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Utilization of Stevia Leaves Powder in Reduced Calorie Cake

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ABSTRACT

The aim of this paper was to study the possibility of using stevia leaves powder as sugar replacer with substitution ratio of 10, 20 and30% of sucrose in producing low calorie cake. There was an assessment of the physicochemical and sensory properties. The substituted sucrose was compensated by indigestive polydextrose. The results affirmed that there was an increment in the amount of protein, ash and crude fiber and decrement in carbohydrate and energy. The height and specific volume of cake decreased with the addition of stevia leaf powder. The sensory quality of the 10% stevia leaves powder cake tested by appearance, taste, color, odor and texture was better than that of the control, and overall acceptability of the cake with the addition of 10% stevia leaf powder was the best.

Keywords: Cake, low calorie and stevia

INTRODUCTION

Today consumers are more cautious about low calorie foods and beverages. Cakes are well accepted all over the word due to their appropriate organoleptic properties (Quatromoni *et al.,* 2002). Sucrose is the main sweetener in cakes. In addition to sweetening power, sucrose acts as a tenderizer and stabilizer by increasing the egg protein denaturation and starch gelatinization temperature (Baeva *et al.,* 2003). However, due to its high levels of sucrose in cake, some health problems such as obesity created as the result of over-consumption (Chung *et al.,* 2009). Low/noncaloric sweeteners can provide some expectations for those who want to avoid the debilitating diseases the debilitating diseases associated with excessive sugar consumption (Malik *et al.,* 2006). An important class of low caloric sugar substitutes is known as high intensity sweetener, this is at least 50 - 100 times sweeter than sucrose (Gupta *et al.,* 2013). Nowadays, the most common high intensity sweeteners in the world market are made of synthetic compounds. A frequent metallic aftertaste of such synthetic sweeteners does not provide the realistic taste of sugar as well as some types of synthetic sweeteners such as saccharin is associated with the potential risk of cancer of bladder when they are used heavily (Swithers *et al.,* 2009).

Sugar alcohols are some kind of carbohydrates with slow and incomplete absorption that have been frequently used to produce reduced-calorie sponge cakes (Prakash and DuBois, 2008). Therefore, finding other alternative sweeteners especially from natural sources would be of a great value in this area. Stevia is a medical and commercial natural sweetener plant used in a wide range in the world. Stevia named botanical with *rebaudiana Bertoni*. Stevia bush leaves have specific glycosides that produce sweeteners but do not have calories value. It is estimated that it is 300 times sweeter than the sugar. Stevia (*Stevia rebaudiana Bertoni*) is a low-calorie plant, because it provides the body with only 2.7 kcal/g. Biotech companies commercialize the production of different forms of stevia through tissue culture and sale of stevia such as freshly leaves, liquids, and leaf powder (Aswin *et al*., 2015).

Many researchers (El-Azab and Bothayna, 1997; El-Hofi *et al*., 2004) investigated the effect of utilizing an admixture of sugar replacers (sorbitol, fructose, and xylitol) or synthetic sweeteners (aspartame, acesulfame-k, and saccharine) with sugar on the attributes of the prepared cakes. the authors revealed that the substitution of sugar (sucrose) with sugar replacers or sweeteners with levels more than 25% caused a decrement in acceptability and the quality of the processed cakes. Thence, there is an importance of using an appropriate bulking factor and sweeteners to substitute conventional sugars in order to enhance the quality attributes of the cakes (Lin and Lee, 2005). Non-digestible dextrin is widely used in food production. One of the most important uses is such as an agent of bulking (Granstrom and Leisola 2009). This is generated by enzymatic and heat treatment of cornstarch, causing an unsystematic distribution of β- and α- (1-4), (1-2), (1-6), and (1-3) bonds with a mean molecular weight about 2,000 Daltons (Ohkuma and Wakabayashi, 2001). The aim of this paper was to study the possibility to substitute10, 20 and30% of sucrose with stevia leaves powder for producing low calorie cake and it would be a great replacement diet for diabetics.

MATERIALS AND METHODS

1. Materials

The ingredients were wheat flour (72% extraction), powdered sucrose, butter, vanilla, baking powder, dry milk powder and fresh whole eggs were obtained from the local market. Stevia leaves (*Stevia rebaudiana*) were purchased from Sugar Crops Research Institute, Agriculture Research Center, Kafrelshiekh, Egypt.

2. Preparation of stevia leaves powder (SLP):

The field's samples were cleaned and the green fresh leaves were allowed to dry using an oven at 60ºC for 16 hrs. Once dried, it was milled, then sieved (60 meshes) and kept in closed plastic bags in the laboratory until analyzed.

3. Cake preparation

The cake was prepared using the formula of Bedoya-Perales and Steel (2014) that includes 28grams of wheat flour (72%), 13.55 grams of eggs, 10 milliliters of milk, 0.45 gram of baking powders, 0.2 gram of vanilla, 24 grams of sugar and 24 grams of butter. To prepare the control cake, the sugar was mixed with homogenated eggs and butters that containing vanilla for 20 minutes using standard mixer. Wheat flour and baking powder were added in small portions and mixed for five minutes, then baked at 205C for 30minutes. To prepare the replacer cake, sugar cake formulas (weight

basis) 10, 20 and 30% of sucrose was replaced with stevia leaves powder.

4. Proximate composition

Chemical composition of stevia leaves powder and cake samples (moisture, crude protein, ether extract and ash) was estimated using A.O.A.C.(2005) methods, where total carbohydrates were determined using a method as described by Bamigbola *et al.* (2016). The total value of calories was calculated by the equation stated via FAO/ WHO (1974).

Where,

energy(calories) = 4 (carbohydrate + protein) + 9 (fat).

5. Specific gravity and pH :

The specific gravity of the dough is determined by the weight ratio of the standard container full of dough to the weight of the container full of the water. The pH of the dough is estimated by directly dipping the pH meter electrode into the dough at the room temperature by the digital pH meter(Jenway, Model 3020).

6. Cakes volume, height, specific volume and Moisture absorption:

Cakes volume (cm^3), height in the center (cm), specific volume (v/w) and moisture absorption were conducted according to A.A.A.C (2002) methods and calculated using the following equation

$$\%\text{Moisture absorption} = \frac{\text{Submerged weight of cake cub}}{\text{Original weight of cake cub}} \times 100$$

7. Crust Color:

Crust color was evaluated regarding the method suggested by Attia *et al.* (1993). The crust of the cake (1g) was extracted with 5 mL acetone (80%) for 24 h at room temperature and the absorbance of the extract was measured at 420 nm (S1200, Unico, NJ).

8. Ink print:

Sponginess was determined according to the methods described by Desai *et al.* (2010). Sponginess was performed by ink print texture of cut cake using a sharp cutter and printing by ink print on white paper

9. Sensory evaluation of cake:

The baked cakes were served to panel of 20 judges. The panelists were asked to evaluate color, taste, texture, aroma and overall acceptability on a 1 to 10 hedonic scale as described by Ahmed *et al.* (2012). A score 1 being "dislike extremely" and 10 being "like extremely".

3. Statistical analysis

The variance of the results was analyzed by (ANOVA) one way. The SPSS programe (version 16, 2007) was implemented. Tukeys B-test was used to compare the differences among individual means.

RESULTS AND DISCUSSION

1. Chemical composition of dried stevia leaves powder

The data given by the chemical analysis of dried stevia leaves powder showed that moisture, protein, fat, ash, crude fiber and carbohydrates were 5.21, 12.93, 3.31, 8.74, 16.19, and 58.83%, respectively (Table 1). These results are in agreement with those reported by Tadhani and Subhash (2006), Muanda *et al.* (2011) and Shivanna *et al.* (2013). They reported that protein, fat, crude fiber, ash, and carbohydrates were (8.4 - 19.31%), (2.3 - 6.2%), (13.24 - 19.8%), (7.89 - 13.64%) and (35.2 – 52.8%), in this order.

Table 1. Gross chemical composition of dried stevia leaves powder (%on dry weight basis).

Component (%)	Moisture	Crude protein	Ether extract	Ash	Crude fiber	*Total carbohydrate
Stevia leaves powder	5.21	12.93	3.31	8.74	16.19	58.83

***Total carbohydrates were calculated by difference**

Total carbohydrates = 100 – (protein+ ether extract + Ash + crude fiber)

2. Effect of stevia leaves powder on chemical composition and energy content of low calorie cakes

The chemical composition of prepared cake regarding crude fiber, crude protein, ash, crude fat, and total carbohydrate are displayed in Table 2. The results in Table 2 appeared a gradually increasing in cake content of protein, crude fibre, ash and total carbohydrate as a function for levels of stevia leaves powder increment until reach to 30%. The crude fiber, protein, ash and crude fat contents of cake were gradually increased from12.50 to13.40%, from0.70 to1.85%, from1.20 to1.80% and from24.86 to25.09% respectively, as a function for increasing the amounts of stevia leaves powder. Also, data in the same table cleared that substitution of 10%, 20% or 30% sucrose with stevia leaves powder reduced gradually total carbohydrates and energy content of the prepared cakes. The energy decrement percentages were 8.52%, 9.97% and 11.44% when 10%, 20% and 30% of sucrose was substituted with stevia leaves powder, respectively. These results agreed with those of Martinez-Cervera *et al.* (2012).

Table 2. Chemical composition and energy content of low calorie cakes

Components (%)	Cake samples			
	Control	10% stevia leaves powder	20% stevia leaves powder	30% stevia leaves powder
Crude fiber	0.7^{d}	1.07^{c}	1.46^{b}	1.85^{a}
Crude protein	12.5^{d}	12.78^{c}	13.09^{b}	13.40^{a}
Ash	1.20^{d}	1.41^{c}	1.59^{b}	1.80^{a}
Ether extract	24.86^{b}	24.91^{b}	25.01^{a}	25.09^{a}
Total Carbohydrate	51.74^{a}	49.34^{b}	46.94^{c}	44.54^{d}
Energy (K.cal.)/100g	516.7^{a}	472.67^{b}	465.21^{c}	457.57^{d}
Energy decrement (%)	-	8.52^{c}	9.97^{b}	11.44^{a}

Mean followed by different letters in the same row differs significantly (P≤0.05).

3. Low calorie cake batter physical characteristics:

Data tabulated in Table (3) revealed that there was a significant influence on cake dough specific gravity as a result of stevia leaves powder levels increments. Cake batters prepared with substituting 30% of sucrose with stevia leaves powder had a higher specific gravity than control and other treatments. The results indicat that substituting 30% of sucrose with stevia leaves powder might prevent the formation air cells with great numbers inside the cakes batter.

Table 3. Physical properties of low calorie cakes batter

Samples	Specific gravity (cm^3/g)	pH
Control	0.91^{d}	6.8^{a}
10% stevia leaves powder	0.93^{c}	6.7^{b}
20% stevia leaves powder	0.94^{b}	6.6^{c}
30% stevia leaves powder	0.96^{a}	6.6^{c}

Mean followed by different letters in the same column differs significantly (P≤0.05).

The pH values of cakes batter were not influenced by the levels of substitutions as shown in Table (3). in all cakes batter the values of pH were within the range of the optimal values(6.5 to 7.7) according to Hussein *et al.* (2011).

4. Quality properties of low calorie cakes

Volume, weight, specific volume, moisture absorption and crust color of cake integrated with stevia leaves powder were measured and the results were tabulated in table (4). The data in the Table (4) revealed decrease in volume, weight and specific volume of cake with increasing levels of sucrose substitution with stevia leaves powder up to 30%. The volume, weight and specific volume of cake decreased gradually from 374 to 298cm3, from 83.0 to 75.5g and from 4.51 to 3.94cm3/g respectively, with increasing proportion of stevia leaves powder. Also, data in the same table cleared that substituting 10%, 20% or 30% of sucrose with stevia leaves powder increased gradually moisture absorption and crust color values of the low calorie cakes from 102.3 to 125.4% and 0.037 to 0.053, respectively. The obtained results were in the same trend with those recorded by Choi *et al.* (2013).

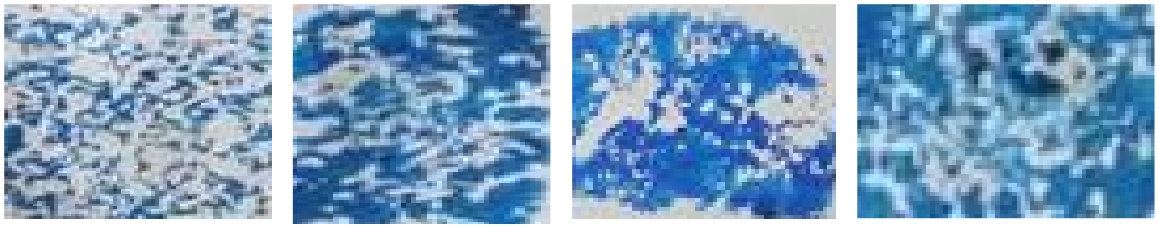
Table 4. Quality properties of low calorie cakes

Samples	Volume (cm^3)	Weight (g)	Specific volume (cm^3/g)	Moisture absorption (%)	Crust color
Control	374^{a}	83^{a}	4.51^{a}	102.3^{d}	0.037^{c}
10% stevia leaves powder	348^{b}	81.4^{b}	4.30^{b}	109.7^{c}	0.041^{b}
20% stevia leaves powder	319^{c}	77.8^{c}	4.10^{c}	117.5^{b}	0.049^{b}
30% stevia leaves powder	298^{d}	75.5^{d}	3.94^{d}	125.4^{a}	0.053^{a}

Mean followed by different letters in the same column differs significantly (P≤0.05).

5. Cake sponginess

The sponginess of cakes prepared using different levels of stevia leaves powder was shown in Figures (1). It is clear from these Figures that there were big differences between the control cake and the rest of the tested samples that have different levels of stevia leaves powder from the sponginess point of view. Apparent also from these Figures that sponginess and cell regulation of cake decreased when stevia leaves powder percentages was increased from 10% up to 30% of sucrose, where the best sponginess properties of cake was found when 10% of sucrose was substituted with stevia leaves powder. The results of Choi *et al.* (2013) were in the same trand as our findings



Control **10% stevia leaves powder** **20% stevia leaves powder** **30% stevia leaves powder**

Fig. 1. Ink print of cake prepared by different levels of stevia leaves powder

6. Sensory evaluation of prepared cake

The results about sensory scores of cake integrated with stevia leaves powder were tabulated in Table5. Those data stated that cake contained 10% stevia leaves powder obtained highest scores of appearance (9.50), texture (9.00), and overall acceptability (9.04) in comparison with control cake and other cakes samples. One can observe that, the color score (9.60) and taste score(9.32) were higher than control cake sample. Although, the cake with 10% SLP was given a better overall acceptability score. Thus, the cakes contained 10% SLP given the overall acceptability score of cake with 10% SLP is considered as standardized and utilized for additional investigations.

Generally, all investigated samples were acceptable. Those results were in the hormone with those found by Choi *et al.* (2013).

Table 5. Sensory properties of low calorie cake

Treatment Sensory	Control	10% stevia leaves powder	20% stevia leaves powder	30% stevia leaves powder
Appearance	8.73^{b}	9.50^{a}	8.60^{c}	8.25^{d}
Taste	9.32^{a}	8.95^{b}	8.43^{c}	8.40^{d}
Colour	9.60^{a}	8.42^{b}	8.26^{c}	8.15^{d}
Odour	9.15^{b}	9.60^{a}	8.67^{c}	8.61^{d}
Texture	8.50^{b}	9.00^{a}	8.41^{c}	8.24^{d}
Total acceptability	8.67^{b}	9.04^{a}	8.42^{c}	8.00^{d}

Mean followed by different letters in the same row differs significantly (P≤0.05)

REFERENCES

AACC (2002). Approved methods of the American Association of Cereal Chemists. Published by the American Association of Cereal Chemists Inc. St. Paul., Minnesota, USA.

Ahmed, A. R.; Mohammed, I. and Senge, B. (2012). Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake. *Annals of Agricultural Sciences*, *58*(1), 83-95.

AOAC (2005). Official Methods of Analysis of the Association of Official Analytical Chemists, 18th ed., AOAC International, Arlington, Virginia, USA.

Aswin, K. A..; Sankara, N. B. and Sandiya, R. (2015). Stevia the Ideal Sweetener: A Review. Research Journal of Pharmaceutical, Biological and Chemical Sciences,6 (2):174.

Attia, E., H.A. Shehata and A. Askar (1993). An alternative formula for the sweetening of reduced-calorie cakes. Food Chem., 48:169-172.

Baeva, M.R., Terzieva, V.V. and Panchev, I.N. (2003). Structural development of sucrose-sweetened and sucrose-free sponge cakes during baking. Nahrung 47, 154–160.

Bamigbola, Y. A., Awolu, O. O., and Oluwalana, I. B. (2016). The effect of plantain and tigernut flours substitution on the antioxidant, physicochemical and pasting properties of wheat-based composite flours. *Cogent Food & Agriculture*, *2*(1), 124-132.

Bedoya-Perales, N. S. and Steel, C. J. (2014). Effect of the concentrations of maltogenic α-amylase and fat on the technological and sensory quality of cakes. *Food Science and Technology*, *34*(4), 760-766.

Choi, S. N., Kim, H. J., Joo, M. K., and Chung, N. Y. (2013). Quality characteristics of castella prepared by substituting sugar with stevia leaf powder. *Korean journal of food and cookery science*, *29*(2), 153-160

Chung, Y.S., Kwak, Y.H., Lee, M.N. and Kim, D.J. (2009).Quality characteristics of sponge cake with erythritol. J. Korean Soc. Food Sci. Nutr. 11, 1606–1611.

Desai, A. D., Kulkarni, S. S., Sahoo, A. K., Ranveer, R. C., and Dandge, P. B. (2010).Effect of supplementation of malted ragi flour on the nutritional and sensorial quality characteristics of cake. *Advance Journal of Food Science and Technology*, *2*(1), 67-71.

El-Azab, M. A. and Bothayna, M. (1997). Production of a cake containing bran, sweeteners substitutes and bulking agents. Arab Univ. J. Agric. Sci. 5(2):275-296.

El-Hofi, A.A., Galal, W. K. and El-Amry, H. G. (2004). Production of low calorie muffin. Annals of Agric. Sci., Moshtohor 42(4):1703-1712.

FAO/WHO (1974). Handbook on human nutritional requirements. Published by FAO, Rome, 53-63.

Granstrom, T.B. and Leisola, M. (2009). Production and applications of xylitol. Agro Food Ind. Hghi-Technol. 20, 27–33.

Gupta, E., Purwar, S., Sundaram, S. and Rai, G. K. (2013). Nutritional and therapeutic values of Stevia rebaudiana: A review. *Journal of Medicinal Plants Research*, *7*(46), 3343-3353.

Hussein, E. A., El-Beltagy, A. E., and Gaafar, A. M. (2011). Production and quality evaluation of low calorie cake. *American journal of food technology*, *6*(9), 827-834.

Lin, S. and C. Lee (2005). Qualities of chiffon cake prepared with indigestible dextrin and sucralose as replacement for sucrose. Cereal Chem., 82 (4): 405-413.

Malik, V.S.; Schulze, M. B and Hu, F.B. (2006). Intake of sugar- sweetened beverages and weight gain: a systematic review. Am J Clin Nutr, 84: 274–288.

Martinez-Cervera, S., Sanz, T.; Salvador, A. and Fiszman, S.M. (2012). Rheological, textural and sensorial properties of low-sucrose muffins reformulated with sucralose/ polydextrose. LWT - Food Sci. and Technol., 45: 213-220.

Muanda, F. N., Soulimani, R., Diop, B., and Dicko, A. (2011). Study on chemical composition and biological activities of essential oil and extracts from Stevia rebaudiana Bertoni leaves. *LWT-Food Science and Technology*, *44*(9), 1865-1872.

Ohkuma, K. and Wakabayashi, S. (2001). Fibersol-2: A soluble, nondigestible, starch-derived dietary fibre. In: Advanced Dietary Fibre Technology. B. V. McCleary and L. Prosky, eds. Blackwell Science: Oxford, UK, 509-523.

Prakash, I., and G. E. DuBois (2008). Development of rebiana, a natural, non-caloric sweetener. Food and Chemical Toxicology, 46(7, Supplement 1), S75–S82.

Quatromoni, P., D. Copenhafer, R. D'Agostino and B. Millen (2002). Dietary patterns predict development of overweight in women: The Framingham Nutrition Studies. J. Am. Diet. Assoc., 102: 1239-1246.

Shivanna, N., Naika, M., Khanum, F. and Kaul, V. K. (2013). Antioxidant, anti-diabetic and renal protective properties of Stevia rebaudiana. *Journal of Diabetes and its Complications*, *27*(2), 103-113.

Swithers, S. E., Baker, C. R. and Davidson, T. L. (2009). General and persistent effects of high-intensity sweeteners on body weight gain and caloric compensation in rats. *Behavioral neuro - science*, *123*(4), 772.

Tadhani, M. and Subhash, R. (2006). Preliminary studies on Stevia rebaudiana leaves: proximal composition, mineral analysis and phytochemical screening. *J. Med. Sci*, *6*(3), 321-326.

الإستفادة من مطحون أوراق الأستيفيا في إنتاج كيك منخفض السعرات الحرارية

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أجريت هذه الدراسة بهدف إستبدال جزء من السكر بمطحون أوراق الأستيفيا و كانت نسب الإستبدال (١٠، ٢٠، ٣٠ %) بهدف إنتاج كيك منخفض السعرات الحرارية و تم تقييم الخصائص الفيزوكيميائية و الخواص الحسية للكيك المنتج. و قد أظهرت النتائج أن هناك زيادة في نسبة كلا من البروتين و الألياف الخام و الرماد بينما إنخفضت نسبة الكربوهيدرات الكلية و كمية السعرات الحرارية. و كان هناك إنخفاض في قيم إرتفاع الكيك و الحجم النوعي لها كنتيجة لإضافة مطحون أوراق الاستيفيا. و أظهرت نتائج التقييم الحسي للكيك المنتج أن الكيك المحتوي علي نسبة ١٠ % كان أفضل العينات.