

Using Vegetable Puree as a Fat Substitute in Cakes

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Abstract: Squash and cantaloupe puree (25, 50, 75 and 100%) were used to substitute fat in the production of cake. Cakes prepared with 25% puree (for both squash and cantaloupe) had higher volume than that of control cake. No difference in cake volume was found between control cake and those prepared with 50% puree. At 100% replacement level, cake volume was lowest. Reduced-fat cakes with puree had more moisture and minerals as well as fewer calories than the control. Replacement of baking fat by puree resulted in a significant increase in hardness, springiness and chewiness, but to a limited extent the cohesiveness. On the other hand, there were no differences between the acceptability of reduced-fat cakes with puree up to 75% and control cakes. The addition of puree did not result in undesirable changes in colour. While the high moisture content in cakes (with puree) was more acceptable among the panelists. These results showed that purees are an acceptable fat replacer in cakes and effective in reducing the amount of fat and calories. Moreover, during storage moisture loss and increase hardness was observed in produced cakes.

Keywords: Low Calorie, Cake, Cantaloupe, Squash, Puree

1. Introduction

Nutrition related diseases are increasing because, among other reasons, energy intake is too high and dietary fiber intake is below recommendations. This result in a duplication of the population with overweight and obesity in the last 30 years [64]. Obesity may be related to other non-communicable diseases [27].

Since fat provides the highest energy value of all major food constituents, fat substitution by other ingredients is a great challenge, especially in bakery products, as they can contain high levels of fat [22]. In bakery products, fat improve texture, mouth feel and flavor [26; 66]. Also, fat provides several advantages to cakes, such as higher volume and softness in the final product. Commercial fat replacers like polydextrose [13], as well as natural fat replacers like okra gum [52], apple sauce, prune paste [57] pawpaw puree [65] and avocado puree [63] have all been used with some degree of success in baked products. Cake is considered one of the most important bakery products for Egyptian people it is either home-made or produced on commercial scale [19].

Cantaloupe (*Cucumismelo* L.) is an important plant from the Cucurbitaceae family [50]. Cantaloupe is one of the most

consumed fruit crops worldwide due to its pleasant flavour and nutritional value. Cantaloupes are a diverse group of fresh, dessert fruits that includes the orange flesh cantaloupes, green flesh honeydew, and mixed melons. Previous studies showed that cantaloupe pulp extract possesses high antioxidant and anti-inflammatory properties [60; 39].

Squash (*Cucurbita maxima* L.), which is a member of the same family, is recognized as an important source of vitamins and minerals (vitamins A and C) and it's very low calories [41]. Manaois *et al.* [38] fortified rice crackers with squash to improve its nutrient profile with a local crop.

The objective of this study was to investigate the amount of squash and cantaloupe purees that can be used as a fat replacer in cake production; to demonstrate the impact of the replacement on the acceptability of consumers to the product; to evaluate the effect of replacement on product properties and the decrease in energetic value of the resulting product.

2. Material and Methods

2.1. Materials

Cantaloupe, squash and baking ingredients were purchased from the local market in Cairo, Egypt. Chemicals were of

analytical reagent grade.

2.2. Cake Preparation

Madeira-type cake was prepared according to the formula of Hussien *et al.* [29] using the following recipe: 28 g wheat flour (72% extraction rate), 24 g milk butter, 24 g sugar (sucrose), 13.55 g whole eggs, 0.45 g baking powder, 0.25 g vanilla and 10 g water. Sugar and butter were creamed for 3 min at medium speed in a bowl. Then, eggs and vanilla were added and mixed in at the same speed for 2 min. The flour, baking powder and water were added and the batter was mixed for 4 min at high speed. After scraping down the bowl the batter was mixed for an additional 1 min at the same speed. The butter in fat replacer treatments formula was replaced with 25, 50, 75 or 100% (fat weight basis) cantaloupe or squash puree. The same order of mixing as described for the control was followed.

2.3. Storage of Cakes

The cakes were cooled at room temperature, sealed polyethylene bags and then stored at 18±2°C for 14 days (except for 100% replacement due to fungal or microbial contamination). Samples were evaluated every 2 days for mold free shelf life, moisture and hardness during storage period.

2.4. Chemical Analysis

The cakes and ingredients were analyzed for moisture, protein, fat and ash according to AOAC [4]. Carbohydrate content was calculated by difference. The analyses were performed in triplicate. Total calories were calculated by the formula of James [32] as follows:

$$\text{Total calories} = \text{Fat} \times 9 + \text{Protein} \times 4 + \text{Total carbohydrate} \times 4$$

2.5. Physical Properties for Batter and Cakes

Specific gravity of the batter and cakes was determined as the ratio of the weight of a standard container filled with batter to that of the same container filled with water. The specific volume was calculated as the ratio of apparent volume to weight. The batter pH was determined according to the AACC [1] method. The measurements were performed in triplicate. Cake height was measured to the nearest millimeter with amicrometer. Volume (ml) was measured by seed displacement [2], and weight (g) was determined according to AACC method [2]. Water activity (a_w) was measured with a rotronic Hygro Lab EA10-SCS (Switzerland) a_w meter. The measurements were performed in triplicate.

2.6. Profile Texture Analysis

Crumb hardness, cohesiveness and springiness were determined according to Baixauli *et al.* [8], using a Texture Profile Analyzer (TPA) according. Cake texture parameters were determined by a universal testing machine (Brook field Engineering Lab. Inc., Middleboro, MA 02346- 1031, USA). A 25-mm diameter cylindrical probe was used in a TPA at 2 mm/s speed.

2.7. Sensory Evaluation

Cake samples were left to cool (25°C±2) for 4 h after packing then subjected to organoleptic characteristics. Cakes were judged for crust and crumb color, texture, taste, flavor, and overall score by 10 well trained panellists (five males and five females) from the staff of Food Technology Research Institute as described by Bennion and Bamford [10].

2.8. Statistical Analysis

The analytical data were analyzed using SPSS 16.0 software. Means and standard deviations were determined using descriptive statistics. Comparisons between samples were determined using analysis of one-way variance (ANOVA) and multiple range tests. Statistical significance was defined at $P \leq 0.05$.

3. Results and Discussion

3.1. Chemical Analysis of Raw Materials

Table (1) shows the chemical composition of ingredients. Data showed that squash and cantaloupe are higher in moisture and carbohydrate content than butter.

Chemical composition of cantaloupe agrees with results obtained by Eitenmiller *et al.* [21]. He reported protein to range between 0.61-0.68 g/100g, fat 0.07-0.23g/100g; ash 0.76-0.84 g/100g. While they reported it contains 0.10mg/100g for zinc and 0.16 mg/100g for iron. As for squash, the results are in range with results obtained by Jacobo-Valenzuela *et al.* [31] they reported fat 0.04-0.14g/100g; ash 0.70-1.90 g/100g;. Minerals averaged around 0.31 mg/100g for iron and 0.24mg/100g for zinc. While fiber was higher (1.48g/100g) than that reported by Jacobo-Valenzuela *et al.* [31] (0.85-1.24g/100g). The pH value of cantaloupe puree agrees with results of Syahidah *et al.* [58], who reported the pH value to range between 6.46 and 6.48. As for Squash puree the results are in agreement with work by Oakeshott, [43] who reported the pH values as weakly basic in zucchini (8.2-8.3) but the pH value of butter is 6.69 which agrees with work by Ozkan *et al.* [45].

Table 1. Chemical Analysis of Raw Materials.

Constitutes (%)	Squash Puree	Cantaloupe Puree	Butter
Moisture	94.74±0.02	88.77±0.01	17.94±0.03
Protein	0.67±0.01	0.61±0.03	1.035±0.02
Fat	0.05±0.04	0.23±0.02	98.84±0.04
Carbohydrate	99.01±0.03	97.3±0.04	0.07±0.01
Fiber	1.48±0.02	0.89±0.01	0.00±0.04
Ash (g/100)	0.87±0.02	0.80±0.03	0.20±0.02
Ca (mg/100)	0.13±0.01	0.64±0.06	38.64±0.03
Fe (mg/100)	0.33±0.03	0.15±0.02	0.19±0.05
Zn (mg/100)	0.22±0.04	0.09±0.03	0.06±0.01
pH	8.23±0.01	6.47±0.04	6.69±0.05

* Values are means of three replicates ±SD.

3.2. Specific Gravity and pH of Cakes

Table (2) shows specific gravity and pH of cake batter with and without fat replacer. Batter's specific gravity is related to the ability of the cake batter to incorporate air during mixing. Low specific gravity is associated with good aeration of the batter. Specific gravity values of cake batters prepared with 25% substitution were significantly lower than that of control cake (0.89, 0.90 and 0.93 for cantaloupe, squash and control cakes respectively). Similar results were obtained by Hussein *et al.* [29] who explained that replacement of fat with 25% puree might aid in incorporation large numbers of air cells into the batter, which led to increased viscosity and thereby high stability, leading to higher retention of air bubble in the cake batter. But increasing the replacement level resulted in an increase in the specific gravity of batter. These results agree with work by Capriles *et al.* [14]. Khalil [35] reported that the specific gravity of the cake batter prepared with more than 50% fat replacement level was higher than the control. This increase occurs because fat in cake systems helps incorporate and retain air as reported by Bath *et al.* [9]. While Pong *et al.* [47] reported that batters prepared without shortening had higher specific gravity than those prepared with shortening.

The pH values of cake batters decreased with the increase in the replacement levels. Our results agree with Hussein *et al.* [29] who reported that the pH value of cake batters decreased as the fat replacement increase when studying the effect of fat replacement with artichoke powder on cake batters. The pH values of all cake batters were within the optimum levels (6.5-7.7) described by Ash and Colmey [6]. According to Pyler [48], pH is of great importance in the definition of color and texture of cakes. Texture tends to become softer as the pH increases. The change in pH of batter is due to the addition of cantaloupe puree, which has a pH of 6.46 and squash puree, with a pH of 8.2 [43].

Table 2. Specific Gravity and pH of Cake Batter with and without Fat Replacer.

Samples	Batter	
	Specific Gravity (g/cm ³)	pH
Control (100% Butter)	0.93±0.003 ^d	6.90±0.033 ^a
Cantaloupe puree		
25%	0.89±0.003 ^c	6.79±0.003 ^b
50%	0.93±0.001 ^d	6.78±0.003 ^{bc}
75%	0.95±0.003 ^c	6.77±0.003 ^{bc}
100%	0.97±0.006 ^b	6.75±0.003 ^c
Squash puree		
25%	0.90±0.003 ^c	6.70±0.003 ^{de}
50%	0.94±0.003 ^d	6.67±0.007 ^d
75%	0.96±0.003 ^{bc}	6.65±0.017 ^{ef}
100%	0.99±0.003 ^a	6.60±0.001 ^f

* Values are means of three replicates ±SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

3.3. Physical Properties of Cakes

Table (3) presents physical properties of cake with and without fat replacer. Cakes with 25% substitution had higher height than control, but upon increasing the level of substitution more than 50%, the height decreased. Pong *et al.* [47] explained that shortening incorporates a greater amount of air but does not maintain the air on baking. Substituted cakes, on the other hand, did not incorporate as much air but maintained more air bubbles. Visual observation revealed that the batter prepared with puree (cantaloupe or squash) was more viscous than that of the control. The higher viscosity of the batter made with puree may have contributed to maintaining the air bubbles by forming stronger and more cohesive films around them. Matsakidou *et al.* [40] reported that the formation of continuous channels is found to be essential in maintaining the volume of the cake in cooling once removed from the oven.

Volume is a very important quality for cakes, which strongly influences consumer preference and is directly related to the type and amount of shortening used. Fat provides several advantages to cakes, such as higher volume and softness in the final product, due to higher air incorporation during batter preparation and inhibition of gas-bubble coalescence, leading to a finer and softer crumb structure [10, 12]. Cakes prepared with 25% puree (for both squash and cantaloupe) had higher volume (163.70 and 165.05 ml) compared to control cake (150.51 ml). No difference in cake volume was found between control cake and those prepared with 50% puree. At 100% replacement level, cake volume was the lowest. Turabi *et al.* [59] observed that higher apparent viscosity might help in the entrapment of air into the cake batters and thereby causes significantly higher porosity and volume. While Khalil [35] and Raeker and Johnson [49] suggested that this might indicate that fat replacers had the ability to retain greater amount of air into the batter (less specific gravity) and maintained more air during the final stage of baking (large cake volume).

As substitution increased (above 50%), cakes yielded less volume upon baking, which means that the product is less aerated and denser. These results agree with work of Borneo *et al.* [12]. Height and specific gravity full the same trend. Generally a batter of high specific gravity or less air incorporated would have a lower volume and standing height.

The measurement of water activity has been shown useful for predicting the stability and safety of foods, with respect to microbial growth, deterioration reactions, and chemical and physical properties [23]. When compared with the standard, the cakes with fat substitution showed a significant difference in a_w at time zero. All formulations presented critical stability over the shelf-life, since they showed values of a_w exceeding 0.887, conducive to the development of some positive and negative gram bacteria and yeast [33]. These results agree with work by Zambrano *et al.* [67].

Table 3. Physical Properties of Cakes with and without Fat Replacer.

Samples	Height (cm)	Volume (ml)	Specific Volume (cm ³ /gm)	Density	a _w
Control (100% Butter)	5.69±0.01 ^b	150.51±0.44 ^b	3.54±0.03 ^b	0.27±0.01 ^c	0.808 ^a
Cantaloupe Puree					
25%	5.82±0.03 ^a	163.70±0.41 ^a	2.46±0.01 ^e	0.40±0.00 ^c	0.790 ^b
50%	5.69±0.01 ^b	150.85±0.41 ^b	2.40±0.02 ^e	0.41±0.02 ^c	0.773 ^c
75%	5.35±0.04 ^d	124.65±0.31 ^d	2.46±0.01 ^e	0.41±0.01 ^c	0.754 ^d
100%	5.01±0.08 ^c	105.65±0.24 ^c	2.75±0.03 ^f	0.36±0.00 ^d	0.739 ^c
Squash Puree					
25%	5.80±0.02 ^a	165.05±0.43 ^a	3.66±0.01 ^a	0.38±0.03 ^d	0.789 ^b
50%	5.67±0.04 ^b	150.47±0.37 ^b	3.31±0.01 ^c	0.40±0.01 ^c	0.775 ^c
75%	5.47±0.01 ^c	129.15±0.24 ^c	3.05±0.00 ^d	0.43±0.01 ^b	0.750 ^d
100%	5.32±0.03 ^d	124.35±0.24 ^d	2.87±0.01 ^c	0.45±0.02 ^a	0.732 ^c

*Values are means of three replicates ±SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

3.4. Chemical Analysis of Cakes

Tables (4 and 5) show chemical analysis of cakes with and without fat replacer. Butter replacement had a statistically significant effect on the moisture content, with the 100% puree samples having the highest and the control the lowest moisture level, results are consistent with work by Dadkhah *et al.* [18]. Wekwete and Navder [63] referred this increase to the high moisture content of squash and cantaloupe purees

(94.74 and 88.77) compared to only 17.94% moisture of butter. Also, the high fiber content of purees could affect the moisture content as reported by Grigelmo-Miguel *et al.* [26] when studying the influence of the peach dietary fiber in reduced-fat muffins. Khouryieh *et al.* [36] reported that the high water-holding capacity of dietary fiber contributed to water retention in formulations and prevented evaporation during baking, resulting in high moisture content.

Table 4. Chemical Analysis of Cakes with Cantaloupe Puree as a Fat Replacer.

Samples	Control (100% butter)	25%	50%	75%	100%
Moisture	20.05±0.02 ^c	20.80±0.01 ^d	26.47±0.03 ^c	31.72±0.01 ^b	37.01±0.03 ^a
Protein	9.38±0.01 ^b	9.40±0.03 ^a	9.40±0.01 ^a	9.41±0.05 ^a	9.42±0.01 ^a
Carbohydrate	59.92±0.03 ^c	70.59±0.06 ^d	76.64±0.02 ^c	82.54±0.03 ^b	88.46±0.02 ^a
Fat	30.7±0.01 ^a	25.30±0.01 ^b	19.06±0.01 ^c	11.80±0.01 ^d	3.37±0.01 ^e
Fiber	0.16±0.08 ^e	0.23±0.02 ^d	0.30±0.03 ^c	0.35±0.04 ^b	0.41±0.03 ^a
Ash	2.50±0.03 ^c	2.65±0.02 ^d	2.79±0.08 ^c	2.83±0.01 ^b	2.87±0.05 ^a
Energy	553.50±0.03 ^a	500.03±0.02 ^b	469.82±0.02 ^c	440.22±0.01 ^d	410.62±0.02 ^e
Ca	88.00±0.05 ^c	92.7±0.006 ^d	98.2±0.01 ^c	104±0.0497 ^b	112±0.027 ^a
Fe	0.87±0.01 ^d	0.92±0.02 ^c	0.93±0.01 ^b	0.93±0.01 ^b	0.94±0.02 ^a
Zn	0.63±0.004 ^c	0.67±0.008 ^d	0.74±0.003 ^c	0.81±0.009 ^b	0.89±0.011 ^a

*Values are means of three replicates ±SD, number in the same row followed by the same letter are not significantly different at 0.05 level.

The addition of puree to cakes, substituting up to 100% of butter, produced only a slight increase in protein content, because protein in cakes mainly came from eggs (Tables 4, 5). As expected, the replacement resulted in a sharp significant decrease in fat content, which is in contrast with work by Hussien *et al.* [29]. On the other hand, the fat content of cakes decreased linearly with the reduction of the percentage of butter.

Fiber increased, as expected, with the increase in replacement level, this is due to high fiber content in puree (26.67 and 7.84 in both squash and cantaloupe respectively).

Carbohydrate content was higher in cakes containing puree than in the control (Tables 4, 5). Also, carbohydrate levels increased with increase in replacement level. Reduced-fat cakes with puree showed a higher ash content than the control (Tables 4, 5). These results agree with work by Hussein *et al.* [29].

As expected, owing to the reduction in fat content of substituted cakes, their caloric value was significantly reduced. These results agree with work by Noor Aziah *et al.* [42], who reported the decrease in caloric values in sponge cakes prepared with dietary fiber from mango pulp and peel.

Table 5. Chemical Analysis of Cakes with Squash Puree as a Fat Replacer.

Samples	Control (100% butter)	25%	50%	75%	100%
Moisture	20.05±0.02 ^c	22.42±0.01 ^d	27.20±0.03 ^c	32.82±0.01 ^b	38.40±0.02 ^a
Protein	9.38±0.01 ^c	9.40±0.02 ^b	9.40±0.01 ^b	9.42±0.01 ^a	9.42±0.01 ^a
Carbohydrate	59.92±0.03 ^c	66.30±0.02 ^d	71.54±0.01 ^c	78.78±0.02 ^b	87.21±0.04 ^a
Fat	30.70±0.02 ^a	25.30±0.01 ^b	19.10±0.01 ^c	11.90±0.05 ^d	3.34±0.02 ^e
Fiber	0.16±0.01 ^c	0.27±0.04 ^d	0.38±0.02 ^c	0.48±0.01 ^b	0.58±0.01 ^a
Ash	2.50±0.03 ^c	2.67±0.02 ^d	2.79±0.08 ^c	2.85±0.01 ^b	2.89±0.05 ^a
Energy	553.50±0.03 ^a	526.50±0.04 ^b	495.30±0.02 ^c	459.00±0.01 ^d	416.85±0.02 ^e
Ca	88.00±0.06 ^c	93.40±0.02 ^d	99.50±0.01 ^c	107.00±0.01 ^b	115.00±0.05 ^a
Fe	0.87±0.01 ^d	0.93±0.01 ^c	0.94±0.02 ^b	0.96±0.01 ^a	0.97±0.01 ^a
Zn	0.63±0.004 ^c	0.69±0.01 ^d	0.75±0.01 ^c	0.82±0.01 ^b	0.92±0.01 ^a

*Values are means of three replicates ±SD, number in the same row followed by the same letter are not significantly different at 0.05 level.

3.5. Texture Profile Analysis

Texture profile was performed on cakes to obtain the textural parameters (hardness, cohesiveness, and springiness) of the cakes, as shown in the Table 6. Replacement of baking fat by puree resulted in a significant increase in hardness, springiness and chewiness but to a limited extent the cohesiveness.

Hardness of substituted cakes significantly increased from 10.02 to 11.05 for control and 100% replacement respectively, with no difference between cantaloupe and squash purees. These results agree with work by Grigelmo-Miguel *et al.* [26] and Zahn *et al.* [66] who reported that

fiber-based fat replacers increased the hardness (firmness) in muffins. Indrani and Rao [29] and Sahin [52] referred the increase in hardness to the decrease in the amount of air bubbles, which are incorporated in the batter during beating and expand during baking, as a result of fat reduction. While Rodriguez-Garcia *et al.* [51] reported that narrow bubble size distribution in small areas resulted in significantly softer cakes. Alava *et al.* [3] observed that the cake had a softer texture when a homogenous distribution of bubbles was observed in the batter; whereas when the bubble size distribution was broad, the cake tended to have a harder texture.

Table 6. Texture Profile Analysis of Cakes with and without Fat Replacer.

Samples	Hardness	Springiness	Cohesiveness	Chewiness
Control (100% butter)	10.02±0.04 ^a	1.80±0.01 ^a	0.30±0.02 ^a	5.00±0.07 ^a
Cantaloupe puree				
25%	10.05±0.01 ^a	2.00±0.08 ^b	0.32±0.01 ^{ab}	5.10±0.01 ^b
50%	10.21±0.02 ^b	2.05±0.01 ^c	0.33±0.03 ^{bc}	5.80±0.07 ^c
75%	10.50±0.01 ^c	2.54±0.01 ^d	0.34±0.02 ^{bc}	6.50±0.02 ^d
100%	11.05±0.03 ^d	3.06±0.08 ^e	0.36±0.03 ^d	6.77±0.05 ^e
Squash puree				
25%	10.04±0.01 ^a	2.01±0.01 ^b	0.32±0.02 ^{ab}	5.12±0.01 ^b
50%	10.23±0.02 ^b	2.07±0.01 ^c	0.34±0.01 ^{bc}	5.78±0.07 ^c
75%	10.48±0.02 ^c	2.56±0.02 ^d	0.35±0.01 ^{bc}	6.45±0.02 ^d
100%	11.03±0.02 ^d	3.10±0.02 ^e	0.37±0.03 ^d	6.75±0.05 ^e

* Values are means of three replicates ±SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

The replacement of 50% baking at significantly increased springiness of the crumb of the cakes, Zahn *et al.* [66] explained this by the increase in the strength of the bonds in the crumb network. While Grigelmo-Miguel *et al.* [26] reported that there was no effect on either cohesiveness or springiness have been observed when replacing lower amounts of baking fat in muffins (≤10%) by peach dietary fiber. Zahn *et al.* [66] suggested that this might be an effect that depends on concentration. The cohesiveness values increased with the increase in fat replacement level. These results are in contrast with work by Rodriguez-Garcia *et al.* [51] who stated that this increase might be due to a denser crumb cell structure in replaced cakes.

3.6. Sensory Evaluation

Table (7) illustrates the averages of scores for each organoleptic characteristic. Crumb and crust color, appearance characteristics were with no significant differences among the cakes. This indicates that the addition of puree did not result in undesirable changes in color. These results agree with work by Hayek and Ibrahim [28]. The finding here agree with others' findings that butter has limited contribution when it comes to color and appearance of baked products [15; 56; 28]. Hayek and Ibrahim [28] reported that high moisture in fruits or vegetables based fat substitute plays an important role in determining the percentage of

replacement. The high moisture content in cakes (with puree) was more acceptable among the panelists this agrees with Hayek and Ibrahim [28]. While Khalil [35] and Hussein [29] reported that cakes prepared with 25 or 50% fat replacers had higher mean scores for flavor and softness (moistness) than

control, which agree with our findings. No significant difference between the control, 25% and 50% replacements in overall acceptance scores, but the 75% and 100% substitutions were significantly different. These results agree with work by Wekwete and Navder [62, 63].

Table 7. Sensory Evaluation of Cakes with and without Fat Replacer.

%	Crust Color	Crumb Color	Texture	Moistness	Taste	Flavour	Appearance	Overall Acceptance
Control	9.30±0.667	9.33±0.235	9.99±0.054 ^a	8.67±0.357 ^b	9.67±0.533 ^a	9.33±0.381 ^a	9.10±0.36	92.7±2.70 ^a
Cantaloupe puree								
25	9.33±0.667	9.33±0.333	9.98±0.025 ^a	8.72±0.213 ^b	9.67±0.363 ^a	9.45±0.33 ^a	9.10±0.57	92.5±2.73 ^a
50	9.25±0.321	8.67±0.025	9.67±0.667 ^a	8.93±0.667 ^b	9.57±0.133 ^a	9.35±0.33 ^a	9.33±0.56	91.5±0.29 ^a
75	9.33±0.667	9.33±0.667	8.67±0.333 ^b	9.33±0.533 ^a	8.67±0.667 ^b	9.33±0.82 ^a	9.33±0.66	88.3±5.67 ^b
100	9.23±0.333	8.00±0.577	8.00±0.010 ^c	9.67±0.333 ^a	8.23±0.617 ^c	9.00±0.57 ^b	9.00±0.15	82.2±2.68 ^c
Squash puree								
25	9.25±0.010	9.00±0.012	9.97±0.021 ^a	8.74±0.357 ^b	9.62±0.215 ^a	9.23±0.35 ^a	8.95±0.54	91.99±0.98 ^a
50	9.23±0.667	9.33±0.533	9.33±0.667 ^a	8.95±0.667 ^b	9.55±0.333 ^a	9.13±0.37 ^a	9.07±0.61	92.02±0.95 ^a
75	9.24±0.333	9.00±0.577	9.00±0.577 ^a	9.20±0.005 ^a	8.70±0.125 ^b	9.00±0.33 ^b	9.05±0.49	87.97±1.17 ^b
100	9.23±0.667	9.00±0.757	7.93±0.333 ^c	9.33±0.379 ^a	8.00±0.433 ^c	8.67±0.88 ^c	9.03±0.88	81.50±3.38 ^c

*Values are means of ten replicates ±SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

3.7. Storage of Cakes

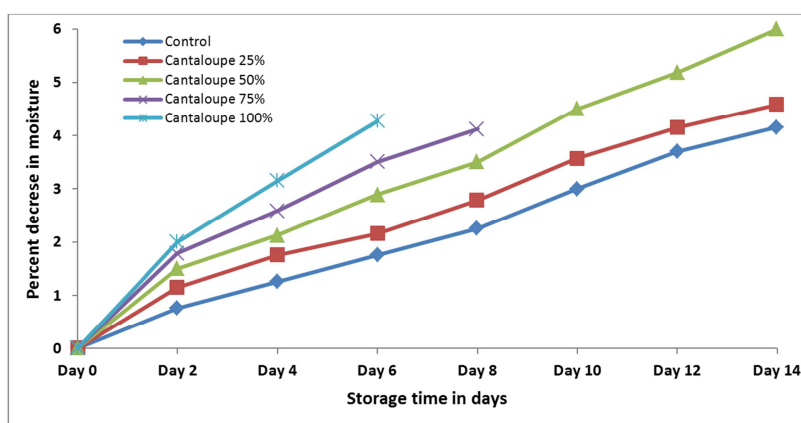


Fig. 1. Percent Moisture Loss in Cakes with Cantaloupe Puree as Fat Replacer.

Jones [34] reported that shelf-life determines the quality of industrial cakes. Cakes are usually expected to be kept for 1 to 4 weeks. While Doweidar [19] reported that the shelf-life of cakes depends on formulation, packaging, water activity and storage temperature.

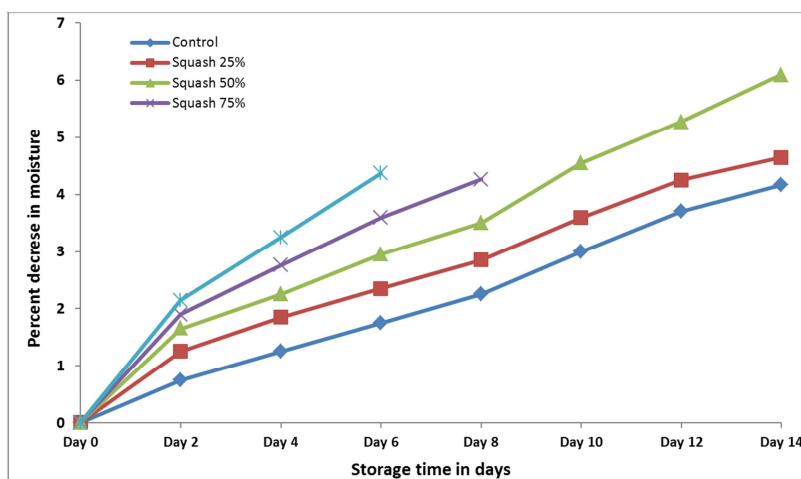


Fig. 2. Percent Moisture Loss in Cakes with Squash Puree as Fat Replacer.

Figure 1 and 2 presents the increase in moisture loss during storage. Results indicated that moisture loss was observed for all cakes during the 14 days of storage. Percent moisture loss of reduced fat cakes was significantly higher than that of control cakes over the storage period due to the higher water level in these cakes, as reported by Capriles *et al.* [14].

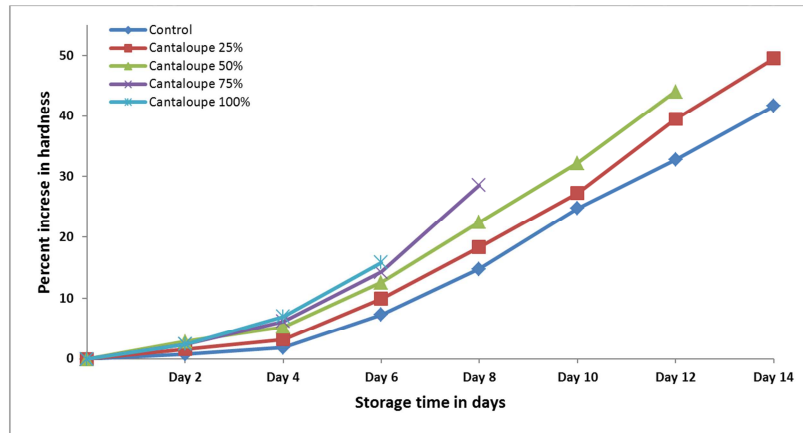


Fig. 3. Percent Increase in Hardness in Cakes with Cantaloupe Puree as Fat Replacer.

Figure 3 and 4 presents the percent increase in hardness during storage. Data revealed that reduced fat fresh products presented higher hardness values than control fresh cakes. Reduced fat fresh products presented higher hardness values than control fresh cakes.

Baik *et al.* (2000) reported texture changes in cake crumb during storage to be related to moisture loss and deterioration of starch chains. While Gomez *et al.* [25] referred the deterioration to the interaction between hydrocolloids and starch.

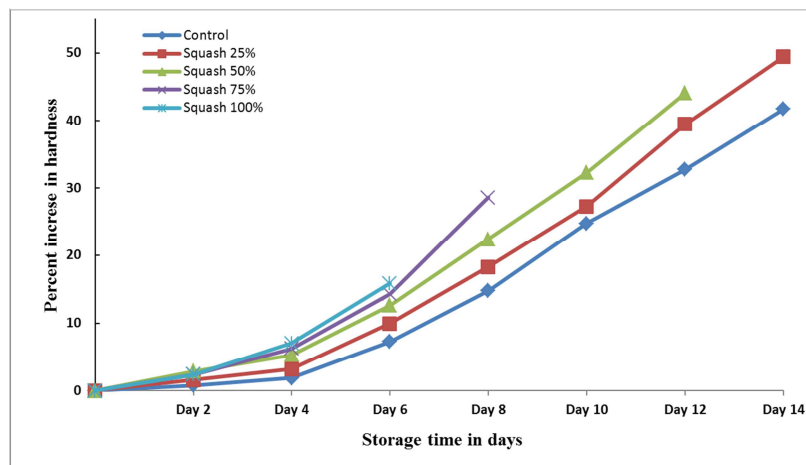


Fig. 4. Percent Increase in Hardness in Cakes with Squash Puree as Fat Replacer.

4. Conclusion

This experiment showed that purees are an acceptable fat replacer in cakes and effective in reducing the amount of fat and, as a result, calories. Cakes prepared with up to 50% puree (for both squash and cantaloupe) had no difference in volume and appearance between them and the control cake. The addition of puree did not result in undesirable changes in color. While the high moisture content in cakes (with puree) was more acceptable among the panelists.

The results promote the need for additional studies regarding replacement of fat in other baked goods. Depending on the required shelf-life, the use of preservatives to increase storage life and avoid any microbiological growth.

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