. n=3. Firmness of Stevia muffins were significantly (P<0.05) different from control muffins.

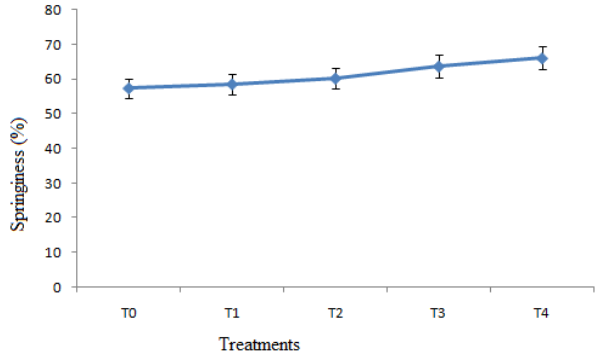

Figure 2: Graphical presentation of springiness of Stevia muffins. *Values represent mean ± S.E.R. n=3. Springiness of stevia muffins were significantly (P<0.05) different from control muffins.

Springiness is related with freshness of muffins; thus, the higher springiness values shows best quality of muffins [29]. Sucrose leads to a tenderizing effect on the muffin texture due to its ability to retard the gelatinization of starch. When sucrose was replaced with stevia leaves powder in muffin the springiness improved as compared control muffins [35].

Color: The results regarding L^*, a^* and b^* values of stevia leaves powder muffins color are shown in Table 6. Means relating L^* values of functional muffins have revealed that T_0 showed the maximum L^* color value (67.13 ± 1.13). Whereas L^* values of T_1, T_2, T_3 and T_4 were 65.52 ± 0.62, 63.32 ± 0.69 and 61.45 ± 0.47 and 58.22 ± 0.34 respectively (Table 6). According to results, maximum a^* value (4.00 ± 0.02) was recorded in T_0 and muffins with stevia (T_1 to T_4) showed the negative values of a^* that indicated greenness of muffins as -0.44 ± 0.04 to -0.89 ± 0.02. T_0 showed highest b^* mean value (25.00 ± 0.14). The results corresponding b^* values about all the treatments with stevia powder explains that these values significantly decreased from (T_1) 24.54 ± 0.16 to 19.87 ± 0.24 (T_4). According to results the brightness, redness and yellowness of control muffins were higher than muffins containing stevia powder because of caramelization and Millard reaction. The Millard reaction, non-enzymatic browning includes the contact of reducing sugars with proteins that results in attractive reddish-brown color [36]. Although sucrose is a non-reducing sugar, but it undergoes Millard reaction due to the conditions such as temperature and pH that lead to hydrolysis of the sucrose to its component sugars (fructose and glucose) which could result in maillard browning [32]. However, Replacement of sucrose with stevia powder in muffins resulted in development of only a mild brown color due to no sucrose present [36]. The results are confirmed by the research work of [25] who reported that stevioside (major glycoside in stevia) is thermally stable at high temperature. During development of food product with stevioside, they do not undergo caramelization when heated.

Organoleptic evaluation of functional muffins

Color and flavour: Color and flavor scores were significantly changed as a function of varying levels of stevia powder in muffins (Table 7). Mean scores for color and flavor among the treatments T_1 to T_4 ranged from (7.32 ± 0.20-5.22 ± 0.27) and (7.00 ± 0.28-5.33 ± 0.22) respectively. The highest mean scores of both the parameters (8.22 ± 0.25 and 7.15 ± 0.32) were obtained by the T_0 (Table 7). By increasing the amount of stevia powder, the color and flavor of muffins became greenish and different due to presence of phenols and flavonoids that resulted in lower scores for color and flavor of muffins. The results are inconformity with findings of [30,37] they stated that the lightness of the muffins significantly decreased with the stevia and apple pomace powder incorporation.

Taste, sweetness, texture and appearance: Average scores for taste, sweetness, texture and appearance scores of the muffins with stevia are presented in Table 7. According to results taste, sweetness, texture and appearance values of functional muffins significantly affected among all the treatments. The average scores (Table 7) for taste, sweetness, texture and appearance of functional muffins (T_1 to T_4) ranged from (6.82 ± 0.14-5.00 ± 0.25), (7.15 ± 0.12-7.13 ± 0.14), (7.65 ± 0.32-5.18 ± 0.17) and (7.00 ± 0.11-5.55 ± 0.08) respectively. However, highest values of taste (7.12 ± 0.12), sweetness (7.15 ± 0.10), texture (8.00 ± 0.36) and appearance (7.20 ± 0.14) were recorded for control muffins (T_0). The mean values for taste, sweetness, texture and appearance of stevia muffins decreased as compared to T_0 but remained acceptable according to judges scores.

The addition of stevia as a non-caloric sweetener resulted in bitter after taste and different texture and appearance than control muffins because of the presence of essential oils, tannins and flavonoids [38]. Results of current study are supported by the researches of [37,39] who found that taste, texture and appearance of food products with stevia decreased while sweetness was close to the control samples.

Overall acceptability

The result regarding overall acceptability of stevia muffins showed substantial increase in all the treatments as compared to control (Table 7). Keeping in view the mean scores for overall acceptability, muffin containing 100% sucrose (T_0) got maximum points (8.00 ± 0.23) as compared to other treated muffins. While T_1, T_2, T_3 and T_4 obtained 7.67 ± 0.25, 7.22 ± 0.22, 6.57 ± 0.20 and 6.33 ± 0.21 scores for overall

Treatments	L^*	a^*	b^*
T_0	67.13 ± 1.13a	4.00 ± 0.02a	25.02 ± 0.14a
T_1	65.52 ± 0.62 b	-0.44 ± 0.04b	24.54 ± 0.16b
T_2	63.32 ± 0.69c	-0.62 ± 0.05c	23.22 ± 0.12c
T_3	61.45 ± 0.47d	-0.77 ± 0.03cd	21.19 ± 0.20d
T_4	58.22 ± 0.34e	-0.89 ± 0.02d	19.87 ± 0.24e

Means ± standard deviation (n=3). Means in the same column with different letters are significantly different (*P*<0.05).
L^* = brightness; $+a^*$ = redness, $-a^*$= greenness; b^*= yellowness

Table 6: Color (L^*, a^* and b^* values) of stevia muffins.

Treatments	Color	Flavor	Taste	Sweetness	Texture	Appearance	Overall acceptability
T_0	8.22 ± 0.25a	7.15 ± 0.32a	7.12 ± 0.12a	7.15 ± 0.10	8.00 ± 0.36a	7.20 ± 0.14a	8.00 ± 0.23a
T_1	7.32 ± 0.20b	7.00 ± 0.28b	6.82 ± 0.14b	7.15 ± 0.12	7.65 ± 0.32b	7.00 ± 0.11b	7.47 ± 0.25b
T_2	6.47 ± 0.18c	6.67 ± 0.22c	6.02 ± 0.18c	7.14 ± 0.13	7.04 ± 0.21c	6.65 ± 0.10c	7.22 ± 0.22c
T_3	6.00 ± 0.24d	6.00 ± 0.34d	5.77 ± 0.20d	7.14 ± 0.11	6.32 ± 0.20d	6.12 ± 0.09d	6.57 ± 0.20d
T_4	5.22 ± 0.27e	5.33 ± 0.22e	5.00 ± 0.25e	7.13 ± 0.14	5.18 ± 0.17e	5.55 ± 0.08e	6.33 ± 0.21e

Means ± standard deviation (n=5). Means in the same column with different letters are significantly different (P<0.05).
T_0= 100% sucrose
T_1= 25% stevia leaves powder: 75% sucrose
T_2= 50% stevia leaves powder: 50% sucrose
T_3= 75% stevia leaves powder: 25% sucrose
T_4= 100% stevia leaves powder
Where 1g of stevia leaves powder= 20 g of sucrose

Table 7: Organoleptic evaluation of stevia muffins.

acceptability respectively from the judges (Table 7). The findings are supported by the results of [8,37] who interpreted that overall quality of muffins had inverse relation with concentration of stevia and apple pomace powder.

Conclusion

The bakery products especially muffins are popular among the consumers but in them cane sugar is used that resulted in health problems. Stevia a natural, non-caloric sweetener has sweetness several hundred times than sugar with no health issues. The stevia when used in muffins as sugar substitute then it can be termed as a functional muffin due to its health benefits. This study is useful in preparation of low calorie muffins containing stevia that may improve their nutritional profile and also prevent against many diseases including obesity, diabetes etc.

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References

1. Matos M, Sanz T, Rosell C (2014) Establishing the function of proteins on the rheological and quality properties of rice based gluten free muffins. Food Hydrocol 35: 150-158.
2. Carbonell-Capella JM, Buniowska M, Esteve MJ, Friola A (2015) Effect of Stevia rebaudiana addition on bioaccessibility of bioactive compounds and antioxidant activity of beverages based on exotic fruits mixed with oat following simulated human digestion. Food Chem 184: 122-130.
3. Ogden CL, Carroll MD, Flegal KM (2008) High body mass index for age among US children and adolescents, 2003-2006. JAMA 299: 2401-2405.
4. Megeji NW, Kumar JK, Singh V, Kaul VK, Ahuja PS (2005) Introducing Stevia rebaudiana, a natural zero-calorie sweetener. Current Science 88: 801-804.
5. Starrat AN, Kirby CW, Pocs R, Brandle JE (2002) Rebaudioside F, a diterpene glycoside from Stevia rebaudiana. Phytochem 59: 367-370.
6. Chatsudthipong V, Muanprasat C (2009) Stevioside and related compounds: therapeutic benefits beyond sweetness. Pharmacol Ther 121: 41-54.
7. Abdo BM (2016) Sweetness equivalence ratio of Stevia (Stevia rebaudiana Bertoni) with sugar adopted in Ethiopia. Int J Adv Biol Biomed Res 4: 58-61.
8. Zahn S, Forker A, Krugel L, Rohm H (2013) Combined use of rebaudioside A and fibres for partial sucrose replacement in muffins. LWT-Food Sci Technol 50: 695-701.
9. Kujur RS, Singh V, Ram M, Yadava HN, Singh KK, et al. (2010) Anti-diabetic activity and phytochemical screening of crude extract of Stevia rebaudiana in alloxan-induced diabetic rats. Pharmacognosy Res 2: 258-263.
10. AOAC (2005) Official methods of analysis of AOAC International (18th Edn). Association of Official Analytical Chemists, Washington D.C, USA.
11. Tadhani M, Subash R (2006) Preliminary studies on stevia rebaudiana leaves: proximal composition, mineral analysis and phytochemical screening. J Med Sci 6: 321-326.
12. Abou-Arab AE, Abou-Arab AA, Abu-Salem MF (2010) Physico-chemical assessment of natural sweeteners steviosides produced from Stevia rebaudiana Bertoni plant. Afri J Food Sci 4: 269-281.
13. Sakanaka S, Tachibana Y, Okada Y (2004) Preparation and antioxidant properties of extracts of Japanese persimmon leaf tea (kakinoha- cha). Food Chem 89: 569-575.
14. Dewanto V, Wu X, Adom KK, Liu RH (2002) Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity. J Agric Food Chem 50: 3010-3014.
15. Shahidi F, Liyana-Pathirana CM, Wall DS (2006) Antioxidant activity of white and black sesame seeds and their hull fractions. Food Chem 99: 478-483.
16. AOAC (2000) Official methods of analysis of AOAC International (17th Edn). The Association of Official Analytical Chemists, Gaithersburg, MD, USA.
17. Gao J, Brennan MA, Mason SL, Brennan CS (2016) Effect of sugar replacement with stevianna and inulin on the texture and predictive glycaemic response of muffins. Inter J Food Sci Technol 51: 1979-1987.
18. Kumar N, Sarkar BC, Sharma HK (2011) Effect of air velocity on kinetics of thin layer carrot pomace drying. Food Sci Technol Int 17: 459-469.
19. Meilgaard MC, Civille GV, Carr BT (2006) Sensory evaluation techniques (4th Edn). CRC Press, New York, p: 464.
20. Steel RGD, Torrie JH, Dickeyi D (1997) Principles and procedures of statistics: a biometrical approach (3rd Edn). McGraw Hill Book Co Inc, New York, p: 666.
21. Akbarzadeh S, Eskandari F, Tangestani H, Bagherinejad ST, Bargahi A, et al. (2015) The effect of Stevia rebaudiana on serum omentin and visfatin level in STZ-induced diabetic rats. J Diet Suppl 12: 11-22.
22. Lemus-Mondaca R, Ah-Hen K, Vega-Galvez A, Honores C, Moraga NO (2015) Stevia rebaudiana leaves: effect of drying process temperature on bioactive components, antioxidant capacity and natural sweeteners. Plant Foods Hum Nutr 71: 49-56.
23. Singh S, Garg V, Yadav D, Beg MN, Sharma N (2012) In-vitro antioxidative and antibacterial activities of various parts of Stevia rebaudiana (bertoni). Int J Pharm Pharm Sci 4: 468-473.
24. Periche A, Castello ML, Heredia A, Escriche I (2015) Influence of drying method on steviol glycosides and antioxidants in Stevia rebaudiana leaves. Food Chem 172: 1-6.
25. Garcia-Serna E, Martinez-Saez N, Mesias M, Morales FJ, del Castillo MD (2014) Use of coffee silverskin and stevia to improve the formulation of biscuits. Pol J Food Nutr Sci 64: 243-251.
26. Ruiz-Ruiz JC, Moguel-Ordonez YB, Matus-Basto AJ, Segura-Campos MR (2015) Antidiabetic and antioxidant activity of Stevia rebaudiana extracts (var. morita) and their incorporation into potential functional bread. J Food Sci Technol 52: 7894-7903.
27. Yaseen T, Rehman S, Ashraf I, Ali S, Pasha I (2012) Development and nutritional evaluation of date bran muffins. J Nutr Food Sci 2: 124.

28. Chauhan A, Tanwar B (2016) Development of value added products (bun, muffin, noodles and nuggets) by substitution with carissa spinarum and ficus carica powder. Asian J Pharm Clin Res 9: 130-136.

29. Rumiyati R, James AP, Jayasena V (2015) Effects of lupin incorporation on the physical properties and stability of bioactive constituents in muffins. Int J Food Sci Technol 50: 103-110.

30. Younas MB, Rakha A, Sohail M, Rashid S, Ishtiaq H (2015) Physicochemical and sensory assessment of apple pomace enriched muffins. Pak J Food Sci 25: 224-234.

31. Martinez-Cervera S, Salvador A, Sanz T (2014) Comparison of different polyols as total sucrose replacers in muffins: thermal, rheological, texture and acceptability properties. Food Hydrocoll 35: 1-8.

32. Hamzah Y, Aluwi NFM, Sembok WZW (2013) Effect of stevia as a sweetener substitution on the quality of Kuih Baulu. 13th ASEAN Food Conference, 9-11 September 2013, Singapore Meeting Future Food Demands: Security & Sustainability.

33. Rodriguez-Garcia J, Sahi SS, Hernando I (2014) Functionality of lipase and emulsifiers in low-fat cakes with inulin. LWT-Food Sci Technol 58: 173-182.

34. Psimouli V, Oreopoulou V (2013) The effect of fat replacers on batter and cake properties. J Food Sci 78: C1495-C1502.

35. Akesowan A (2009) Quality of reduced-fat chiffon cakes prepared with erythritol-sucralose as replacement for sugar. Pak J Nutr 8: 1383-1386.

36. Lathia N (2011) Instrumental and sensory characteristics of a baked product containing barley flour with varying amounts of beta-glucan and sugar substitute. M.Sc. thesis, Graduate School-New Brunswick, Rutgers, The State University of New Jersey, p: 94.

37. Struck S, Gundel L, Zahn S, Rohm H (2016) Fiber enriched reduced sugar muffins made from iso-viscous batters. LWT-Food Sci Technol 65: 32-38.

38. Goyal S, Samsher K, Goyal RK (2010) Stevia (Stevia rebaudiana) a bio-sweetener- a review. Int J Food Sci Nutr 61: 1-10.

39. Torri L, Frati A, Ninfali P, Mantegna S, Cravotto G, et al. (2016) Comparison of reduced sugar high quality chocolates sweetened with stevioside and crude stevia 'green' extract. J Sci Food Agric 97: 2346-2352.