Sensory and Physical Evaluation of Cakes Substituted with Whole Zucchini and Kiwi Puree as Fat Replacers

تقييم حسي و فيزيقي لكيك مستبدل باستخدام معجون الكوسة و الكيوي كبدائل للدهون

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ABSTRACT: The link of fats to chronic diseases is well established. Over-consuming of high energy-dense foods may contribute to prevalence of obesity as well as the risk of chronic diseases. Fat replacers are used to provide some or all of the functional properties while providing fewer calories than the fat being replaced. In our study whole zucchini and whole kiwi fruit were used as fat replacer in producing low fat cakes at (25, 50, 75 and 100% replacement). The chemical analysis of raw materials showed that they both have low fat content, while zucchini has higher content of moisture, ash and crude protein content whereas kiwi had higher carbohydrate content.

The cakes substituted by the different aforementioned levels with whole zucchini and kiwi showed dramatic drop in crude fat at 100% substitution and significant increase in all parameters with a significant drop in the caloric content by 24.84% in zucchini and 24.88% in kiwi cakes.

According to sensory evaluation and physical measurements of weight, height, volume and specific volume of cakes, it was concluded that the highest level of substitution whether in whole zucchini or kiwi accepted by panelists reached as high as 75% substitution. Therefore, this level was tested and further evaluated for texture profile analysis, content of phenolic compounds and fatty acid profile.

Texture profile test showed that, hardness cycle (1), hardness cycle (2) and gumminess significantly increased in both whole zucchini and kiwi fruit substitution as compared to control.

It was noticed that the total phenolics, total flavonoids and total unsaturated fatty acid content were increased by percentage of 39.7, 136.8 and 121.63 for whole zucchini and 74.7, 92.83 and 156.52 for whole kiwi fruit, respectively. But the total saturated fatty acid content was decreased by 27.05 and 29.71 for whole zucchini and kiwi fruit, respectively.

Keywords: Fat, Fat replacers, cake, zucchini, kiwi, texture profile analysis, total phenolics and flavonoids and fatty acid composition.

INTRODUCTION

Nutrition-related diseases are on the rise as a result of excessive calorie consumption and low dietary fiber intake, which is below the recommended daily limit. Overweight and obesity have increased in the previous 30 years as a result of nutrient imbalance (**Smethers and Rolls, 2019**). Obesity has been linked to a number of non-communicable disorders. Because fat has the largest calorie value of any major food ingredient, fat substitution by other ingredients is challenging, particularly in bread goods, which often include significant quantities of fat. **(Colla K. *et al.*, 2018)**

Fat improves the texture, mouth feel, and taste of baked goods. In addition, fat gives various benefits to cakes, such as increased volume and softness in the final product. (**Grigelmo-Miguel *et al.*, 2001 and Zahn *et al.*, 2010)**. Because consumers are more aware of the relationship between dietary fat intake and obesity, which has been related to a variety of diseases like cancer, diabetes, and cardiovascular disease, fat-reduced meals are becoming more and more popular in the functional food market. Carbohydrate-based fat substitutes are beneficial owing to their ability to promote gel formation and viscosity, give flavour and texture, and enhance water retention capacity (**Dervisoglu *et al.*, 2006 and Crizel *et al.*, 2013**).

Increased consumption of baked goods and increased health problems has forced manufacturers and researchers to re-evaluate the

product's formulation. (**Conforti *et al.*, 1997**). American Dietetic Association described fat replacers as "an ingredient that can be used to provide some or all of the functions of fat, yielding fewer calories than fat" **(Eshak *et al.*, 2021).** Fat substitutes are employed in a broad range of food products, some of which include meat, dairy, and baked goods. Ingredients having a carbohydrate, protein, or fat origin can be used as fat replacers. There are numerous varieties of fat replacers with various structures and functions. (**Colla *et al.*, 2018**).

Recent trends indicated an increase in the use of whole foods such fruits, vegetables, legumes, and cereal-based components as fat replacements. These foods often succeed because, when mashed or prepared, they have a very creamy texture. Bananas, which have a high starch content, avocados, which have a high oil content, and legumes, which have high protein and starch contents, can all contribute to be fat replacer. **(Colla K. *et al.*, 2018)**

Zucchini (*Cucurbita pepo L.*) belongs to the family *Cucurbitaceae* is one of the most popular vegetable crops for human nutrition, not only in Egypt, but also all over the world. (**Abd El-All et al., 2013**). All summer squash is a rich source of nutrients, especially the natural antioxidants beta-carotene, folic acid, and vitamins C and E. They contain healthful minerals including potassium, iron, calcium, magnesium, phosphate, copper, and zinc. **(Lijuan *et al.*, 2018).** Kiwi fruit (*Actinidia chinensis Planch*.), also known as the Chinese gooseberry, is an edible berry that originated from the central and southern regions of China. A range of vitamins, minerals, and trace elements found in kiwi fruit help to improve immune system performance and prevent cardiovascular disease as well as multiple metabolic disorders. **(Mahmoud, 2017**).

A greater understanding of the link between nutrition and health has resulted in changes in consumer eating patterns, raising the demand for healthier foods. (**Cena and Calder 2020**)

Therefore the objective of this study was to investigate the effect of using fruits and vegetables (kiwi and zucchini) that can be applied as a fat replacer in several baked products to show how the substitution affects customer acceptance of the product, assess the influence of the substitution on product characteristics and the decrease in energy value of the resulting products, and to provide nutritious and functional products.

MATERIALS & METHODS

MATERIALS

Zucchini and kiwi were purchased from a local market in Alexandria city. Margarine, ((Fern) from IFFCO Egypt, Attaqa, Suez) contained (cow milk 12%, non-hydrogenated refined palm oil, emulsifier, water, citric acid, potassium sorbet, soya lecithin, whole milk powder, Beta carotene and flavor) was used as a fat source in the production of control cakes and cookies and was purchased from local market in Alexandria city. Wheat flour (72% extraction), Sugar, brown sugar, egg, baking powder, vanillin and sodium bicarbonate: were purchased from the local market in Alexandria city.

Chemicals and reagents:

Solvents, chemicals and reagents were obtained from El-Gomhouria company, Alexandria, Egypt and Sigma Aldrieh (Steinheim, Germany). All chemicals and reagents used were analytical grade.

METHODS

Preparation of kiwi fruit and zucchini

Raw materials used as fat replacers whole kiwi fruit and whole zucchini were washed thoroughly, cut into small pieces then put in a blender to be thoroughly mixed into a paste form (puree), which is the final shape used as a substitute for fat used in the present study.

Preparation of cakes

Cakes were made using the described procedure by Penfield and Campbell (1990), Table (1) shows the formula used in preparing the cakes.

Table (1): Ingredients which are used for the cakes preparation

Ingredients (g/156g flour)	Substitution %				
	control	25	50	75	100
Shortening	120	90	60	30	0
Fat replacer (kiwi or zucchini)	0	30	60	90	120
Milk (ml)	158	158	158	158	158
Sugar	200	200	200	200	200
Egg	56	56	56	56	56
Flour	156	156	156	156	156
Baking powder	5.8	5.8	5.8	5.8	5.8
Salt	3	3	3	3	3

Analytical Methods

Chemical analysis

The proximate chemical composition (moisture, protein, crude fiber, crude fat, total ash and carbohydrates) was determined according to **(AOAC 2000**). The following equation was used to calculate the caloric value of products: E= (4*total carbohydrate% +4*protein % + 9*fat %) Where E= calories per 100g product.

Fatty Acid Composition of fats

The fatty acid methyl esters were prepared using trans-esterification with a cold methanol solution containing potassium hydroxide as catalyst. The fatty acid methyl esters were identified by G.C capillary column according to the method of (**IOOC, 2001).** Identification of fatty acid methyl ester by GLC:Agilent 6890 series GC apparatus provided with a DB-23 column (60mx 0.32 x 0.25µm).

Total phenols and flavonoid content

Preparation of ethanolic extracts of cake

Five grams of sample was mixed with 30 mL ethanol (75%), stirring for 2 hours at room temperature. Finally, the mixtures were filtered using Whatman filter paper No.1 and the extracts were stored at -20 °C until analysis (**Öztürk *et al*., 2018**).

Determination the content of total phenolic of extracts

Total phenolic content of extracts were determined using the method developed by (**Abirami *et al*., 2014**). Total phenol content (TPC) was expressed as Gallic acid equivalent in mg/g plant material or extract.

Determination of total flavonoids content of extracts

Total flavonoids content of extracts were determined according to (**Barros et al., 2011**). The absorbance was measured at 510 nm using a spectrophotometer (Pg T80+, England). A calibration curve of Rutin was prepared and total flavonoids content was determined as Rutin (µg/g).

Physical measurement of cake

The pH of the cake was measured according to the method of (**AOAC, 2000**) using a Microprocessor pH Meter (HANNA instrument pH2011). The cake was weighted after removal from the pan. Cake volume was measured by rapeseed displacement after cooling for 1 hr. at room temperature (~25 ºC) (AACC, 1983). The height (cm) was measured in the center of the cake. The ratio of the volume to its weight cake was calculated to find the specific volume of each cake sample (**Ponge *et al.*, 1991**).

Texture Profile Analysis (TPA) of cake

The texture was determined by a universal testing machine (Cometech, B type, Taiwan), provided with the software. An aluminium 40 mm diameter cylindrical probe was used in a "Texture Profile Analysis" (TPA) double compression test to penetrate to 50%depth, at 1mm/s speed test. Hardness cycle 1, hardness cycle 2, gumminess, chewiness, while springiness was calculated from a TPA graphic.

Sensory evaluation of cake:

Eight trained panelists of the staff members of Food Science department evaluated cakes for colour, flavour, taste, texture and overall acceptability. Every panelist was asked to test and check how much did he or she like the characteristic under test and also to show their attitude by checking the point that best described their feeling about the characteristic. After that, their rating was given hedonic scale ranging from 9(extremely like) to 1 (extremely dislike). (**Mansour *et al.*, 2003**)

Statistical analysis:

Data of physical measurements, chemical analysis and sensory evaluation of cake were analyzed by analysis of variance using the Statistical Analysis System (SAS 2001). Means were separated using Duncan's test (**Steel, 1997**) at a degree of significance ($P \leq 0.05$).

RESULTS & DISCUSSION:

Chemical Composition and caloric value of whole zucchini and whole kiwi fruit

Proximate chemical composition and caloric value of whole zucchini and whole kiwi fruit used as fat replacers are shown in Table (2)results showed that, whole zucchini possessed a significant higher moisture content, crude protein and ash than whole kiwi fruit which possessed the highest carbohydrate. Whole zucchini also showed lower crude fat content. Whole zucchini also showed a significant lower caloric value than whole kiwi fruit.

Table (2): Proximate chemical composition and caloric value of whole zucchini and whole kiwi fruit used as fat replacers (on dry basis)

Parameters %	Whole zucchini	Whole kiwi fruit
Moisture	93.18±0.20[a]	81.5±1.12[b]
Crude fat	0.08±0.07[b]	0.19±0.03[a]
Crude protein	15.23±0.115[a]	5.3±0.05[b]
Crude fiber	6.07±0.079[b]	8.23±.025[a]
Ash	13.11±0.00[a]	5.95±.0.07[b]
Carbohydrate	65.51±5.88[b]	80.33±0.12[a]
Caloric value (Kcal/100g)	324.03±0.25[b]	344.26±0.16[a]

Results are presented as the mean± SD of three replicates. In same rows, means with same letters do not differ significantly (P< 0.05).

Chemical Composition of cakes substituted with whole zucchini

Table (3) displays the results of substituting whole zucchini at 25, 50, 75, and 100% of the butter in the cake formula on the proximate chemical composition and caloric content of cakes. Results of whole zucchini showed that when the replacement level increased, the moisture content increased considerably. This observation was made in a trend as fat replacement increased by an average of 7.35, 21.73, 23.65 and 41.02 percent for fat replacement levels of 25, 50, 75, and 100%, respectively, while crude fat was dramatically reduced.

However, as compared to control cakes, the protein content of the replacement cakes was significantly different (P>0.05) and was significantly altered by 6.63, 11.41, 13.8 and 19.78 percent respectively. With regard to the carbohydrate content, it tended to rise positively as the percentage of fat replacement increased.

Whole zucchini was used to replace all the butter in the recipe, which led to cakes that had a greater percentage of carbohydrate content than the control cakes. In terms of the caloric content of the low-fat cakes prepared, it was found that cakes made with fat replacement levels of 25, 50, 75, and 100% had calorie values that were, on average 2.94, 10.17, 17.05 and 24.84 percent lower than control cakes. The pH of the fat-replaced formulae did not differ from the control cakes' pH significantly (P≤0.05) in any way, ranging from 6.93 to 7.52.

Table (3): Proximate chemical composition and caloric value of cakes substituted with different levels of whole zucchini as fat replacers (on dry basis).

	% of fat substitution by whole zucchini				
Parameters %	**Control**	**25**	**50**	**75**	**100**
Moisture	31.59±1.34[c]	33.97±0.62[c]	38.45±0.3[b]	39.06±1.45[b]	44.55±0.84[a]
Crude fat	28.39±1.06[a]	26.94±0.00[a]	19.67±0.81[b]	11.38±0.24[c]	3.86±0.23[d]
Crude protein	9.20±0.02[e]	9.81±0.01[c]	10.25±0.10[b]	10.47±0.26[b]	11.02±0.12[a]
Crude fiber	0.55±0.00[e]	0.78±0.02[d]	0.95±0.01[c]	1.29±0.01[b]	1.76±0.01[a]
Ash	1.72±0.31[b]	2.44±0.463[c]	2.95±0.23[b]	3.51±0.13[a]	3.96±0.08[a]
Carbohydrate	61. 43±0.89[d]	58.80±0.13[d]	65.33±0.97[c]	74.60±0.43[b]	80.40±0.18[a]
Caloric value (Kcal/100g)	532.86±6.15[a]	513.55±0.46[b]	478.69±3.88[c]	442.01±2.02[d]	400.48±1.96[e]
PH	6.93±0.058c	7.46±0.05[b]	7.48±0.015[b]	7.52±0.01[a]	7.54±0.015[a]

Results are presented as the mean± SD of three replicates. In same rows, means with same letters do not differ significantly (P< 0.05).

Chemical Composition of cakes substituted with whole kiwi fruit

Approximate chemical content and calorie impact of cakes produced with whole kiwi fruit replaced by 25, 50, 75, and 100% of butter (by weight) were shown in Table (4).

The results demonstrated that substituting whole kiwi fruit for fat had an impact on the moisture level of cakes. The rise in fat replacement level was accompanied by a steady, considerable increase in moisture content. For levels of fat replacement of 25, 50, 75, and 100% the percentages of the increase in moisture content were 6.80, 16.62, 20.29 and 31. 31 respectively more than of the control cakes. It is observed that as fat replacement increased, the crude fat a significantly (P≤ 0.05) reduced. Fat content was reduced by an average of 21.1, 48.40, 65.94 and 85.80 percent compared to that of the control cake. Fat-replaced cakes' protein composition was not substantially (P≤0.05) different from control cakes'. An observed gradual increase in

carbohydrates was noticed, in contrast to the trend in the changes in crude fat, by 8.55, 21.37, 28.35 and 37.38 percent greater carbohydrate content for all levels than the control cake. This might be explained by the substitution of a fatty substance (butter) with a carbohydrate substance (whole kiwi fruit). The caloric value of cakes clearly decreased (P≤0.05) when whole kiwi fruit was used in place of butter as shown in Table (4). For fat replacement levels of 25, 50, 75, and 100% the caloric value of cakes was reduced by percentages of 5.62, 12.87, 17.91 and 23.18% respectively compared to the control cake. The pH of the fat-replaced formulae ranged from 6.93 to 7.15, and it did not differ from the control cakes' pH significantly (P≤0.05) in any way.

These results were in agreement with **Dingwei *et al*.** (2021) when examined the proximate chemical composition of low-fat meatballs of pork with different amounts of superfine powder KWIDF to determine the effects of insoluble dietary fibre from kiwi fruit pomace. It was discovered that low-fat meatballs moisture content was higher than the control samples (P≤0.05) significantly, because the water partially replaced the fat, while the content of fat of low-fat meatballs with KWIDF superfine powder was significantly lower compared with samples of control (P≤0.05). It might be stated that eating the kiwi fruit pomace mixed with the meatballs has a beneficial impact.

Table (4): Proximate chemical composition and caloric value of cakes substituted with different levels of whole kiwi fruit as fat replacers (on dry basis).

	% of fat substitution by whole kiwi fruit				
Parameters %	**Control**	**25**	**50**	**75**	**100**
Moisture	31.59±1.34^{c}	33.74±3.13^{c}	36.84±1.00^{bc}	38.00±0.68^{b}	41.48±1.23^{a}
Crude fat	28.39±1.06^{a}	22.40±0.74^{a}	14.65±0.85^{b}	9.67±0.06^{c}	4.03±.0.41^{d}
Crude protein	9.20±0.021^{e}	9.25±0.08^{c}	9.94±0.01^{c}	10.34±.015^{b}	10.57±0.01^{a}
Crude fiber	0.55±0.00^{e}	0.78±0.01^{c}	0.97±0.01^{c}	1.32±0.01^{b}	1.81±0.01^{a}
Ash	1.72±0.31^{b}	1.69±0.08^{c}	2.07±0.06^{bc}	2.13±0.02^{ab}	2.49±0.34^{b}
Carbohydrate	60.14±0.89^{d}	65.28±1.19^{d}	72.99±0.69^{c}	77.19±0.05^{b}	82.62±0.48^{a}
Caloric value Kcal/100g)	532.86±6.15^{a}	502.89±7.90^{a}	464.3±4.13^{b}	437.4±0.35^{c}	409.3±1.79^{d}
PH	6.93±0.06^{ab}	7.02±0.13^{ab}	6.87±0.05.8^{b}	7.00±0.15^{ab}	7.15±0.19^{a}

Results are presented as the mean± SD of three replicates. In same rows, means with same letters do not differ significantly (P< 0.05).

Physical properties of cakes made with whole zucchini as a fat replacer:

Figure (1) summarizes the physical characteristics of cakes substituted with whole zucchini at 25, 50, 75, and 100% (of butter weight). Results of the cake's heights showed a clear, significant (P≤0.05) decline as compared to the control cake. As for the weight results a relative no significant change in weight for levels of 25, 50 and 75 were observed, wherase a significant decline at the 100% substitution level was obvious.

Compared to control cakes, the volume of cakes made with 75% and 100% whole zucchini was significantly lower in volume than 25, 50 and control cakes, whereas cakes made with 25% and 50% zucchini exhibited significantly (P≤0.05) higher volumes than control. The cake's specific volume can be used as a measure of the product's porous structure and subsequent volume development. In the current investigation, replacing 25% of the butter with whole zucchini had a higher specific volume, while no significant (P≤0.05) impact on the specific volume were observed with cakes made with 50% substitution. As a matter of fact 75% and 100% whole zucchini were significantly lower in specific volume.

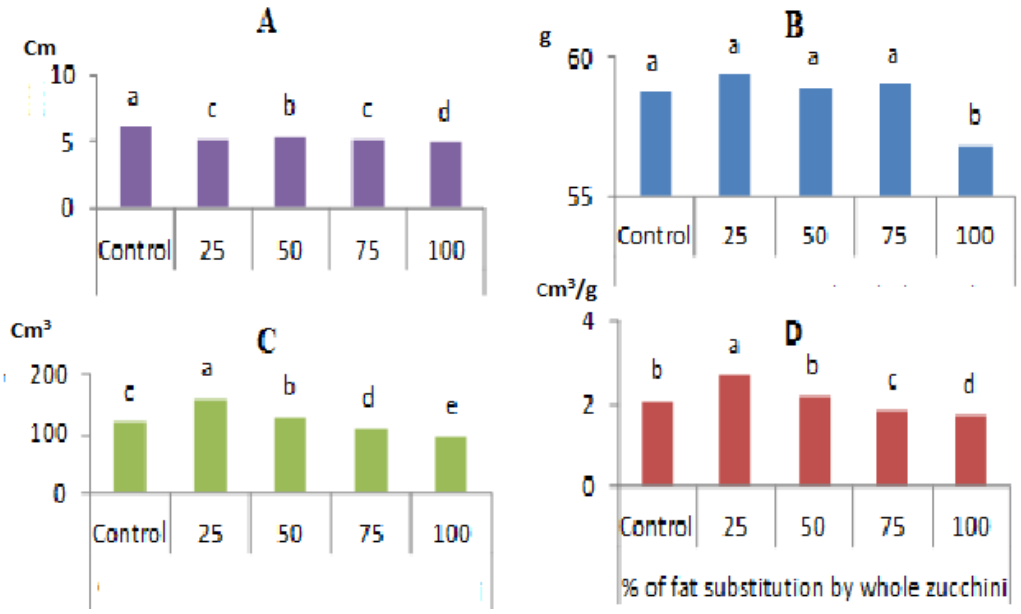

Fig. (1): Physical properties of cakes made with whole zucchini as a fat replacer: A (height), B (weight), C (volume) and D (specific volume).

Physical properties of cakes made with whole kiwi fruit as a fat replacer:

The findings of our study on the impact of whole kiwi fruit replacement with butter at levels of 25, 50, 75, and 100% on the physical characteristics of cakes (weight, volume, height, and specific volume) are displayed in Figure (2).

In terms of cake qualities, the volume of cakes made with whole kiwi fruit at replacement levels of 25% showed a higher volume than that of their full-fat equivalent, but substitution level at 50%, 75 and 100% were significantly decreased. The specific volume showed higher specific volume at level 25% of the substitution, while no significant change at substitution of 50 and 75% was observed when compared to control. Meanwhile, a slight decrease was observed at 100% substitution. The weight of the cakes significantly ($P \leq 0.05$) decreased as the level of substitution increased. However, raising the replacement level to 50% resulted in no significant ($P \leq 0.05$) reduction in height of the cake as compared to the control. Whereas it was decreased significant at replacement levels of 75 and 100%.

According to Psimouli and Oreopoulou (2013), the specific volume of the cake can be used as a gauge for how the volume develops and, in return, for how the product is porous. In comparison to the control cakes, he noticed that samples of cakes containing inulin and maltodextrin had much lower specific volumes. More particular, the viscosity of the batter decreased as the percentage of replacement increased, which reduced the incorporation of air bubbles and the capacity to hold air during baking. In the case of pectin, however, the increase in fat replacement from 65% to 100% led to a greater consistency coefficient and, as a result, made it easier for many air bubbles to develop (as shown by the lower specific gravity), resulting in a cake with a specific volume that was similar to the control. Since oligofructose samples mostly raised the temperature of starch gelatinization and showed specific volumes similar to those of control samples despite the relevant batters' specific gravities being lower, starch gelatinization temperature appears to also play a role in volume development.

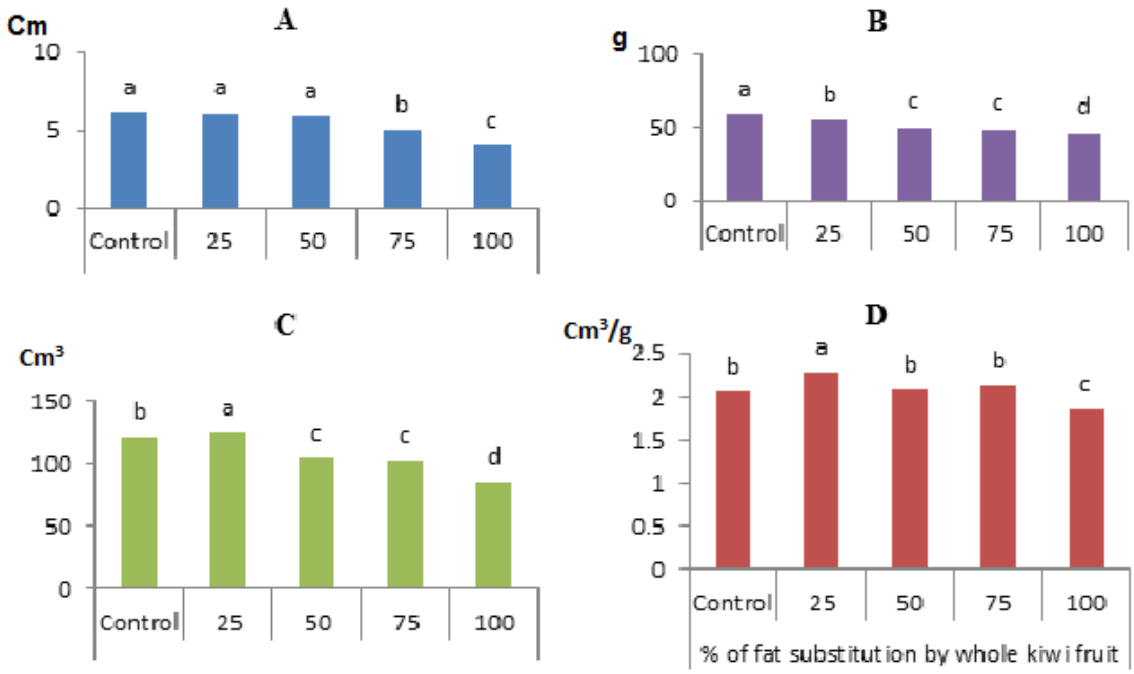

Fig. (2): Physical properties of cakes made with whole kiwi fruit as a fat replacer: A (height), B (weight), C (volume) and D (specific volume).

Sensory evaluation of cakes made with whole zucchini as a fat replacer

Sensory attributes (colour, flavour, texture and over all acceptance) were evaluated in the cakes prepared with whole zucchini at levels of 25, 50, 75 and 100% (butter weight basis); sensory evaluation results are shown in Table (5) and Fig. (3) which illustrates the appearance of cakes replaced by whole zucchini as fat replacer. Results showed that the colour of cakes was not affected by the addition of whole zucchini as a fat replacer at levels of 25, 50% and 75%,wherase replacing cakes at 100% whole zucchini resulted in cakes with significantly ($P \leq 0.05$) lower score by panelists as compared to control cakes. **Wafaa *et al.*, (**2011) reported that in general, cakes and cookies substituted with 25 and 50% pectin and 50 and 75% egg white were nearly similar in yellowness colour to the control samples. Concerning the flavour, it was found that replacement of up to 75% with whole zucchini did not significantly affect the flavour of cakes, and was highly accepted.

The texture of cakes was also not affected by replacing levels of 25, 50, and 75% whole zucchini, but increasing the fat replacement level to 100% resulted in cakes with significant ($P \leq 0.05$) lower texture scores when compared to control. The same trend was found with the overall acceptance which showed no significantly ($P \leq 0.05$) difference in cakes with 75% fat replacement with whole zucchini, as compared to the control cake. That is to say, cakes replaced up to 75% whole zucchini were highly acceptable by panelists.

Table (5): Sensory scores of cakes substituted with whole zucchini as fat replacer

Parameters	**% of fat substitution by whole zucchini**				
%	**Control**	**25**	**50**	**75**	**100**
Color	8.82 ± 0.40^{a}	7.54 ± 0.93^{bc}	7.73 ± 1.19^{b}	7.82 ± 1.60^{b}	5.45 ± 0.52^{c}
Flavor	8.73 ± 0.47^{a}	7.73 ± 0.79^{bc}	7.91 ± 1.14^{b}	8.09 ± 1.22^{b}	6.09 ± 0.94^{c}
Texture	8.64 ± 0.50^{a}	7.91 ± 0.70^{b}	8.00 ± 1.26^{b}	8.36 ± 1.03^{ab}	6.09 ± 1.04^{c}
Over all acceptance	8.82 ± 0.40^{a}	7.73 ± 0.65^{bc}	7.91 ± 0.22^{b}	8.27 ± 1.191^{ab}	6.00 ± 0.77^{c}

Results are presented as the mean± SD of three replicates. In same rows, means with same letters do not differ significantly ($P < 0.05$).

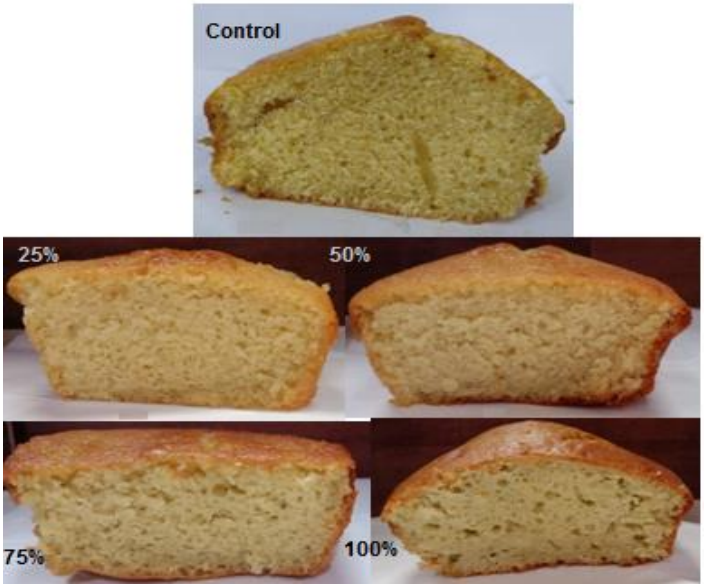

Fig. (3): General appearance of cakes replaced by whole zucchini compared to control

Sensory evaluation of cakes made with whole kiwi fruit as a fat replacer:

Sensory properties attributes for colour, flavour, texture and over all acceptance were evaluated in cakes substiuted with whole kiwi fruit as a replacement for butter at levels of 25, 50, 75 and 100%. Results of the sensory evaluation shown in Table (6) and Fig (4) illustrates the appearance of the whole kiwi fruit- compared to control. Results showed that concerning colour of the substituted cakes showed the same trend as cakes substituted with zucchini. **Psimouli and Oreopoulou** (2013) demonstrated that various types of carbohydrate- and protein-based fat replacers replaced fat in cakes at a range of 35% to 100%. It was noticed most samples with fat replacers at levels of 35% and 65% did not significantly differ in crust colour from the control. Concerning flavour, it was found that replacing butter with whole kiwi fruit did not significantly ($P \leq 0.05$) affect flavour up to 100% level of substitutions. The texture of cakes was also not affected by replacing 25, 50 and 75% of butter with whole kiwi fruit, but increasing the fat replacement level up to 100% resulted in cakes with significant ($P \leq 0.05$) lower texture score when compared to control cakes. **Kim *et al.*,** (2001) concluded that the amylodextrin tended to retrograde or associate quickly after gelatinization. Thus, the cake containing amylodextrin may have set quickly, resulting in textural rigidity.

Concerning overall acceptance of substituted cakes at 25, 50 and 75% whole kiwi, no significant differences were observed which recommends high acceptance up to 75%. However, at 100% replacement, lower scores were observed but still far from rejection. It may be concluded that the highest level of substitution whether with whole zucchini or kiwi was accepted by panelist reached as high as 75% substitution. Therefore, this level will be further tested and evaluated for texture profile analysis, content of phenolic compounds and fatty acid profile.

Table (6): Sensory scores of cakes made with whole kiwi fruit as fat replacer

Parameters %	% of fat substitution by whole kiwi fruit			
	25	50	75	100
Color	8.73 ± 0.47^{a}	7.500 ± 0.74^{b}	7.54 ± 1.21^{b}	7.00 ± 1.55^{bc}
Flavor	8.64 ± 0.50^{a}	7.77 ± 0.75^{b}	7.68 ± 1.14^{bc}	7.41 ± 1.43^{b}
Texture	8.82 ± 0.40^{a}	8.00 ± 0.89^{b}	8.04 ± 0.91^{b}	7.23 ± 1.33^{bc}
Over all acceptance	8.82 ± 0.40^{a}	7.95 ± 0.65^{b}	7.86 ± 0.78^{b}	7.18 ± 1.33^{bc}

Results are presented as the mean± SD of three replicates. In same rows, means with same letters do not differ significantly ($P < 0.05$).

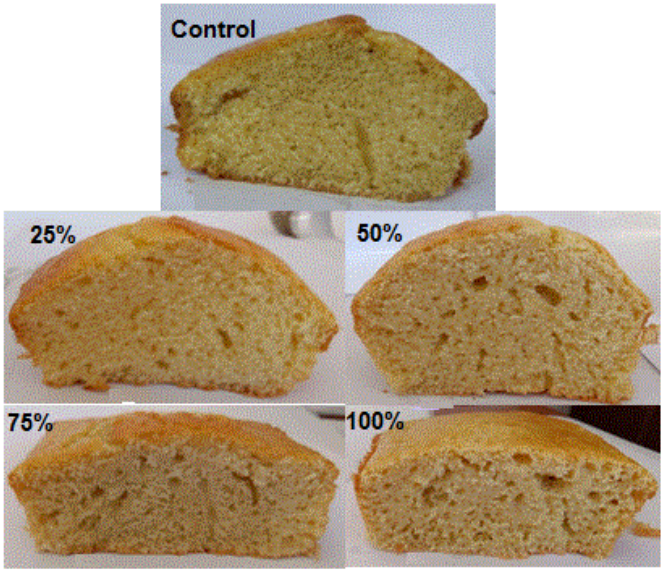

Fig. (4): General appearance of cakes replaced by whole kiwi fruit compared to control

Texture profile analysis

One of the most important characteristics of food is its texture, which is defined by how the product feels to the touch (**Szczesniak, 1987**). The impact of replacing fat with whole zucchini and whole kiwi fruit at the most accepted level of 75 % (according to sensory evaluation) was examined using texture profile analysis (TPA). From experimental (TPA) data, five textural metrics can be derived: hardness cycle 1, hardness cycle 2, springiness, gumminess and chewiness. A typical experimental force-time graph for cake texture profile analysis is shown in Figure (5). Result in Figure (5) show the effect of replacing level 75% with whole zucchini in comparison with control, The hardness cycle (1), hardness cycle (2) and gumminess values of cakes substituted with whole zucchini at a 75% fat substitute were significantly increased, while springiness were not significantly changed, but chewiness was greatly increased.

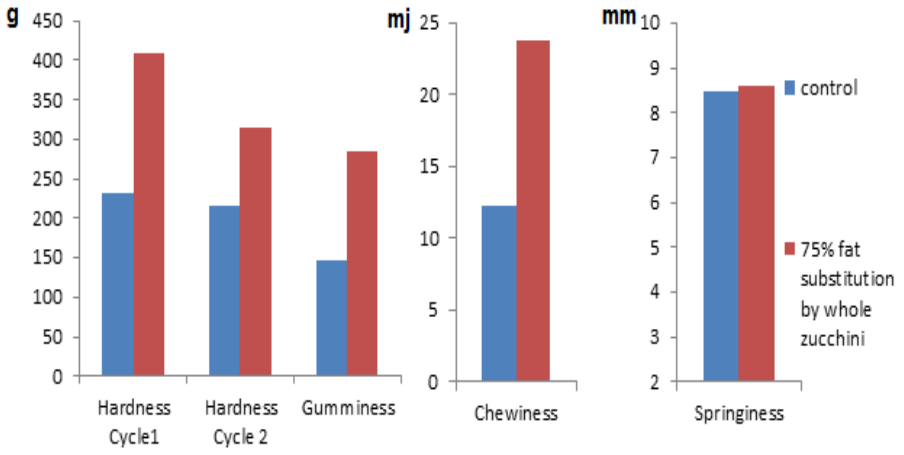

Fig. (5) Texture profile analysis of cakes substituted with 75% whole zucchini

The effect of replacing level 75% with whole kiwi fruit in comparison to control are shown in Fig (6). The hardness cycle (1), hardness cycle (2), gumminess and chewiness values of cakes with whole kiwi fruit a significant ($p<0.05$)increase as compared to control. whereas springiness showed a decrease as compared to control

Dingwei *et al*. (2021), studies showed that hardness increased significantly as KWIDF superfine powder concentration increased, the highest level of hardness ($P \leq 0.05$) was for products group substituted with the 7% KWIDF superfine powder. It has been found that improving the texture and sensory qualities of meat products can be accomplished by replacing the fat in meat products with other useful substances like dietary fibre. (**Henning *et al*., 2016**). This might be owing to fact that low content fiber groups water-holding capacity which raised the moisture content of meatballs, along

with the growth of fiber content, To increase hardness, microscopic IDF particles could be included to the beef protein's three-dimensional gel net structure. **(Hu *et al.*, 2017**). Because the kiwi fruit fiber has a very strong viscosity similar to the gel, low-fat meatballs' gumminess and chewiness significantly changed when compared to the control group (P 0.05) along with their hardness. However, the springiness caused a rise in the initial stage and thereafter a drop (P≤ 0.05) when compared to the control treatment. This might be explained by the fact that KWIDF has gel characteristics, which increase the rigidity of the protein network structure in meatballs and reduce their capacity to recover and withstand secondary compression.

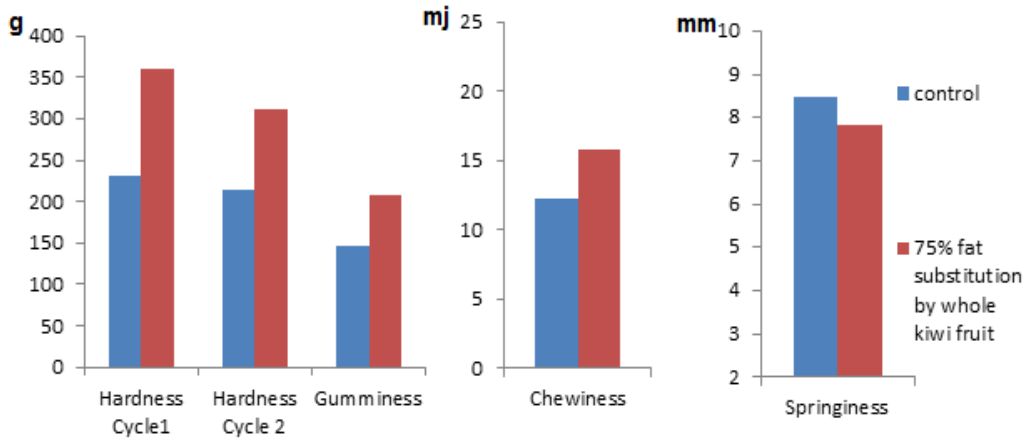

Fig. (6) Texture profile analysis of cakes substituted with 75% whole kiwi fruit

Total phenolics and flavonoids

Table (7) illustrate the total phenolics and flavonoids of the most accepted cake replaced with 75% of whole zucchini or whole kiwi fruit. It was clearly noticed that total phenolics was increased by 39.7 and 74.7 % when 75% of whole zucchini and whole kiwi fruit was used as fat replacer, respectively, while in case of total flavonoids it was increased by 136.8 and 92.83 % respectively.

According to Vijerathna et al. (2019), adding sugarcane bagasse powders enhanced the overall phenolic content of cookies, which ranges from 0.310.09 to 153.301.33 g GAE/g., which indicate that sugarcane bagasse powder includes phenolic chemicals. Cookies using 10% of peel bagasse powder had the greatest phenolic content of all the cookies. The level of phenolic content in peel bagasse powder is higher than it would be without it. According to a previously published study, adding white grape pomace to biscuits improved their phenolic content (Mildner-Szkudlarz et al., 2012). The amount of phenolics increased as the white grape pomace concentration was raised (Mildner-Szkudlarz et al., 2012). Similar to this, the content of phenol increased as sugarcane bagasse powder was added to cookies.

Table (7): Total phenols and flavonoids of the most accepted cake replaced with 75% whole zucchini or whole kiwi fruit

products	Total phenolic (mg GA/g)	Total flavonoids (µg/ml)
Control	3.40±0.34^{c}	21.90±1.45^{c}
Whole zucchini cake	4.75±0.77^{b}	51.86±2.24^{a}
Whole kiwi fruit cake	5.94±0.51^{a}	42.23±0.78^{b}

Results are presented as the mean± SD of three replicates. In same rows, means with same letters do not differ significantly (P< 0.05).

Fatty acid profile

Results of the fatty acid composition of the most accepted cakes replaced with 75% whole zucchini and whole kiwi fruit as fat replacer are shown in Table (8) Saturated fatty acid C12:0, C14:0 and C16:0 were 2.89, 4.62 and 46.14% for control, compared to 0.65, 0.89 and 34.13% in case of 75%replacment by whole zucchini and 0.37, 0.98 and 34.11% for 75% replacement by whole kiwi fruit. A dramatic drop in saturated fatty acid was observed at 75%replacement whether substituted by whole zucchini or kiwi fruit, as matter of fact, the fatty acid C 16:0 was the most prevailing saturated fatty acid.

Also table (8) show the unsaturated fatty acid C18:2, C18:3 and C16:1 content in control were 0.74, 7.51 and 0.59 %, while at 75% replacement

with whole zucchini they increased to 5.03, 14.26 and 0.80 %, and increased to 4.97, 15.64 and 2.7% with whole kiwi fruit, respectively.

The percentage of total saturated fatty acids in control was 59.01% while it was decreased to 43.05 and 41.84%, respectively when whole zucchini and whole kiwi fruit were used as a fat replacer. Total unsaturated fatty acid was increased from 9.2 in the case of control to 20.39 and 23.6 when whole zucchini and whole kiwi fruit used as fat replacer respectively.

Taj khan *et al* (2018) studied the fatty acid composition of several Gouda cheese reinforced with mango kernel fat (MKF); Short-chain, medium-chain, and long-chain fatty acids all showed considerable change. The percentages of short-chain fatty acids decreased, and it was found that the addition of MKF greatly raised the quantity of C18:1, C18:2, and C18:3 in cheese samples. Scientific research supports the function of unsaturated fatty acids in lowering risky LDL cholesterol. To reduce the risk of cardiovascular disorders, nutritionists advise consuming 50% of calories from C18:1oil.

Thus it may be concluded that at 75% substitution of cakes with whole zucchini and kiwi the nutritional value of cakes was highly enhanced as can be proved by the increase in phenolics , flavonoids and unsaturated fatty acids.

Table (8): Fatty acid analysis of most accepted cakes replaced with whole zucchini and whole kiwi fruit as fat replacer

Fatty acid		Control	75% fat replacement	
			Whole zucchini	Whole kiwi fruit
Saturated fatty acids				
Lauric	C 12:0	2.89	0.65	0.37
Myristic	C 14:0	4.62	0.89	0.98
Pentadecanoic	C 15:0	0.30	0.11	0.12
Palmitic	C 16:0	46.14	34.13	34.11
Heptadecanoic	C 17:0	0.19	0.15	0.14
Stearic	C 18:0	4.63	7.05	6.05
Arachidic	C 20:0	0.24	0.07	0.07
Unsaturated fatty acids				
Myristoleic	C 14:1	0.21	0.15	0.13
Palmtoleic	C 16:1	0.74	5.03	4.97
Linoleic	C 18:2	7.51	14.26	15.64
ɤ-linolenic	C 18:3	0.59	0.80	2.7
Eicosenoic	C 20:1	0.15	0.15	0.16
Total saturated fatty acids%		59.01	43.05	41.84
Total unsaturated fatty acids%		9.2	20.39	23.6

CONCLUSION:

Zucchini and kiwi have low fat and caloric value. Cakes substituted by different levels of whole zucchini and kiwi showed dramatic drop in crude fat and caloric content at 100% substitution.

According to sensory evaluation and physical measurements of weight, height, volume and specific volume of cakes, it was concluded that the highest level of substitution whether in whole zucchini or kiwi accepted by panelists reached as high as 75% substitution.

It was noticed that the total phenolics, total flavonoids and total unsaturated fatty acid content were increased in 75% substituted cakes, while the total saturated fatty acid content was decreased

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الملخص العربي

تقييم حسي و فيزيقي لكيك مستبدل باستخدام معجون الكوسة و الكيوي كبدائل للدهون

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إن ارتباط الدهون بالأمراض المزمنة راسخ و مؤكد, قد يساهم الإفراط في تناول الأطعمة الغنية بالطاقة في انتشار السمنة وكذلك خطر الإصابة بالأمراض المزمنة. تستخدم بدائل الدهون لتوفير بعض أو كل الخصائص الوظيفية مع توفير سعرات حرارية أقل من الدهون التي يتم استبدالها. في دراستنا تم استخدام الكوسة الكاملة وفاكهة الكيوي الكاملة كبديل للدهون في إنتاج كعكات قليلة الدسم عند (25 ، 50 ، 75 و 100٪ بديل). أظهر التحليل الكيميائي للمواد الخام أن كلاهما يحتوي على نسبة منخفضة من الدهون ، بينما يحتوي الكوسة على نسبة عالية من الرطوبة والرماد ومحتوى البروتين الخام بينما يحتوي الكيوي على نسبة عالية من الكربوهيدرات.

تم استبدال الكيك بمستويات مختلفة من الكوسة الكاملة والكيوي بانخفاض كبير في الدهون الخام عند استبدال 100٪ وزيادة معنوية في جميع المعاملات مع انخفاض معنوي في محتوى السعرات الحرارية بنسبة 24.84٪ في الكوسة و 24.88٪ في كعك الكيوي.

وفقًا للتقييم الحسي والقياسات الفيزيائية للوزن و الارتفاع والحجم والحجم المحدد من الكعك ، تم الاستنتاج أن أعلى مستوى من الاستبدال سواء في الكوسة الكاملة أو الكيوي المقبول من قبل أعضاء اللجنة وصل إلى 75 ٪ استبدال. لذلك ، تم اختبار هذا المستوى وتقييمه بشكل أكبر لتحليل المظهر الجانبي للنسيج ومحتوى المركبات الفينولية ومحتوي الأحماض الدهنية.

أظهر اختبار المظهر الجانبي للقوام زيادة معنوية في دورة الصلابة (1) ودورة الصلابة (2) والصمغ في كل من الكوسة الكاملة وبدائل فاكهة الكيوي بالمقارنة مع مجموعة المقارنة.

لوحظ زيادة الفينولات الكلية والفلافونويد الكلي ومحتوى الأحماض الدهنية غير المشبعة بنسبة 39.7 و 136.8 و 121.63 للكوسة الكاملة و 74.7 و 92.83 و 156.52 لفاكهة الكيوي الكاملة على التوالي. أما المحتوى الكلي من الأحماض الدهنية المشبعة فقد انخفض بمقدار 27.05 و 29.71 لكل من الكوسة وفاكهة الكيوي على التوالي.