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e-mail: info@world-food.net

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Evaluation and properties of formulated low calories functional yoghurt cake

A. M. Abdel-Salam [1]*, A. S. Ammar [1] and W. K. Galal [2]

*[1]Food Science and Human Nutrition Department, Faculty of Agriculture and Veterinary Medicine, Qassim University, Saudi Arabia. [2]Home Economic and Artistic Education Department, Bukairyh College of Education, Qassim University, Saudi Arabia. *e-mail: amsalam68@hotmail.com*

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Abstract

The aim of this study was to prepare and evaluate a formulated functional yoghurt cake using hot water extract of stevia leaves as a sweetener. The ingredients of the regular yoghurt cake were replaced by both low caloric value and functional ingredients. Sucrose was replaced by hot water extract of stevia, butter was replaced by olive oil, full cream milk was replaced by skimmed milk, whole egg was replaced by egg white and 72% extraction wheat flour was replaced by whole wheat flour. Orange peels and lemon rind were also added to the formulated yoghurt with stevia extract. Sensory evaluations for both the regular yoghurt cake and formulated yoghurt cake for diabetics were carried out using scores of the appearance, color, odor, flavor, texture and overall acceptability. The obtained results showed that the regular yoghurt cake and formulated yoghurt cake for diabetics have a good score. The biological evaluation of rat blood parameters of control and yoghurt cake for diabetics groups showed that bilirubin, high-density lipoprotein (HDL) cholesterol, triglycerides, cholesterol, creatinine, alkaline phosphatase, blood glucose and gamma-glutamyl transpeptidase (γ-GT) values (means) in yoghurt cake for diabetics group were similar to results obtained in regular yoghurt cake group. There was a slight decrease in urea and aspartate aminotransaminase (AST) (37.05 mg/dl and 86.82 U/L, respectively) values in yoghurt cake for diabetics group compared with control (43.26 mg/dl and 97.00 U/L, respectively). It was concluded that formulated functional yoghurt cake containing hot water extract of stevia, whole wheat flour, egg white, skimmed milk, yoghurt, orange peel lemon rind and olive oil would be a great meal for diabetics.

Key words: Stevia, yoghurt cake, biological evaluation, sensory evaluation, diabetes.

Introduction

One of the major nutritional problems that faces mankind in this century is the consumption of high quantities of fat and sugar, which has been associated with serious health problems, especially diabetes. Many studies have been performed to produce low calorie bakery products using wheat flour, wheat bran, lacy and/or maltodextrin, fructose, acesulfame-k and stevioside in cakes[1], stevioside in biscuits [2, 3], stevioside in strawberry juice and jam [3], aspartame and stevioside in muffin [4].

Stevia rebaudiana (Bertoni) (Asteraceae) is a sweet herb. Stevioside, the major sweet substance of this plant (5-10 % of dry weight) is 300 times as sweet as sucrose, having steviol as it's aglycone and attached to three glucose molecules. The leaves of *Stevia rebaudiana* also contain several structurally related compounds such as rebaudioside A-E, dulcoside A and steviolbioside, several of which are sweet [5].

Stevia sweetener, crude extract from leaves, have been used for a few decades to sweeten beverages, soju, soy sauce, yogurt and other foods in Korea, Japan and Brazil [6]. Currently, stevia in leaf or extracted forms is permitted as a dietary supplement in the US [7]. The dry extract from stevia leaves also contains flavonoids, alkaloids, water-soluble chlorophylls and xanthophylls, hydroxycinnamic acids (caffeic, chlorogenic, etc.), neutral water-soluble oligosaccharides, free sugars, amino acids, lipids, essential oils and trace elements [8]. Stevia sweetener extracts have been suggested to exert beneficial effects on human health, including antihypertensive [9, 10], antihyperglycemic [11,12] and anti-human rotavirus [13, 14] activities. Likewise, Geuns [15] mentioned the advantages of stevioside as a dietary supplement for human subjects are manifold: it is stable, non-caloric, maintains good dental health by reducing the intake of sugar and opens the possibility for use by diabetic and phenylketonuria patients and obese persons.

Scientific literature does not prove that stevia extracts and stevioside have a potential toxicity to humans [16, 17]. Biological study of stevia leaves and purified stevioside was performed by Mohsen *et al.* [18]. They found that low doses had no effect on total cholesterol, triglycerides, alanine aminotransaminase (ALT), aspartate aminotransaminase, protein and glucose. However, at high doses results showed a slight increase in the above tested parameters comparing to the low doses. Therefore, this study was undertaken to investigate the characteristics and biological evaluation of low calorie yoghurt cake and it would be a great replacement diet for diabetics.

Materials and Methods

Materials: Fresh cow milk samples (3.10% fat) were purchased from healthy animals in private farms (Saudi Arabia). Stevia leaves (*Stevia rebaudiana* Bertoni*)* were purchased from the local market, Cairo, Egypt. Sucrose, vanillin, olive oil, full cream and skimmed milk, butter, egg, orange peels and lemon rind were obtained from local market, Saudi Arabia. Whole and 72% extraction wheat flour were purchased from the local market, Saudi Arabia. Starter cultures

of *Streptococcus salivarius* subsp. *thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* were obtained from Chr. Hansen's Lab., Copenhagen, Denmark.

Preparation of yoghurt: Yoghurt was prepared according the method described by Tamime and Robinson [19] and Al-Wabel *et al*.[20]. Yoghurt cultures of *Streptococcus salivarius* subsp. *thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* were inoculated and incubated for 4-6 h at 42ºC. After coagulation, the curd was tested for pH, stirred in an electric blender and stored refrigerated (4-6°C).

Preparation of stevia extract: Hot water extract of stevia leaves was prepared according to the method described by Deans and Svoboda[21] and Bakri and Douglas [22]. About 50 g of stevia leaves were milled, placed in a flask (2 L) with 1000 ml of distilled water and boiled for 15 min, the mixture was filtered twice, first through cheese-cloth (50% cotton/50% polyester) and then through filter paper (Whatman No. 2). The amount of obtained stevia extract was preserved in sterile dark bottles (500 ml) in a cool environment (4°C) until further use.

Preparation of regular and diabetic yoghurt cakes: The preparation of regular yoghurt cake and yoghurt cake for diabetics were carried out using the replacement of sugar with hot water extract of stevia leaves of equal sweetness, 72% extraction flour with whole wheat flour, fresh milk with skimmed milk, butter with olive oil and whole egg with egg white only. Table 1 shows composition of regular and diabetic yoghurt cake.

All ingredients including olive oil or butter, yoghurt, whole or skimmed milk, whole egg or egg white, sugar or stevia extracts, 72% extraction wheat flour or whole wheat flour, baking powder, vanilla, lemon rind and orange peel were added, mixed and stirred in a medium bowl using an electric mixer until combined thick and creamy, and then the mixture was spread into the prepared pan, baked, cooled and stored until test.

Sensory evaluation for the appearance, color, flavor and overall properties of regular and diabetic yoghurt cake were adopted from N.A.S.A [23]: (+++) very good, (++) good, (+) accepted, (-) unaccepted.

Biological evaluation of yoghurt cake for diabetics: Twenty male albino Wistar rats weighing about 80-100±30 g were randomly divided into two test groups (each containing 10 rats). Animals were placed in cages and were given initially the basal diet. The composition of basal diet used in this study was as follows: milk protein (12%), sucrose (5%), fat (10%), vitamin mixtures (1%), salt mixtures (4%), fiber (4%) and starch (64%). The animals were divided into two groups, the first group was kept as untreated (control group) fed on the basal diet only. The second group was fed on formulated yoghurt cake for diabetics. The feeding experiment was continued for 3 weeks and at the end of the experimental period, animals were anesthetized by exposure to an atmosphere of 100% diethyl ether and killed by decapitation. Blood samples were taken into plain tubes. Serum was collected after centrifugation (3000 rpm) for 15 min and frozen at -20ºC for subsequent analyses. Bilirubine was determined in serum according to the method of Jendrassik and Grof [24]. Alanine aminotransaminase (ALT) and aspartate aminotransaminase (AST) activities were determined according to the method of Reitman and Frankel [25]. Urea and creatinine were determined in serum according to Tietz [26] and Bonsnes and Taussky [27], respectively. Triglyceride was determined in serum according to Stein and Myers [28]. γ-GT was determined in serum according to the method of Young [29]. HDL cholesterol in serum was determined according to Lopes-Virella *et al*. [30]. Glucose in serum was determined according to the method of Widdowson and Penton [31]. Alkaline phosphatase in serum was determined according to Tietz *et al*. [32].

Determination of textural properties of yoghurt cakes: Cake texture was measured as an indicator of product firmness. Cake texture was determined by a texture analyzer pro.v2.1 (Brookfield) provided with the software. The parameters, hardness and deformation, were used as an indicator of cake texture.

Statistical analysis: Mean, standard deviation and coefficient of variation of the obtained data from each different experimental group were calculated and conducted according to the method described by Miller and Miller [33].

Results and Discussion

As shown in Table 1, whole wheat flour was used instead of 72% extraction wheat flour according to Fung *et al*. [34], who stated that whole grains reduce the postprandial glucose and increase insulin response for diabetics people.The sensory evaluation properties of regular yoghurt cake and yoghurt cake for diabetics were found to have good scores and were acceptable for all panel-tests presented in Table 2.

Table 1. Composition of tested yoghurt cake for diabetics compared with regular yoghurt cake.

Regular yoghurt cake		Yoghurt cake for diabetics	
200 g	72% extraction wheat flour	200 g	Whole wheat flour
200 g	Sucrose granulated	100 ml	Stevia extract (3.3% TSS)
1 t	Baking powder	1 t	Baking powder
50 g	Butter	50 g	Olive oil
4	Whole egg	4	Egg white
450 g	Yoghurt	450 g	Yoghurt
½ t	Vanilla extract	½ t	Vanilla extract
150 ml	Full cream milk	150 ml	Skimmed milk
-	-	5 g	Lemon rind
-	-	100 g	Orange peel

* TSS: Total Soluble Solids.

Table 2. Sensory evaluation properties of regular yoghurt cake and yoghurt cake for diabetics.

Sensory evaluation	Regular yoghurt cake	Yoghurt cake for diabetics
Appearance	+++	++
Color	+++	++
Flavor	+++	++
Overall	+++	++

(+++) very good, (++) good, (+) accepted , (-) un-accepted.

Table 3. Calories and food energy (kJ) of regular and yoghurt cake for diabetics (100 g).

	Regular yoghurt cake	Yoghurt cake for diabetics
Calories	252	162
Food energy (kJ)	1053	677

The calories and food energy (kJ) of regular yoghurt cake and yoghurt cake for diabetics are shown in Table 3. The yoghurt cake for diabetics had low calories and food energy (162 and 677 per 100 g) compared with regular yoghurt cake (252 and 1053, respectively).

The fat content of the cake was minimized in order to lower its caloric value, since it is well documented that obese and diabetic people have a tendency towards hypercholesterolemia [34], thus the following precautions were taken during formulation of the cake. The high-fiber/carbohydrate-rich meal significantly improved vascular dilation capability. By contrast, the high-fat/low-carbohydrate meal significantly impaired the artery's ability to dilate. These results indicate that meals rich in fiber and carbohydrates can acutely improve blood vessel health in persons with metabolic syndrome, possibly helping to prevent cardiovascular disease. The whole wheat flour was used because it based carbohydrate and fiber which may play a role in enhancing early insulin secretion in individuals with metabolic syndrome, which may lower the risk of deteriorating glucose tolerance and development at type II diabetes [35]. Whole egg was replaced with egg white in the tested formula. The tested yoghurt cake for diabetics contained olive oil, which plays an important role in diabetes. Olive oil was used, avoiding butter and margarine addition to the cake. Skimmed milk was preferred to fresh milk. Sucrose was replaced by hot water extract of stevia. Researchers have demonstrated that people who include olive oil in their diet have a better control over their diabetes and lower levels of some fats in the blood when compared with diets rich in butter and carbohydrates normally recommended for this type of diabetes [36-38]. The obtained results are in agreement with Abdel-Salam and Ahmed [39] that low calorie formulated functional cheesecake with fructose, whole wheat, egg white, skimmed milk, kareesh cheese and olive oil would be a great meal replacement diet for diabetics. Yoghurt is used extensively as a marinade in particularly Indian and other Asian types of cooking, along with a variety of herbs and spices. Yoghurt cakes provide calcium, protein and vitamin. Lemon rind and orange peels were used to increase the functional properties and taste of the tested yoghurt cake for diabetics.

Textural properties of yoghurt cakes: Food texture test measures the characteristics related to food mastication in mouth. This can be done using sensory evaluation or by instrumental methods. The parameters of hardness and deformation are used as an indicator of cake texture quality. Cake texture is soft solid foam. Data in Table 4 show that cake tested to 244.7 mm deformation (particularly when fresh) exhibits elastic characteristics. As a result of adding ground stevia leaves, the cake becomes firmer, it increases hardness (3176 g) compared with the control (3161 g), reflecting an increase in the cake toughness.

Biological evaluation of yoghurt cake for diabetics: Blood parameters of control and yoghurt cake for diabetics groups rats are shown in Table 5. Bilirubine, triglycerides, cholesterol, creatinine, alkaline phosphatase, glucose and γ-GT values (means) in blood of yoghurt cake for diabetics group were similar to results obtained from control group. A slight decrease in urea and AST (37.05 mg/dl and 86.82 U/L, respectively) values was found in yoghurt cake for diabetics group comparing to the control one (43.26 mg/dl and 97.00 U/L, respectively). There was a slight increase in HDL cholesterol with mean value of 40.30 mg/dl in yoghurt cake for diabetics group compared with control group (35.93 mg/dl).

The obtained results from the biological evaluation are in agreement with findings reported by Mohsen *et al*. [18]. They found that low doses had no effect on total cholesterol, triglycerides, AST, ALT, protein and glucose in serum. However, at high doses results showed a slight increase in the above tested parameters comparing to the low doses.

It could be concluded that sugar of regular yoghurt cake can be replaced by hot water extraction of stevia as a sweetener to produce and formulate functional low caloric yoghurt cake containing whole wheat, egg white, skimmed milk, yoghurt, orange peel, lemon rind and olive oil, and it would be a great meal for diabetics.

Table 4. Textural properties of regular yoghurt cake and yoghurt cake for diabetics.

Parameter	Unit	Regular yoghurt cake	Yoghurt cake for diabetics
Hardness	Gf	3161.00	3176.00
Deformation	Mm	244.75	244.75

Table 5. Blood parameters of control and yoghurt cake for diabetics rats groups.

Parameter	Unit	Control			Yoghurt cake for diabetics		
		Mean	SD	% C.V	Mean	SD	% C.V
Urea	mg/dl	43.26	10.17	23.51	37.05	3.02	8.16
Creatinine	mg/dl	<0.500	1	1	<0.500	1	1
GOT (AST)	U/L	97.0	12.12	12.49	86.82	10.88	12.53
Bilirubin (mg/dl)	mg/dl	<0.500	1.0	1.0	<0.500	1.0	1.0
Triglycerides	mg/dl	135.33	14.01	10.35	135.83	66.40	48.89
HDL cholesterol	mg/dl	35.93	4.11	11.46	40.30	4.518	11.26
γ-GT	U/L	<0.500	1.0	1.0	<0.500	1.0	1.0
Alkaline phosphatase	U/L	<0.50	1	1	<0.50	1	1
Glucose	mg/dl	105	1	0.95	106	1	0.94
Cholesterol	mg/dl	106.66	1.15	1.08	107.5	0.547	0.50

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