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# Feasibility of Using Green Tea Powder as a Natural Antioxidant and Stevia as a Sweetener in Non-Fermented Layer Cake

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*ABSTRACT*

**Background:** Today there is an increasing demand for low-calorie and functional food products worldwide. Green tea powder (GTP) has antioxidant property due to its phenolic structure which makes it a good natural replacement for synthetic antioxidants. Stevia is a calorie-free product which can be substituted for sucrose in foods. The aim of this study was to investigate the feasibility of using GTP and stevia instead of flour and sugar, respectively, in the formulation of non-fermented layer cake**. Methods:** To do so, different concentrations of GTP (10, 20, 30% w/w) and stevia (40, 60, 80% w/w) were incorporated into the formulation of cake. Ten treatments were designed and the rheological properties of dough including farinograph and extensograph characteristics were measured. Three dough samples with superior rheological properties along with control sample were baked. The physicochemical and sensory properties of the selected samples were compared with those of control sample. **Results:** The layer cakes containing 10% GTP and 40%, 60%, and 80% stevia were selected as the superior treatments and their quality properties were compared with those of control sample. Increased concentration of stevia significantly reduced the specific volume and increased the firmness of the layer cake samples. There was no significant difference in total acceptance between the layer cakes containing GTP and stevia and control sample. **Conclusion:** The treatment containing 10% green tea powder and 80% stevia was selected as the superior treatment regarding the nutritional and quality properties.

**Keywords***: Green tea powder; Non-fermented layer cake; Stevia*

## Introduction

The cereal industry is among the largest sectors of the food industry worldwide and products such as biscuits, cookies, and cakes are the most popular products due to their convenient consumption and long shelf life (usually about four weeks). Cakes as bakery products come in many varieties and are popular among the people especially children and adolescents. Layer cake is among the most common types of cakes with a crispy crust and a soft crumb (Majzoobi and Darabzadeh, 2009). Different sweeteners are used in bakery products which affect their sweet taste, appearance, volume, color, and texture (Nour Mohammadi *et al.*, 2012).The main sweetener used in these products is sugar. It makes the product sweet and tender, develops a brown crust and

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keeps the product fresh longer (Hamaker *et al.*, 1992, Schrieber and Gareis, 2007). Stanhope (2016) reported that using high amounts of sugar in sweets reduced the plasticity of gluten thereby, decreasing their volume (Schrieber and Gareis, 2007, Walter and Soliah, 2010). Also, excess of sugar causes tooth decay and obesity. On the other hand, due to the lack of metabolism of glucose resulted by sucrose hydrolysis in the body in the absence of insulin and increased level of blood sugar in diabetics, there is a growing demand for special foods for diabetics (Kroyer, 1999) . Today, the consumers pay more attention to the quality and health of foods, so there is a great demand for healthy and low-calorie food products (Ozturk *et al.*, 2008). Bakery products such as non-fermented layer cakes and sweets are widely consumed; however, nutritionists recommend their low consumption because of their high sugar and fat content. Therefore, healthier products can be marketed by improving the nutritional value of the above-mentioned products (Rosell *et al.*, 2001). Mariotti and Alamprese studied the effect of food industry on health and growth as well as the public interest in using the sucrose replacers and reported that the consumers were tended to consume low-calorie products (Mariotti and Alamprese, 2012). Today attempts are being made to use sugar replacers such as invert syrup, glucose syrup, date syrup, molasses, stevia, etc. in such products (Lees, 2012). Stevia is the "steviol glycoside" which is the extract of Stevia rebaudiana Bertoni. It is a natural calorie-free sweetener with its extract being 250-300 times sweeter than sucrose. Research studies have shown the benefits of stevia on diabetes and hypertension. Stevia is known as the best sugar replacer for diabetics. Its positive effect on improving the flavor, taste, color, and smell of foods have been demonstrated (Kroyer, 1999, Tai *et al.*, 2019). Masoumi *et al.* conducted extensive research on stevia and its beneficial effects on diabetes and hypertension and reported that it was one of the best sugar replacers for diabetics (Masoumi *et al.*, 2020). Green tea powder (GTP) has phenolic compounds resulting in antioxidant activity which extends the shelf life and also makes a healthy product. GTP exerts healthful effects on the consumer such as preventing cancer, diabetes, hypertension, etc. (Lai and Nelson). Lu *et al.* added GTP to sponge cake and found that the amounts of protein, fiber, ash, and different catechins of the cake samples increased, while the cake volume decreased (Lu *et al.*, 2010). In the studied the chemical and functional properties of stevia and reported that increased water retention by stevia leaf powder was due to its protein content (10 g/100 g dry matter) and by increasing the stevia concentration the protein content of the cake samples increased (Walter and Soliah, 2010). Also, Lin *et al.* stated that increased level of stevia could increase the ash content of the samples due to mineral content of stevia (Lin *et al.*, 2003). Mineral content of the stevia greatly influences the ash content of the sample which is directly proportional to the concentration of stevia added to the sample (Kroyer, 1999). Stevia is a natural and calorie-free product which can improve the aroma, flavor, and color of food. It has multiple benefits for people suffering from diabetes and high blood pressure. GTP also has antioxidant properties and can prevent cancer, diabetes, reducing the incidence of arthritis, etc. (Tai *et al.*, 2019). The objective of this study was to investigate the feasibility of using GTP as a natural antioxidant and the use of stevia as natural sweetener in non-fermented layer cakes.

## Material and Methods

*Materials:* The materials used in this study included null wheat flour (Setareh Co., Iran), GTP (Golestan Co., Iran), stevia powder (Takfa Co., Iran), salt (Hedieh Co., Iran), sugar (Golestan Co., Iran), baking powder (Hermin Co., Iran), liquid oil (Naz Co., Iran), egg (Telavang Co., Iran), vanilla (Golha Co., Iran), and skim milk powder (Caseinate Co., Iran). All the chemicals used were prepared by Merck Company (Germany).

*Chemical tests of wheat flour:* The moisture, ash and protein contents, flour falling number (FN), and pH value were determined according to AACC method (American association of Cereal Chemists (AACC), 2003)

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*Rheological tests of dough:* Rheological tests of dough included farinograph (Brabander, Germany) by method of AACC No. 21-54 and extensograph tests (Brabander, Germany) by method of AACC No. 114 performed (American association of Cereal Chemists (AACC), 2003).

*Non-fermented layer cake preparation:* The control layer cake dough was prepared according to the method of Bilgen *(Bilgen et al., 2004)*. The ingredients required for preparing the layer cake were determined on the basis of 100 g of null flour. To do so, lukewarm water (114.3 g), egg (50 g), sugar (118 g), liquid oil (33.3 g), vanilla (2 g), skim milk powder (10 g) and salt (2 g) were mixed thoroughly using Moulinex mixer (Model depose 13025, France) at 380 rpm for 3 min. Then, null wheat flour (100 g) and baking powder (2.8 g) were added and mixed for 3 min to make the desirable dough. The prepared doughs of equal weight were baked in an oven (Model Saiva, Germany) at 220 ℃ for 12 min. To prepare the treatments of interest, GTP at 10%, 20%, and 30% (w/w) instead of flour and stevia at 40%, 60%, and 80% equivalent to sucrose sweetness was incorporated into the control formulation (**Table 1**). It should be noted that different ratios of GTP and stevia were determined based on the pretreatment to produce layer cakes with desirable quality properties.

**Post-bake tests**

*Tests of non-fermented layer cake*: Protein, ash, and moisture were determined using AACC 150-1, AACC 08-08, and AACC 44-16, respectively (American association of Cereal Chemists (AACC), 2003). Catechin (antioxidant) concentration was determined following the methodology of Lu *et al.* (Lu *et al.*, 2010) with the help of High Performance Liquid Chromatography (HPLC). The specific volume of the cake samples was measured by the method presented by Henry Simon company (UK) using a volume measuring device in $cm^3/g$.

***Texture measurement:*** The texture of the cake sample was measured by standard AACC 74-09 upon production (American association of Cereal Chemists (AACC), 2003), 12 and 48 hours after production using universal testing machine (Instron, Model 1116, UK). To prepare the sample for texture measurement, the crust was removed and then the crumb was cut into 2.9 cm square cubes.

*Sensory evaluation:* The sensory properties were evaluated by 6 trained panelists using 5-point hedonic scale. The cake samples were baked, cooled, cut, and coded.

*Data analysis:* Data were analyzed by ANOVA and Duncan test using Minitab software version 16 at 95% confidence interval.

## Results

*Chemical test of wheat flour:* The mean of moisture (%), ash (%), protein (%), Falling number (S) and pH of wheat flour were 12.50±0.19, 0.40±0.01, 8.50±0.35, 659±34 and 5.85±0.05, respectively.

*Rheological tests of layer cake dough:* The results of farinograph test are presented in **Table 2**. As shown in the Table, the lowest and the highest rates of water absorption were observed for treatment 3 and treatments 4 and 7, respectively ($P \leq 0.05$).

*Extensograph test:* The results of extensograph test are shown in **Table 3**. The highest tensile strength and maximum tensile strength were observed for treatments 9 followed by 6 and the lowest ones were found for control sample. The highest tensile strength within 90 min was found for treatments 9 and 6. Also tensile strength of control sample was significantly lower than that of other treatments ($P \leq 0.05$). Within 135 min, the highest tensile strength was found for treatment 9, which was significantly ($P \leq 0.05$) lower than control and other treatments and the lowest tensile strength was observed for control.

*Determination of specific volume of selected treatments:* As shown in **Table 4**, treatment 1 had the largest dough volume showing a significant ($P \leq 0.05$) difference from control and other treatments and the lowest specific volume was observed for treatment 3.

*Texture test of selected treatments:* As shown in **Table 5**, the results of compression test by Instron machine demonstrated that by increasing time and stevia concentration in the formulation of cake, its firmness increased significantly ($P < 0.045$). The highest and the lowest levels of firmness were observed for treatment 3 (80% stevia + 10% GTP) and treatment 1 (40% stevia + 10% GTP).

*Chemical test of selected treatments:* The results of chemical test are shown in **Table 6**. The highest and the lowest moisture contents were found for control and treatment 3, respectively; however, there was no significant ($P < 0.05$) difference in moisture content between the treatments.

*Total acceptance of selected treatments*: the mean of total acceptance of all selected treatments (0, 1, 2 and 3) were 5.00±0.00. There was no significant ($P > 0.05$) different in total acceptance between the selected treatments and control sample.

**Table 1.** Non-fermented layer cake treatments.

| Treatments | Descriptions |
|---|---|
| 0 | Non-fermented layer cake without stevia and GTP (control) |
| 1 | Non-fermented layer cake containing 10% w/w GTP + 40% stevia |
| 2 | Non-fermented layer cake containing 10% w/w GTP + 60% stevia |
| 3 | Non-fermented layer cake containing 10% w/w GTP + 80% stevia |
| 4 | Non-fermented layer cake containing 20% w/w GTP + 40% stevia |
| 5 | Non-fermented layer cake containing 20% w/w GTP + 60% stevia |
| 6 | Non-fermented layer cake containing 20% w/w GTP + 80% stevia |
| 7 | Non-fermented layer cake containing 30% w/w GTP + 40% stevia |
| 8 | Non-fermented layer cake containing 30% w/w GTP + 60% stevia |
| 9 | Non-fermented layer cake containing 30% w/w GTP + 80% stevia |

**Table 2.** Results of farinograph test.

| Treatments | Water absorption (%) | Dough expansion time (min) | Dough consistency and stability (min) | Degree of dough softening after 10 min (Brabender) | Degree of dough softening after 12 min (Brabender) | Farinograph quality number |
|---|---|---|---|---|---|---|
| 0 | 52.60±0.15$^{d}$ | 2.10±0.01$^{ab}$ | 2.80±0.15$^{bc}$ | 38.00±0.15$^{b}$ | 88.00±0.50$^{de}$ | 68.0±0.00$^{g}$ |
| 1 | 52.30±0.10$^{d}$ | 1.90±0.20$^{a}$ | 5.00±0.10$^{e}$ | 34.00±0.25$^{ab}$ | 73.00±0.10$^{a}$ | 73.0±0.10$^{h}$ |
| 2 | 51.30±0.35$^{c}$ | 1.85±0.12$^{a}$ | 4.75±0.25$^{e}$ | 36.00±0.15$^{bc}$ | 75.00±0.00$^{b}$ | 74.00±0.24$^{ahi}$ |
| 3 | 44.50±0.22$^{a}$ | 1.80±0.10$^{a}$ | 3.55±0.15$^{d}$ | 30.00±0.10$^{a}$ | 76.00±0.20$^{b}$ | 76.00±0.00$^{i}$ |
| 4 | 66.00±0.30$^{e}$ | 3.05±0.10$^{cd}$ | 2.10±0.15$^{ab}$ | 38.00±0.40$^{bc}$ | 87.00±0.50$^{d}$ | 60.0±0.50$^{f}$ |
| 5 | 51.00±0.35$^{c}$ | 2.09±0.10$^{c}$ | 3.30±4.25$^{cd}$ | 41.00±0.00$^{bc}$ | 89.00±0.20$^{ef}$ | 58.0±1.00$^{e}$ |
| 6 | 49.40±0.32$^{b}$ | 2.00±0.20$^{a}$ | 2.73±0.55$^{bc}$ | 43.10±0.10$^{bc}$ | 80.00±1.00$^{c}$ | 53.0±1.00$^{d}$ |
| 7 | 72.20±0.36$^{ab}$ | 3.50±0.10$^{d}$ | 1.98±0.50$^{a}$ | 40.00±0.00$^{bc}$ | 90.0±0.15$^{f}$ | 48.0±0.50$^{c}$ |
| 8 | 52.80±0.35$^{d}$ | 2.40±0.10$^{c}$ | 1.90±0.20$^{a}$ | 48.00±0.10$^{bc}$ | 98.00±0.00$^{g}$ | 45.0±1.00$^{b}$ |
| 9 | 52.30±0.12$^{d}$ | 2.00±0.10$^{a}$ | 1.50±0.10$^{a}$ | 50.00±0.00$^{c}$ | 105.0±0.20$^{h}$ | 43.0±1.00$^{a}$ |

Values are expressed as mean±SD. Dissimilar letters in each column represent significant difference at 5% significance level. Treatments: (0) wheat flour, (1) 40% stevia + 10% GTP, (2) 60% stevia + 10% GTP, (3) 80% stevia + 10% GTP, (4) 40% stevia + 20% GTP, (5) 60% stevia + 20% GTP, (6) 80% stevia + 20% GTP, (7) 40% stevia + 30% GTP, (8) 60% stevia + 30% GTP, (9) 80% stevia + 30% GTP.




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**Table 3.** Results of extensograph test.

| Treatment | A (cm$^2$) | A (cm$^2$) | A (cm$^2$) | R50 (B.U) | R50 (B.U) | R50 (B.U) | E (mm) | E (mm) | E (mm) | R50/E (Bμ/mm) | R50/E (Bμ/mm) | R50/E (Bμ/mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45´ | 90´ | 135´ | 45´ | 90´ | 135´ | 45´ | 90´ | 135´ | 45´ | 90´ | 135´ |
| 0 | 123$^{e}$ | 111$^{a}$ | 131.85$^{a}$ | 527.10$^{a}$ | 580.10$^{a}$ | 690.10$^{a}$ | 151.80$^{e}$ | 125.7$^{d}$ | 131.8$^{h}$ | 3.47$^{a}$ | 2.52$^{a}$ | 5.05$^{a}$ |
| 1 | 115$^{Cd}$ | 122.3$^{b}$ | 136.30$^{b}$ | 680.85$^{b}$ | 782.90$^{b}$ | 790.90$^{d}$ | 111.00$^{d}$ | 130.5$^{e}$ | 121$^{e}$ | 6.13$^{b}$ | 2.67$^{a}$ | 6.53$^{bc}$ |
| 2 | 119$^{d}$ | 124.3$^{b}$ | 140.30$^{c}$ | 700.90$^{c}$ | 760.90$^{bc}$ | 810.90$^{f}$ | 108.75$^{d}$ | 120$^{b}$ | 110$^{c}$ | 6.44$^{b}$ | 3.3$^{b}$ | 7.36$^{cd}$ |
| 3 | 120.5$^{d}$ | 127$^{c}$ | 135$^{b}$ | 800.5$^{d}$ | 710.9d | 699.9$^{b}$ | 76.85$^{b}$ | 122.5$^{c}$ | 129$^{g}$ | 10.41$^{a}$ | 2.85$^{ab}$ | 5.41$^{a}$ |
| 4 | 116$^{c}$ | 135$^{d}$ | 149$^{d}$ | 780.05$^{e}$ | 790.1$^{c}$ | 800.00$^{e}$ | 89.00$^{c}$ | 130$^{e}$ | 118$^{d}$ | 8.79$^{c}$ | 2.42$^{a}$ | 6.77$^{c}$ |
| 5 | 103$^{a}$ | 150$^{e}$ | 157.$^{e}$00 | 785.30$^{f}$ | 810.15$^{d}$ | 899.1$^{1h}$ | 86.00$^{c}$ | 118.5$^{ba}$ | 104.5$^{b}$ | 9.13$^{cd}$ | 3.37$^{b}$ | 8.64$^{e}$ |
| 6 | 130$^{f}$ | 157$^{f}$ | 171.$^{0f0}$ | 790.25$^{i}$ | 799.0$^{c}$ | 812.40$^{j}$ | 80.00$^{b}$ | 129$^{e}$ | 100.50$^{a}$ | 9.87$^{de}$ | 2.53$^{a}$ | 8.12$^{de}$ |
| 7 | 120$^{d}$ | 160.$^{g}$0 | 170.0$^{f}$ | 783.80$^{j}$ | 870.10$^{f}$ | 700.90$^{c}$ | 89.00$^{c}$ | 125.0$^{d}$ | 1236.5$^{f}$ | 8.80$^{c}$ | 2.46$^{a}$ | 5.54$^{ab}$ |
| 8 | 107$^{b}$ | 167$^{h}$ | 175.0$^{g}$ | 845.40 | 835.35$^{e}$ | 890.10$^{i}$ | 73.90$^{ab}$ | 120$^{b}$ | 105.50$^{b}$ | 11.43$^{f}$ | 2.94$^{ab}$ | 8.43$^{de}$ |
| 9 | 137$^{g}$ | 171$^{i}$ | 179.0$^{h}$ | 862$^{l}$ | 890.9$^{g}$ | 900.90$^{j}$ | 70.50$^{a}$ | 118$^{e}$ | 100$^{a}$ | 12.22$^{f}$ | 3.3$^{b}$ | 8.19$^{de}$ |

Values are expressed as mean. A: Consumed energy or area under the curve, R50: resistance to stability to 50 mm change, E: tensile ability, B.U: Brabender units, Dissimilar letters in each column represent significant difference at 5% significance level. Treatments: (0) wheat flour, (1) 40% stevia + 10% GTP, (2) 60% stevia + 10% GTP, (3) 80% stevia + 10% GTP, (4) 40% stevia + 20% GTP, (5) 60% stevia + 20% GTP, (6) 80% stevia + 20% GTP, (7) 40% stevia + 30% GTP, (8) 60% stevia + 30% GTP, (9) 80% stevia + 30% GTP.

**Table 4.** Results of specific volume test.

| Treatments | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Specific volume (cm$^3$/g) | 1748.55±7.15$^{a}$ | 2103.48±5.20$^{b}$ | 1616.08±2.12$^{a}$ | 1580.55±1.12$^{a}$ |

Values are expressed as mean ± SD. Dissimilar letters in each column represent significant difference (P≤0.05). Treatments: (0) wheat flour, (1) 40% stevia + 10% GTP, (2) 60% stevia + 10% GTP, (3) 80% stevia + 10% GTP.

**Table 5.** Results of texture measurement by Instron machine (N).

| Treatments | 12 h | 24 h | 48 h |
|---|---|---|---|
| 0 | 0.91±0.15$^{c}$ | 0.97±0.11$^{c}$ | 0.99±0.06$^{c}$ |
| 1 | 1.0±04.11$^{c}$ | 1.0±08.09$^{c}$ | 1.0±11.13$^{c}$ |
| 2 | 1.0±32.13$^{b}$ | 1.0±37.10$^{b}$ | 1.0±41.12$^{b}$ |
| 3 | 1.0±61.18$^{a}$ | 1.0±65.13$^{a}$ | 1.0±69.15$^{a}$ |

Values are expressed as mean ± SD. Dissimilar letters in each column represent significant difference (P≤0.05). Treatments: (0) wheat flour, (1) 40% stevia + 10% GTP, (2) 60% stevia + 10% GTP, (3) 80% stevia + 10% GTP.

**Table 6.** Chemical properties of cakes containing green tea and stevia.

| Treatments | Moisture (%) | Ash (%) | Protein (%) | Epigallocatechin Gallate (mg/100g) |
|---|---|---|---|---|
| 0 | 29.30±0.35$^{a}$ | 0.83±0.20$^{a}$ | 7.30±0.80$^{a}$ | Not detected |
| 1 | 29.26±0.60$^{a}$ | 0.97±0.15$^{a}$ | 8.30±0.20$^{ab}$ | 161.02±2.00$^{b}$ |
| 2 | 29.00±0.42$^{a}$ | 1.02±0.35$^{a}$ | 8.91±0.32$^{b}$ | 160.29±0.50$^{b}$ |
| 3 | 28.60±0.50$^{a}$ | 1.17±0.45$^{a}$ | 9.01±0.10$^{b}$ | 159.10±1.20$^{b}$ |

Values are expressed as mean ± SD. Dissimilar letters in each column represent significant difference (P≤0.05). Treatments: (0) wheat flour, (1) 40% stevia + 10% GTP, (2) 60% stevia + 10% GTP, (3) 80% stevia + 10% GTP.

## Discussion

The results of farinograph test are presented in **Table 2**. As shown in the table, the lowest and the highest rates of water absorption were observed for treatment 3 and treatments 4 and 7, respectively ($P \leq 0.05$. The increased water absorption is





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attributed to the presence of fiber and cellulose compounds, gums, dextrin, pectin, and starch in green tea leaves. As indicated in **Table 2**, the longest and the shortest dough expansion times were found for treatments 7 followed by 4 and treatments 3 followed by 2 and 1 showing no significant difference ($P$ > 0.05). Clarke *et al.* showed that the addition of 5%, 10%, and 15% stevia to wheat flour significantly increased the dough expansion time (Clarke *et al.*, 2002); however, 20% stevia decreased the expansion time significantly. Also, the lowest consistency and stability were observed for treatments 7, 8, and 9 and the highest ones were found for treatments 1 followed by 2. In the another studied the effect of ultra-refined GTP on the rheological properties of wheat flour and stated that increased amount of GTP resulted in a significant increase in the dough stability (Lu *et al.*, 2010). The polyphenolic compounds of green tea can form very strong bond with the proteins of wheat flour resulting in an increase in dough stability. The highest degree of dough softening was found for treatment 9 after 12 min followed by treatments 8 and 7 showing a significant difference from control and other samples. Treatment 1 had the lowest degree of dough softening being significantly different from control and other treatments. Oh *et al*. also examined the effect of GTP on dough rheology and reported similar results as high concentrations of GTP increased the degree of dough softening (Oh and Kim, 2002). The greatest and the smallest quality numbers were observed for treatments 3 and 2 and treatments 9, 8, and 7, respectively. The results of extensograph test are shown in **Table 3**. The highest tensile strength and maximum tensile strength were observed for treatments 9 followed by 6 and the lowest ones were found for control sample. The highest tensile strength within 90 min was found for treatments 9 and 6. Also tensile strength of control sample was significantly lower than that of other treatments ($P \leq 0.05$). Within 135 min, the highest tensile strength was found for treatment 9, which was significantly ($P \leq 0.05$) lower than control and other treatments and the lowest tensile strength was observed for control. Oh *et al.* studied the addition of green powder to wheat flour dough and reported that tensile strength of dough increased as the amount of green tea increased (Oh and Kim, 2002). Within 45, 90, and 135 min, the highest and the lowest tensile strengths were observed for control and treatment 9, respectively. Within 45 and 90 min, the smallest and the greatest numbers were found for control and treatments 8 and 9, showing no significant difference ($P \leq 0.05$). Within 135 min, the smallest and the greatest numbers were found for control + treatment 3 and treatment 9, respectively, which were significantly different from other treatments ($P \leq 0.05$). Within 45 min, the highest and the lowest amounts of energy were observed for treatments 9 and 5, respectively. Within 90 and 135 min, the highest and the lowest amounts of energy were observed for treatment 9 and control. Oh *et al*. added green tea to wheat flour and reported that within 45 and 90 min, the area under the dough curve increased significantly as the concentration of green tea increased and decreased within 135 min (Oh and Kim, 2002). As shown in **Table 4**, treatment 1 had the largest dough volume showing a significant difference ($P \leq 0.05$) from control and other treatments and the lowest specific volume was observed for treatment 3. Lu *et al.* investigated the quality and antioxidant properties of green tea and stated that as the amount of green tea increased the volume of cake decreased significantly (Lu *et al.*, 2010). Increased level of flour replacement with cellulose led to further weakening of the gluten network and since the gluten network is responsible for gas retention in bakery products, the volume of cakes decreased (Shahidi and Ambigaipalan, 2015). Walter and Soliah added stevia to bakery products and stated that the cake sample containing 100% stevia had more density and less voluminous than other treatments containing stevia and sugar 25 and 50% stevia resulted in increased specific volume, while the addition of 75 and 100% stevia decreased the specific volume of the samples (Walter and Soliah, 2010). As shown in **Table 5**, the results of compression test by Instron machine demonstrated that by increasing time and stevia concentration in

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the formulation of cake, its firmness increased significantly ($P < 0.045$). The highest and the lowest levels of firmness were observed for treatment 3 and treatment 1. Also, Lu *et al.* studied the quality and antioxidant properties of green tea cake and stated that by increasing GTP concentration, the firmness of cake increased significantly (Lu *et al.*, 2010).

The results of chemical test are shown in **Table 6**. The highest and the lowest moisture contents were found for control and treatment 3, respectively; however, there was no significant difference ($P > 0.05$) in moisture content between the treatments. Lu *et al.* also reported that by increasing GTP concentration, the moisture content of the sponge cake samples remained constant (Lu *et al.*, 2010). The highest and the lowest ash contents were found for treatment 3 and control, showing no significant difference ($P > 0.05$). The highest and the lowest protein contents were observed for treatments 2, 3 and control, respectively. Since, epigallocatechin gallate is the most abundant catechin in green tea, its content was measured in the present study which was found to be significantly higher in all treatments compared to control sample. Zhumaliyeva added GTP to flour and showed that protein, fiber, ash, and different catechins contents of the cake samples increased while their volume decreased (Zhumaliyeva *et al.*, 2015).

## Conclusion

The results demonstrated that the addition of different levels of green tea and stevia had a significant effect on rheological parameters and texture of the produced non-fermented layer cakes. Also there was no positive relationship between the addition of GTP and farinograph andextensograph characteristics. The added GTP increased water absorption and dough expansion time and decreased quality number, consistency, and stability of dough, as the samples containing 10% green and 80% stevia had the highest quality number, consistency, and stability compared to control and other treatments. Since there was no significant difference in total acceptance between the selected samples containing GTP + stevia and control, treatment 3 (80% stevia + 10% GTP) was selected as the superior treatment due to its lower calorie and improved nutritional properties.

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## Authors' contributions

Nateghi L involved in practical work, writing and editing the manuscript. Zarei F involved in writing the manuscript and statistical data analysis. Authors approved the final version of manuscript for publishing.

## Conflict of interests

The authors declare that there was no conflict of interest in this work.

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