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UTILIZATION OF AVOCADO AND CANTALOUPE PUREE AS FAT SUBSTITUTE IN MUFFINS

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ABSTRACT

This study was carried out to investigate the effect of using avocado or canta loupe puree as a fat substitution with the following levels 0%, 25%, 50%, 75% and 100% on quality characteristics of muffins. The results indicated that a significant increase in moisture as substitution levels of both avocado or cantaloupe puree increased relative to a significant lowered in fat content. The substitution of fat with avocado or cantaloupe puree at different levels lowered the weight, volume, height and specific volume of muffins. The texture profile analysis (TPA) showed that both puree increase hardness and resilience of the muffins formulated with 75% and 100% substitution which more was pronounced in avocado puree substituted muffins than control. The sensory evaluation of muffins showed that muffins formulated with avocado (25, 50, 75 and 100%) showed darker color of crumb compared to the control muffins, however, it was more acceptable than the muffins formulated with cantaloupe in the other quality properties. Therefore, avocado can be used as butter substitute in bakery products, since quality properties of muffins were improved by substitution of butter with avocado puree.

Key words: Avocado puree, Cantaloupe puree, Fat-reduced muffins, Physical properties, Sensory evaluation, texture profile analysis.

INTRODUCTION

Fat plays an important role in both taste and texture of baked products; therefore, choosing the appropriate fat substitute for a

product or recipe is a critical step in replacing the fat **(Hayek and Ibrahim, 2013).** Fat replacement in food systems poses a complex problem because fat contributes to sensory and physiological characteristics such as flavor, mouth feel, taste, odor and texture. Effects of product modification on sensory attributes, as well as dietary benefits, must be considered in the development of high-quality, acceptable products **(Setser and racette, 1992).** Replacing dietary fat with fruits and vegetables based ingredients will not only reduce the fat intake, but also provide with nutritional benefits to the product and contribute to increase the consumptions of fruits and vegetables.

Avocado (*Persea americana* Mill., Lauraceae) is an important fruit native to Central America and Mexico and cultivated in almost all tropical and subtropical regions worldwide (**FAO, 2017**). Avocado fruits have high nutritional quality and contain high levels of vitamins, minerals, proteins, and fibers, as well as high concentrations of unsaturated fatty acids, beneficial to health (**Yahia, 2009**). **Khalil (1998)** reported that high lipids and low carbohydrate levels remain in avocado pulp after water removal. Therefore, it is considered one of the few cultured fruits presenting the lipid fraction which reach to 25% .

Cantaloupe (*Cucumismelo* L.) is an important plant from the *Cucurbitaceae* family. Cantaloupe is one of the most consumed fruit crops worldwide due to its pleasant flavor 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 (**Ritschel *et al*., 2004; Vouldoukis *et al*., 2004**; **Mariod and Matthaus, 2008**).

Muffins, classified as quick breads, are popular for breakfast and afternoon snacks in some countries. They are characterized as a soft spongy product with porous crumb structure and high volume. Muffins and other sweet baked goods are usually rich in fat and sugar. Fats in bakery products entrap air into batter or dough to develop crumb and leaven the baked goods (**Dwyer and Gallagher, 2001**; **Matsakidou *et al*., 2010**), as well as contributing to flavor and taste of the final product**.**

The goal of the present study was to investigate possibility of using avocado and cantaloupe puree as a fat substitute in muffins and

evaluating the effect of substitution on chemical, physical properties, texture profile and sensory evaluation

MATERIALS AND METHODS

Materials:

Avocado and cantaloupe fruits (at ripping phase) were purchased from local market, Tanta city, El-Gharbia governorate, Egypt. The ingredients such as wheat flour (72% extraction), sugar, skim milk, egg, shortening and salt which used in muffin production were purchased from local market, Tanta city, El-Gharbia governorate, Egypt .

Methods:

Preparation of avocado and cantaloupe pulp

The avocado and cantaloupe fruits were cut into halves and the seeds were removed. The pulp was scooped out by a spoon and blended into a puree. The mashed pulp of avocado or cantaloupe was then kept in a freezer until use.

Muffins preparation

The control muffins were prepared using the following formula: 34.05% wheat flour, 32.13% water, 13.88% shortening, 15.42% sugar, 2.57% skim milk powder, 0.45% egg, 1.29% baking powder, 0.13% salt and vanilla essence (**Rupasinghe *et al*., 2008**). Another eight treatments were prepared by substitute the shortening with avocado or cantaloupe puree at ratio as follows: 25%, 50%, 75% and 100%.

All dry ingredients together were sifted into a bowl, and a well was made in the middle. The whole egg was beaten in a separate bowl before adding skim milk powder and shortening and/or avocado or cantaloupe puree. The mixture was blended thoroughly and poured into the well in the dry ingredient bowl, prior to mixing. Batter samples approximately 50g were poured into each muffins cup and backed at 200ºC for 22 min.

After a 5-minute setting period, muffins were removed from the pans and allowed to cool at room temperature for 1 hour before being used in various sensory, physical and chemical analyses.

Proximate analysis: Proximate analyses of samples, including moisture, crude protein, total ash, crude fat and crude fiber were

determined in triplicate **(AOAC, 2007)**, and Carbohydrates were calculated by difference.

Physical properties: The weight and volume of each muffins were measured using an electronic balance and seed displacement method, respectively (**AACC, 1983**). The height (cm) was measured in the center of the muffins. The specific volume of each muffins was determined as the ratio of the volume to its weight (**Pong *et al*., 1991**).

Texture profile analysis: Crumb texture was measured by a universal testing machine (Cometech, B type, Taiwan), provided with software. An Aluminum 40 mm diameter cylindrical probe was used in a "Texture profile analysis" (TPA) double compression test to penetrate to 50% depth, at 1 mm/s speed test. Five instrumental parameters were measured in triplicate which was the hardness, cohesiveness, springiness , chewiness and resilience . Cohesiveness is defined as the ratio of positive force area during the second compression to the positive force area during the first compression, while the springiness determines the recovery height of food between the end of first compression and the start of second compression. Chewiness, on the other hand, is the product of hardness, cohesiveness and springiness. It indicates the difficulty of chewing before swallowing (**Bourne, 2003**).

Sensory evaluation: The muffins samples were assessment to sensory evaluation by ten members semi trained panels of Food Science and Technology Dep. Staff. The panelists were asked to score each property using the control muffins as basic for evaluation. The muffins were evaluated for crumb appearance, crumb color, crust color, tenderness, moistness, flavor, mouthfeel and overall acceptability on a 9-point hedonic scale (**Johnson, 1990**).

Statistical Analysis: The data obtained were subjected to analysis of variance according to **SPSS (1997**). Significant differences among individual means were analyzed by Duncan´s multiple range test **(Duncan, 1955**).

RESULTS AND DISCUSSION

Proximate analysis of avocado and cantaloupe puree

The chemical composition of fresh avocado and cantaloupe puree was determined **Table (1).** The moisture content, crude protein and crude fat of avocado puree were 76.84, 2.16 and 19.38%,

respectively. **Soares and Ito (2000**) showed that the avocado pulp contains from 67 to 78% moisture, 13.5 to 24 % lipids, 0.8 to 4.8% carbohydrate, 1.0 to 3.0% protein, 0.8 to 1.5% ash, 1.4 to 3.0% fiber, and energy density between 140 and 228kcal. Also**, Othman *et al*., (2018**) reported that the nutritional composition of avocado puree per 100 g is: moisture (85.35%), ash (1.28%), protein (1.98%), fat content (11.37%), total dietary fiber (1.15%), carbohydrate (0.15%). The protein contents of the samples investigated ranged from 1.62±0.09 to 19.94±1.40% in fruit which was quite higher than 15.55±0.36 as reported by **Ejiofor *et al*. (2018**).

At the same table, cantaloupe puree contained low levels of protein (0.75%), crude fat (0.43%), ash (0.92%). In this respect, **Eitenmiller *et al*., (1985**) reported that cantaloupe puree had protein content range between 0.61-0.68 g/100g, fat 0.07-0.23g/100g; ash 0.76-0.84 g/100g.

Table (1): The nutritional composition (%) of avocado and cantaloupe puree (W.W)

Constituent (%)	Avocado puree	Cantaloupe puree
Moisture	76.84±0.22^{b}	89.37±0.16^{a}
Crude protein	2.16±0.08^{a}	0.75±0.00$_{b}$
Crude fat	19.38±0.12^{a}	0.43±0.11^{b}
Total ash	1.19±0.16$_{a}$	0.92±0.10^{b}
Crude fiber	1.86±0.05^{a}	0.94±0.06^{b}
Carbohydrates	1.88±0.09^{b}	94.55±0.02^{a}

Mean ± Standard deviation of triplicate trails In a row, values have the superscript letters are not significantly different by Duncan's test at 5% levels

Chemical composition of muffins contained different levels of avocado and cantaloupe puree

As shown in **Table (2),** avocado and cantaloupe puree incorporation into muffins significantly affected the chemical composition. Moisture content increased in muffins incorporating avocado and cantaloupe puree comparing with control sample. The moisture content of the control sample was 26.33% increased to 26.68, 27.44, 28.68 and 29.31% when substituted by 25, 5o, 75 and

100% avocado puree, which to be lower than that of the muffins contained 25, 50, 75 and 100% cantaloupe puree, respectively. At full substitution, muffins contain 100% cantaloupe puree showed the highest moisture content. This may be due to that cantaloupe puree had high moisture content. Contrary, **(Dreher and Davenport, 2013**) reported that the moisture content of muffins significantly increased with the addition of avocado. This possibly due to the high content of water derived from avocado puree, which is about 72% of one fruit.

Total ash increased with the incorporation of avocado and cantaloupe puree, with a significant increment ($p < 0.05$) showed in muffins contained 75 and 100%. **Hussien (2016)** reported that the incorporation of cantaloupe and squash into Madeira-type cake, also increased the ash content of final products as compared to the control cake. Protein content in muffins contained avocado puree showed increment as level of substitution increased ,while decrement in muffins contained cantaloupe puree. The protein content in control muffins was 10.23% increased to 12.91 in muffins contained 100% avocado puree while decreased in samples containing 100% cantaloupe puree (9.13%). Previous studies confirmed a similar trend in which incorporation of a fat substitute increased the protein content of baked goods, either significantly or insignificantly **(Grigelmo-Miguel *et al*., 2001; Hussien, 2016).**

Table (2): Chemical composition of muffins incorporated avocado and cantaloupe puree

Constituent (%)	Control	Avocado puree				Cantaloupe puree			
		25%	50%	75%	100%	25%	50%	75%	100%
Moisture	26.33^{g}	26.68^{f}	27.44^{e}	28.68^{d}	29.31^{c}	27.22^{e}	28.56^{d}	30.27^{b}	32.79^{a}
Crude protein	10.23^{d}	10.49^{c}	11.76^{b}	11.85^{b}	12.91^{a}	10.22^{d}	10.20^{d}	9.18^{e}	9.13^{e}
Crude fat	14.43^{a}	13.12^{b}	11.33^{d}	10.27e	9.08^{f}	12.38^{c}	10.13^{e}	8.07^{g}	7.78^{h}
Ash	1.27^{ef}	1.34^{e}	1.37^{e}	2.07^{b}	2.32^{a}	1.32e	1.56^{d}	1.98^{c}	2.13^{ab}
Crude fiber	2.77^{h}	3.56^{ef}	3.87^{e}	4.35^{d}	6.26^{b}	3.29^{g}	4.25^{d}	5.34^{c}	7.15^{a}
*Carbohydrates	71.30^{d}	71.49^{d}	71.67^{d}	71.46^{d}	69.43^{e}	72.79^{c}	73.86^{b}	75.43^{a}	73.81^{b}

In a row, values have the superscript letters are not significantly different by Duncan's test at 5% levels
* Carbohydrates were calculated by difference

Physical properties of muffins

The physical properties of muffins made with avocado and cantaloupe puree as a fat substitute are shown in **Table (3).** The volumes of muffins with puree are significantly lower compared to control sample. Muffins volume decreases significantly ($p<0.05$) with increasing fat substitution, which is due to low amount of air in baked muffins.

The specific volume of baked cake indicates the amount of air that can remain in the final product. A higher gas retention and higher expansion of the product leads to a higher specific volume (**Gomez *et al*., 2008**). Muffins incorporated avocado and cantaloupe puree had significantly higher specific volume as compared to that of the control sample. The specific volume affected the volume development and porous crumb texture of the final products (**Psimouli and Oreopoulou, 2013; Ain *et al*,2016)**

Table (3): Physical properties of muffins prepared from avocado and cantaloupe puree as fat substitute

Parameters	Control	Avocado puree				Cantaloupe puree			
		25%	50%	75%	100%	25%	50%	75%	100%
Weight (g)	112.25^{a}	104.56^{b}	102.67^{c}	99.58^{d}	97.34^{d}	102.6^{c}	100.44^{c}	98.54^{e}	96.39^{e}
Volume (cm^3)	235.89^{a}	233.28^{ab}	232.55^{b}	228.66^{c}	225.78^{d}	234.3^{a}	231.8^{b}	229.23^{c}	226.71^{d}
Height (cm)	4.76^{a}	4.58^{b}	4.43^{c}	4.02^{d}	3.66^{e}	4.66^{b}	4.52^{c}	4.22^{cd}	3.87^{e}
Specific volume (cm^3/g)	2.10^{d}	2.14^{d}	2.23^{c}	2.30^{b}	3.32^{a}	2.28^{b}	2.31^{ab}	2.33^{a}	2.35^{a}

In a row, values have the superscript letters are not significantly different by Duncan's test at 5% levels

Texture profile analysis

Texture profile analysis (TPA) is a useful technique for investigating food products where tenderness and elasticity (resilience) are the main texture properties of a cake and related to quality (**Vassiliki and Vassiliki, 2013**). The parameters shown in **Table (4)** indicate that avocado and cantaloupe substitution in muffins did slightly significantly affect ($p\leq0.05$) the crumb texture. Hardness was defined as the maximum force of the first compression (1mm/s speed test). The hardness of muffins substituted with avocado or cantaloupe puree showed decrease with increasesubstitution levels. Fat substitution, either partially or fully, usually produces harder and springier baked products (**Martinez-Cervera *et al*., 2013**). From the

tabulated data, it could be observed that full fat substitution (in both avocado and cantaloupe puree) showed the softest and springiest texture. This may be due to high content of water in muffins produces softer crumb.

Springiness parameters, noted as elasticity in muffins substitute with avocado puree , revealed to be significantly higher ($p<0.05$) than control. This reflects the high ability of the muffins to go back to its original shape after the deforming force is removed (**Szczesniak, 2012**).

Table (4): Texture profile analysis of muffins made with avocado and cantaloupe puree as fat substitute

Parameters	Fat replacer	Level of replacement				
		Control	25%	50%	75%	100%
Hardness	Avocado	2.42^{a}	2.31^{b}	2.30^{b}	2.12^{c}	1.87^{d}
	Cantaloupe	2.35^{a}	2.23^{b}	2.26^{b}	2.10^{c}	1.76^{d}
Cohesiveness	Avocado	0.88^{a}	0.84^{b}	0.79^{c}	0.77^{c}	$0.80b^{c}$
	Cantaloupe	0.79^{a}	0.72^{b}	0.69^{c}	0.71^{b}	0.73^{b}
Springiness	Avocado	0.86^{c}	0.88^{c}	0.88^{c}	0.92^{b}	0.96^{a}
	Cantaloupe	0.84^{d}	0.87^{d}	0.90^{c}	0.92^{b}	0.94^{a}
Chewiness	Avocado	588.23^{d}	634.15^{c}	676.55^{b}	596.35^{d}	684.97^{a}
	Cantaloupe	589.27^{c}	667.22^{a}	598.56^{c}	656.49^{b}	668.13^{a}
Resilience	Avocado	0.35^{b}	0.32^{b}	0.34^{a}	0.30^{b}	0.36^{a}
	Cantaloupe	0.32^{c}	0.34^{b}	0.33^{c}	0.35^{b}	0.63^{a}

In a row, values have the superscript letters are not significantly different by Duncan's test at 5% levels

Sensory evaluation

The mean scores of crust color, crumb color, tenderness, moistness, texture, flavor, mouthfeel, appearance and overall acceptability of prepared muffins with different levels of avocado puree or cantaloupe puree are presented in **Table (5).** All of tested parameters were significantly ($p\leq0.05$) affected with increasing level of avocado puree or cantaloupe puree which incorporated in muffins. Muffins with 25% cantaloupe puree as fat substitute did not show

significant difference as compared to control in crust color, crumb color, appearance and overall acceptability. This indicated that addition of cantaloupe puree did not result in undesirable changes in crust or crumb color, contradictory to avocado puree which had greenish yellowish color responsible about undesirable and detectable color changes in muffins. A similar result was observed in cake with cantaloupe added as a fat replacer, in which full-fat replacement lowered the acceptance color score as compared to the control product (**Hussien, 2016**). Also, **(Othman *et al.*, 2018**) reported that the color of fat replacer used greatly affected the crumb color of muffins with color changes either desirable or undesirable to the panelists

Muffins with replacement 75, 100% cantaloupe puree had the highest scores of moistness, while muffins with 50% avocado puree as fat substitute received significantly the highest score values in mouthfeel. **(Hayek and Ibrahim ,2013**) 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 muffins with avocado puree was more acceptable among the panelists.

From the same table, it could be observed that muffins containing 50% cantaloupe recorded the highest score of flavor (8.43) compared to control (8.19). In this respect,**(Hussein *et al.*, 2011**) stated that cakes prepared with 25% or 50% fat replacers had higher mean scores for flavor and softness (moistness) than control.

Table (5): Sensory attributes of muffins incorporated with different levels of avocado puree and cantaloupe puree as fat substitute

Attributes	Control	Avocado puree				Cantaloupe puree			
		25%	50%	75%	100%	25%	50%	75%	100%
Crust color	8.86^{a}	8.43^{c}	8.56^{b}	8.44^{c}	8.05^{e}	8.89^{a}	8.24^{d}	8.18^{e}	7.67^{f}
Crumb color	8.47^{a}	8.26^{b}	7.46^{c}	7.33^{d}	7.12^{e}	8.45^{a}	7.33^{d}	7.29^{d}	7.18^{e}
Tenderness	8.17^{a}	7.67^{c}	7.48^{d}	7.53^{d}	7.33^{e}	8.04^{b}	7.42^{d}	7.31^{e}	7.22^{ef}
Moistness	8.25^{cd}	8.21^{d}	8.15^{e}	7.66^{f}	7.15^{g}	8.33^{bc}	8.35^{b}	8.39^{b}	8.72^{a}
Texture	8.22^{a}	8.12^{b}	8.03^{bc}	7.44^{d}	7.21^{f}	8.16^{b}	8.00^{c}	7.54^{d}	7.32^{e}
Flavor	8.19^{c}	8.00^{d}	7.85^{e}	7.56^{f}	7.34^{f}	8.22^{c}	8.43^{a}	8.31^{b}	8.00^{d}
Mouthfeel	8.55^{c}	8.62^{b}	8.77^{a}	8.43^{d}	8.12^{f}	8.43^{d}	8.45^{d}	8.32^{e}	8.03^{g}
Appearance	8.82^{ab}	8.33^{d}	8.74^{b}	8.54^{c}	8.00^{de}	8.85^{a}	8.76^{b}	8.88^{a}	8.32^{d}
Overall acceptability	8.74^{a}	8.23^{c}	8.12^{d}	7.31^{f}	7.00^{g}	8.62^{ab}	8.55^{b}	7.46^{e}	7.32^{ef}

In a row, values have the superscript letters are not significantly different by Duncan's test at 5% levels

As baked goods are known to have high percentage of fat, substitution of it with fruits or vegetables contribute to healthier alternatives.

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الاستفادة من بيوريه الأفوكادو والكانتلوب كبديل للدهن فى فطائر القوالب (المافين)

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أجريت هذه الدراسة لمعرفة تأثير استخدام بيوريه الأفوكادو أو الكانتلوب كبديل للدهن في فطائر القوالب (المافين) باستخدام النسب الآتية (0٪ ، 25٪ ، 50٪ ، 75٪ و 100٪) على خصائص جودة المافين. أظهرت النتائج زيادة معنوية فى الرطوبة على كل نسب الاستبدال لكل من بيوريه الافوكادو أوالكانتلوب نتيجة لانخفاض الدهن بشكل معنوى عند نفس نسب الاستبدال أيضا . استبدال الدهن ببيوريه الأفوكادو أوالكانتلوب بنسب مختلفة أدى الى انخفاض الوزن والحجم والارتفاع والحجم النوعى للمافين.كذلك أوضحت نتائج تحليل مؤشرات القوام للمافين أن كلا من نوعى البيوريه التى تم استخدامهما أدى الى زيادة تماسك ومرونة المافين المدعم بـ 75٪ و100٪ استبدال والذي كان أكثر وضوحا في بيوريه الأفوكادو مقارنة بالكنترول. وقد أظهرت نتائج التقييم الحسي أن المافين المدعم بالأفوكادوعند نسب الاستبدال (25 ، 50 ، 75 و 100٪) أصبح لونه أكثر دكانة بالمقارنة بالكنترول ومع ذلك كان أكثر قبولا من المافين المدعم بالكانتلوب فى باقى الصفات .

لذلك يمكن القول من النتائج السابقة أنه يمكن استخدام الأفوكادو كبديل للدهن فى منتجات المخابزحيث تم تحسين خصائص الجودة فى المافين المدعم ببيوريه الأفوكادو .