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Effect of Adding Avocado on Chemical Physical, Rheological Properties and Bioactive Compounds of Avocado Cake

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ABSTRACT

This research aims to study the effect of replacing fat with avocado puree or powder on the sensory, rheological, physical and chemical properties of the cup cake. Results of sensory evaluation of cup cake samples which prepared from avocado puree or powder showed no significant differences at ($P \leq 0.5$) compared to the control sample. The results showed that there no different changes in physical properties of all cup cake samples. The results of the rheological tests (Farinograph and Extensograph) also showed an improvement in the characteristics of the resulting flour, such as the values of dough development, elasticity and energy intensity.In addition to an observed decrease in water absorption and the degree of softening compared to the control sample. Total phenolics, flavonoids and scavenging ability of cup cake samples containing 100% avocado puree or 50% avocado powder recorded high score being (2.177, 0.133 mg/g and 80.2%) or (3.096, 2.667 mg/g and 57%) in compared with control sample (1.536, 4.933 mg/g and 41.9%). Chemical evaluation showed a lower content in fat of cup cake samples and higher protein content compared to the control sample. Therefore, it is advised to add avocado puree or powder to the cup cake to improve its functional and rheological properties.

***Keywords*:** wheat flour, physical properties, Avocado puree, Avocado powder.

INTRODUCTION

Avocado is one of a tropical fruit, it is the most productive plants cultivated area since;it is an edible fruit from Central America which is easily adaptable in tropical regions including Nigeria, cultivated in the subtropical and tropical areas such as East and West Africa respectively. Fruits which have a yellow-green to purple skin are described as a berry with a thick, fleshy mesocarp surrounding a single large seed. It weigh about 50 to 1 kilogram with the mesocarp (edible flesh) contributing 50-80% and the seed 10 to 25% of its total weight (Pahua-Ramos, 2014).The fruits are a greenish, thick-skinned drupe that may be pear shaped, egg shaped, or spherical, the flesh of which has the consistency of firm butter and a faint nut like flavor when ripe (Arackal, 2017).

Cup cakes considered one of popular bakery products for breakfast and afternoon snack in many countries, it is a sweet baked food made from a thick batter, usually containing flour and sugar, and often shortening, milk, salt, eggs, and a rising agent (as baking powder) as described by (Stevenson, 2003),that sweet, high-calorie baked products which are highly appreciated by consumers due to their good taste and soft texture as well as, characterized by a typical porous structure and high volume which confer a spongy texture (Schatzel, 2018).

The effect of adding avocado puree on the physical and microstructure of butter cake, the cellular structure of the crumb exhibited a decrease in the number of air cells while the average cell size increased with addition of avocado puree was studied by (Marina, 2016), another study confirmed that The feasibility of avocado puree as fat replacer further scanning onto the muffin crumb showed that poor protein matrix formed due to higher avocado incorporation as reported by (Abdul Manaf, 2017),so, this paper aim to making of untraditional products from avocado to take advantage of its high nutritional value and high fat content, plus antioxidant activity including bakery products such as cupcake and study the effect of adding it with pureeor dried form on sensory, physical and chemical properties on acceptable cup cake mixes, as well as studying the effect of adding avocado to the physical properties of the flour.

MATERIALS AND METHODS

Materials

Avocado (*Persea Americana*) and other used ingredients Wheat flour (72%) for all purpose, sugar, salt (sodium chloride), butter, fresh milk, whole egg and baking powder were obtained from local market in El-Mansoura city, El-Dakahlia, Egypt.

Methods

Preparation of avocado puree:

Soft ripened fresh avocado fruit was carefully washed using tap water. Flesh of avocado was scooped out and homogenized in blender Model (BRAUN) according tothe method described by Martinez, (2013).Finally the prepared puree was added in different processed product namely (cupcake).

Preparation of avocado powder:

Peeled fresh avocado fruits were divided into thin slices, then dried on air dryer oven Model (WOF-107) at 400C for 18 hours according to Moyo et al., (2012) and milled to fine powder using domestic blender Model (BRAUN).Finally powdered avocado were stored in polyethylene plastic bags until used.

Preparation of Cupcake:

Avocado puree or powder were used as fat replacer in preparingcup cake as mediated by (Figoni, 2008) and showed in Table (1):

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Table 1. Formula used inprepared Cupcake:

Cup cake formulas Ingredients	F_0	F_1	F_2	F_3	F_4
Flour	200	200	200	200	200
Milk/ml	160	160	160	160	160
Egg	60	60	60	60	60
Salt	1	1	1	1	1
Baking powder	12	12	12	12	12
Sugar powder	80	80	80	80	80
Butter	100	-	50	-	50
Avocado puree	-	100 (as fat replacer)	50 (as fat replacer)	-	-
Avocado powder	-	-	-	100 (as fat replacer)	50 (as fat replacer)

F_0: Cup cake with 100% butter (control sample).
F_1:100% avocado puree (as fat replacer).
F_2: 50% avocado puree (as fat replacer).
F_3: 100% avocado powder (as fat replacer).
F_4: 50% avocado powder (as fat replacer).

Chemical composition and Minerals content of cup cake:

Moisture, ash, crude fiber, protein, fat , total carbohydrates,reduced and non-reducedsugar contents were determined according to the method described in A.O.A.C (2000), in addition to Minerals content namely (P, Ca, K, Na, Mg, Fe and Zn) were determined after dry sample ashing according to the method described by the A.O.A.C. (2000), using Atomic absorption (Perkin – Elmer, Model 3300, USA).

Determination of bioactive compounds:

Total phenolic, total flavonoid compounds and antioxidant acctivy:

The total phenolic content (TPC) was analyzed using the folin –ciocalteu method (Singleton and Rossi 1965). Total flavonoids content (TFC) of avocado methanolic extract was spectrophotometrically determined by the aluminiium chloride modified method according to (Zhuang, 1992). While total antioxidant activity was performed as previously described by Galli et al. (2016).

Physical Properties of Cup cake:

Determination of volume, symmetry and uniformity index of cup cake:

Volume, symmetry and uniformity index were determined using a layer of cake in measuring template as described in A.A.C.C, (1983). Cakes were sliced in half. The interior face of half of the cake was placed against the template .Volume index was calculated by adding the cake، s height at the center (C) and at points halfway between the center and the center of the outer edges (B and D) :

Volume Index = B +C +D

Symmetry index was calculated using the following equation:

Symmetry Index = 2C - (B + D)

Uniformity index was calculated using the following equation:

Uniformity index = B – D

C: the cake، s height at the center

B&D: points halfway between the center and the center of the outer edges.

Texture profile analysis:

Samples texture measurements were carried out with universal testing machine (Cometech, B type and Taiwan) provided with software. 35 mm diameter compression disc was used. Two cycles were applied, at a constant crosshead velocity of 1 mm/s, to 40% of sample depth, and then returned. From the resulting force–time curve, the values for texture attributes, i.e. Firmness (N), gumminess (N), chewiness (N), cohesiveness, springiness and resilience were calculated from the TPA graphic according to (Bourne, M. C.2003).

Rheological properties of flour used in prepared cup cake:

Farinograph and Extensograph test:

Effect of mixing puree or powdered avocado flour with wheat flour was estimation on Farinograph and Extensograph. Water absorption, arrival time, dough development, stability and degree of softening for Farinograph test, while Elasticity, extensibility, P.N and Energy tests for Extensograph test according to A.O.A.C (2005) for cup cake samples.

Cup cake staling:

Alkaline water retention capacity (AWRC %):

The staling rate of Cup cakes samples were determined by alkaline water retention capacity as described by (Kitterman and Rubanthaler 1971).The percentage of the absorbed alkaline solution to 5 g of baked product was calculated as follows:

$$\% \text{ AWRC} = \frac{W_2 - W_1}{W_s}$$

W_1 = Weight of empty tube.
W_2 = Weight of tube with sample after centrifuge.
W_s = Weight of sample.

Sensory evaluation:

Fresh prepared cup cake samples were organoleptically evaluated for, taste, crust color, porosity, spongy, hardness, cohesion, odor, crumb grain and general appearance.Samples judged through 15 panelists in The Food Industries Department at Mansoura University, Egypt.

Statistical Analysis:

The statistical analysis was carried out using ANOVA with two factors under significant level of 0.05 for the whole results using SPSS (Ver. 11) and data were treated as complete randomization design according to Steel et al. (1997). Multiple comparisons were carried out applying LSD.

RESULTS AND DISCUSSION

Chemical propertiesand mineral content of Avocado:

Results in Table (2) showed Some chemical properties and mineral content of Avocado content was (78.51%) moisture, Ash (0.8532%), Protein (5.45%) and Fat (15.143 %) ,while total carbohydrates were (3.153 mg/ml), reduced sugar (0.107 mg/ml) and non- reduced sugar (3.046 mg/ml).These results in accordance with (Mooz, 2012) ,(Vinha, and Barreira, 2013), (Nwaokobia 2018) and (Bhuyan, 2019) who reported that chemical results being 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.

Table 2. Chemicals composition and minerals content of avocado used in cup cake preparation:

Chemical composition	Avocado fruit
Moisture	78.51%
Ash	0.8532%
Protein	5.45%
Total carbohydrates	3.153 (mg/ml)
Reduced sugar	0.107 (mg/ml)
Non- reduced sugar	3.046 (mg/ml)
Crude Fat	15.143%
Calcium (Ca)	0.065%
Magnesium (Mg)	0.0674%
Phosphor (P)	0.27%
Iron (Fe)	0.0009%
Potassium (K)	7.57%
Sodium (Na)	0.29%
Zinc (Zn)	0.0004%

Results for minerals content were as follows: Potassium has the highest amounts with (7.57%) in Avocado compared with the other minerals, while Ca, P Fe, Mg, Zn, and Na have slight amounts in Avocado being 0.065%, 0.27%, 0.0009%, 0.0674%, 0.0004% and 0.29%,respectively. These results in accordance with as mention in Table (2). These results in accordance with (Bhuyan, 2019) who found that mineral content of avocado being

Sodium (8 mg/100g), Potassium (507 mg/100g), Calcium (13 mg/100g), Magnesium (29 mg/100g), iron (0.61 mg/100g), Zinc (0.68 mg/100g) and Phosphorus (54 mg/100g) .

Bioactive compounds Total Phenolic, Total flavonoids, antioxidant activity, Ascorbic acid and Total carotenoids for avocado:

Antioxidant activity of Avocado was recorded (90.6%), while total phenolics and total flavonoids were (18.77 mg/g and 17.71 mg/g); respectively, while Anti oxidant activity, phenolic compound and flavonoid recorded (89.9%, 259.15mg/100g and 2.96mg/100g); respectively. These results in accordance with (Shehata & Soltan, 2013).While ascorbic acid and Total carotenoids content were recorded (11.90 mg/100g and 1.29 mg/100g); respectively as shown in table (3).Also, ascorbic acid and Total carotenoids content were recorded (9.37 mg/100g and 0.59 mg/100g); respectively as mentioned by (Alyala-Zavala,et al.. 2011).

Table 3. Bioactive compounds Total Phenolic, Total flavonoids, antioxidant activity, ascorbic acid and Total carotenoids for avocado:

Consisties	Content
Total phenolic (mg/g)	18.77
Total flavonoids (mg/g)	17.71
Antioxidant activity DPPH (%)	90.6
Ascorbic acid (V.C) (mg/100g)	11.90
Total Carotenoids (mg/100g)	1.29

Sensory characteristics of cup cakes with Avocado puree or powder:

Cup cake prepared with the addition of 100% or 50% avocado puree or powder were evaluated for odor, color, sponge, porosity, hardness, crumb, cohesion and overall acceptability. The mean values were statically analyzed using analysis of variance and least significant difference (LSD) as results reported in Table (4).

Table 4. Sensory characteristics of prepared cup cake with Avocado puree:

Treatment Characteristics	F_0	F_1	F_2	F_3	F_4	LSD
Odor	8.8^a	8.0^a	7.6^{ab}	5.5^c	5.6^{bc}	2.05
Color	8.7^a	8.4^a	8.4	5.6^b	5.5^b	1.5
Taste	8.0^a	7.4^b	6.8^{ab}	3.6^c	5.2^{bc}	2.01
Sponge	8.6^a	8.0^{ab}	6.8^{bc}	6.0^c	6.5^{bc}	1.6
Porosity	8.8^a	7.4^{ab}	7.7^{ab}	5.2^c	6.6^{bc}	1.6
Hardness	8.5^a	8.3^a	7.7^a	7.7^a	8.0^a	1.3
Crumbs	8.7^a	7.5^a	7.8^a	5.7^b	6.1^b	1.3
Cohesion	8.1^a	8.9^a	7.9^a	8.3^a	8.6^a	1.08
Overall acceptability	8.8^a	8.1^a	7.6^{ab}	5.3^c	6.5^{bc}	1.3

a,b,c=Means with different letters in each row are significantly different at 5%.
F_0: Control sample F_1: 100% Avocado puree (as fat replacer).
F_2: 50% Avocado puree (as fat replacer).
F_3: 100%avocado powder (as fat replacer).
F_4: 50% avocado powder (as fat replacer).

From the same table it could be noticed that control cup cake sample have the highest overall acceptability score being (8.8), followed by the sample prepared with 100% Avocado puree (F_1) (8.1) and cup cake sample prepared with 50% Avocado powder (F_4) (6.5) for overall acceptability.

Also results presented in Table (4) showed that the addition of 100% avocado puree (F_1) (as fat replacer) to cup cake was the highest value in (taste, odor, spongy, hardness and cohesion compared to the other formulas with score (7.4, 8.0, 8.0, 8.3 and 8.9); respectively.

Obtained results also showed that addition of 50% avocado powder (fat replacer) (F_4) to cup cake was the lowest value in color and taste compared to the addition of 100% avocado puree (F_1) (as fat replacer) and control sample with score (5.5 and 5.2); respectively as shown in Table (4).

The sample for 100% or 50% Avocado puree or powder have been selected for further analyses, while the other sample which prepared with 100% Avocado puree or 50% Avocado powder recorded for overall acceptability (8.1 and 6.5), respectively.

Physical properties of Cup cake:

Volume index, symmetry index and uniformity index of cup cake:

The results of physical properties namely (volume index, symmetry index and uniformity index) for three samples of cup cake were tabulated in Table (5) as follows:

Results for volume index in prepared cake sample with 100% avocado puree (F_1) was 128.25 mm, followed by control sample was 127.75 mm and prepared cup cake with 50% avocado powder (F_4) were 127.25 mm. The volumes of cup cake prepared with 50% avocado powder (F_4) is significantly lower compared to cup cake prepared with 100% avocado puree (F_1) and control cup cake sample (F_0). Volume decrease was also reported by Martinez-Cervera et al. (2013) when fat content in cup cake was replaced by 50% avocado powder based fat replacer. Cup cake volume decreases significantly ($P < 0.05$) with the addition of 50% avocado powder (F_4) to cup cake as fat replacement, which is due to low amount of air in formulation, this might be explained by the collapse of air membrane in the crumb during baking in accordance with (Nurul Ain, 2016).

Table 5. Physical properties volume, symmetry and uniformity index of avocado cup cake:

Physical properties Cup cake samples	Volume index mm	Symmetry index mm	Uniformity index	Volume Cm^3	Specific volume cm^3/g
F_0	127.75	14	1	155.50	3.31
F_1	128.25	13	1	143.02	3.15
F_4	127.25	14.5	2.5	139.27	3.23

F_0: Control sample. F_1: Cup cake 100% Avocado puree (fat replacer).
F_4: Cup cake 50% Avocado powder (fat replacer).

While results of the uniformity index were in the same value with control and cakes prepared with 100% avocado puree (F_1) (1mm). For good cake quality, uniformity index should be close to zero as mentioned by (LEVENT, 2013). Therefore, the results showed that cup cake prepared with 100% avocado puree (F_1) the highest in quality from the other two samples. No Significant differences ($P \leq 0.05$) for symmetry and uniformity indices were found among all the formulas. Increasing symmetry index value indicated that the cakes were higher in the center than on sides which was in cup cake prepared with 50% avocado powder (F_4), decreasing values in control cup cake sample (F_0) and cup cake prepared with 100% avocado puree (F_1) showed that the cakes had flat surface and negative values showed that the cake volume decreased at the end of the baking process (LEVENT, 2013). The highest volume value was observed in control cup cake 155.50 cm^3 but the lowest one was in cup cake prepared with 50% avocado powder (F_4) being 139.27 cm^3, while the other prepared with 100% avocado puree (F_1) was 143.02 cm^3. Also data observed in the same table showed that Specific volume were (3.31, 3.15 and3.23 cm^3/g) for control, Cup cake with 100% Avocado puree (F_1) and Cup cake with 50% Avocado powder (F_4) ;respectively. The specific volume affected the volume development and porous crumb texture of the final products (Psimouli & Oreopoulou, 2013).

Rheological properties of flour used in prepared cup cake:
Farinograph Parameters:

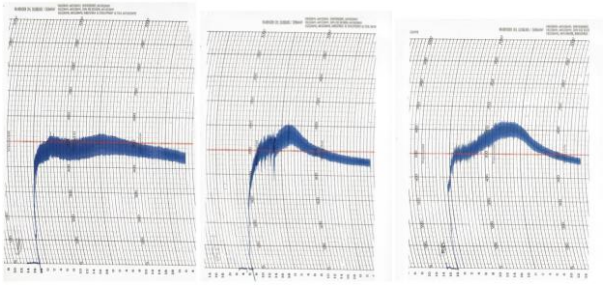
Farinograph parameters were estimated for different flour sample used in cup cake preparation.Results are shown in Table (6) and illustrated in Figure (1).

Data displayed that, water absorption have the highest amount in flour sample with addition of 50% of avocado powder (F_4) to Wheat flour (71.5%) followed by (70.0%) and (70.5%) for sample of 100% Avocado puree (F_1) and control sample (F_0).

Table 6. Farinograph parameters of wheat flour with addition of Avocado puree or powder:

Flour samples Farinograph parameter	F_0	F_1	F_4
Water Absorption (%)	70.5	70.0	71.5
Arrival time (min)	2.0	1.5	1.5
Dough development	2.5	6.0	7.5
Stability (min.)	13.5	10.5	15.5
Degree of softening (B.U)	20.0	40.0	30.0

F_0: Control sample. F_1: 100% Avocado puree (as fat replacer).
F_4: 50% Avocado powder (as fat replacer).



(A)Control flour sample. (B) 100% Avocado puree flour. (C) 50% Avocado flour powder. (As fat replacer) (As fat replacer)

Fig.1. (A, B, C). Farinograph parameters of wheat flour with addition of Avocado puree or powder

Arrival time reached (2 min.) in control sample, while (1.5 min.) in the other two samples, but, Dough development and stability reached the maximum time being (7.5 and 15.5 min) in (F_4) with Avocado powder addition to wheat flour followed by (F_1, F_0) which reported (6.0, 2.5 min.) for Dough development and (10.5, 13.5 min.) for stability which considered an important index for the dough strength. The decrement in the stability time indicates weakness of dough strength, this agrees with (Nada, 2009). Also from the same table; it could be revealed that dough development was gradually increased for the dough sample which prepared with 100% avocado puree (F_1) and the 50% avocado powder (F_4).

Concerning to the Degree of softening was (20.0 B.U) in control sample, while (40.0 and 30.0 B.U) in the other prepared sample with addition of avocado puree (F_1) and avocado powder (F_4); respectively. And it could be observed that the addition of 100% avocado puree (F_1) which given lower stability time value had high degree of softening.

Extensograph parameters

Regarding to Extensibility, it could be observed that the wheat control sample recorded 85 mm followed by (55 and 50 mm) for F_1 and F_4, respectively.

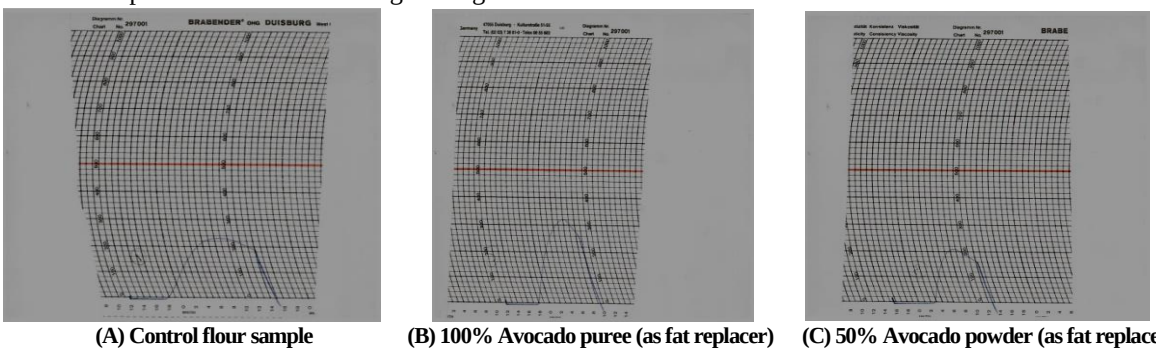
Elasticity results were (230, 320 and 210 B.U) in control sample (F_0), wheat flour with Avocado puree (F_1) and wheat flour with Avocado powder (F_4),respectively. While Proportional number (P.N) reported the highest value in wheat flour with Avocado puree (F_1) (5.18) But it was decreased in wheat flour with the addition of Avocado powder (F_4) (4.20) and the lowest value in control sample (2.71).This effect may be due to the gradual decrease of extensibility value in wheat flour with Avocado puree (F_1) and wheat flour with Avocado powder (F_4), this agree with Rosell et al. (2001).

For the energy, the obtained results also showed that dough energy was gradually decreased from 43cm^3 for control sample and, 28 $cm^3$to 19 cm^3 with addition of Avocado puree or powder to wheat flour, respectively.Those results are shown in Table (7) and illustrated in Figure (2).

Table 7. Extensograph parameters of wheat flour with addition of Avocado puree or powder:

Flour sample Extensograph parameter	F_0	F_1	F_4
Elasticity (B.U)	230	320	210
Extensibility (mm)	85	55	50
P. N	2.71	5.18	4.20
Energy (cm^3)	34	28	19

F_0: Control sample F_1: 100% Avocado puree flour (as fat replacer).
F_4: 50% Avocado flourpowder (as fat replacer).



(A) Control flour sample (B) 100% Avocado puree (as fat replacer) (C) 50% Avocado powder (as fat replacer)

Fig. 2. A, B, C. Extensograph parameters of wheat flour with addition of Avocado puree or powder.

Chemical composition and mineral content of Cup cakes:

The obtained data mention in Table (8) revealed that there was a gradual increase in protein content by adding of 100% avocado puree (F_1) and the highest increase was found in the sample contain 50% Avocado powder (F_4).Fat and ash were decreased comparing with control sample, while the addition of 50% avocado powder (F_4) caused higher value in fat content compared with the other two sample. But ash content for sample of 50% Avocado powder (F_4) near to control sample.

It could be observed that Total carbohydrates and two types of sugar by the addition of Avocado powder or Puree recorded slight differences between them in their content of carbohydrates and the two types of sugar. In Mineral content results reported that cup cake with addition of 50% Avocado powder (F_4) was the highest percentage in Fe (0.008%), Na (0.85%), P (0.39%) and K which recorded (0.23%),while sample with 100% Avocado puree was the highest in Mg and Ca (0.048% and 0.09%), respectively.

Determination of Bioactive compounds Total Phenolic, Total flavonoids and antioxidant activity for cup cake samples:

Data in Table (9) showed that bioactive compound namely total phenolic content in Cup cake with 50 %Avocado powder (F_4) was the highest value (3.096mg/g), while highest Total flavonoid was detected in control cup cake sample (4.933 mg/g).Followed by sample with 50% avocado powder

(F_4) being (2.667 mg/g), while sample with 100% Avocado puree (F_1) recorded (0.133mg/g).

Table 8. Chemical composition and Mineral content of Avocado cup cakes:

Cup cake sample Consistents	F_0	F_1	F_4
Moisture (%)	8.26^{c}	39.95^{a}	34.58^{b}
Protein (%)	8.94^{c}	11.31^{b}	15.75^{a}
Fat (%)	15.30^{a}	4.67^{c}	13.11^{b}
Ash	2.81^{a}	2.73^{ab}	2.58^{b}
Total carbohydrates (mg\ml)	3.746^{a}	3.333^{c}	3.692^{b}
Reduced sugar (mg\ml)	0.131^{a}	0.108^{b}	0.052^{c}
Non-reduced sugar (mg\ml)	3.615^{a}	3.225^{c}	3.640^{b}
Calcium (Ca) (%)	0.14^{b}	0.19^{a}	0.18^{a}
Magnesium (Mg) (%)	0.014^{ab}	0.048^{a}	0.015^{b}
Iron (Fe) (%)	0.001^{c}	0.0018^{a}	0.008^{b}
Sodium (Na) (%)	0.58^{c}	0.78^{b}	0.85^{a}
Phosphorus (P) (%)	0.25^{c}	0.32^{b}	0.39^{a}
Potassium (K) (%)	0.09^{c}	0.11^{b}	0.23^{a}

a, b,c: Means with different letters in each row are significantly different at 5%.
F_0: Control sample F_1: 100% Avocado puree (as fat replacer).
F_4: 50% Avocado powder (as fat replacer).

Table 9. Bioactive compound Phenolic, Flavonoids and Antioxidant activity for cup cake samples.

Cup cake samples Compounds	F_0	F_1	F_4
Total Phenolic (mg/g)	1.536	2.177	3.096
Total flavonoids (mg/g)	4.933	0.133	2.667
Antioxidant activity DPPH (%)	41.900	80.2	57

F_0: Control sample F_1: 100% Avocado puree (as fat replacer).
F_4: 50% Avocado powder (as fat replacer).

Results showed that Antioxidant activity was 80.2% in Cup cake with 100%Avocado puree compared with control sample and Cup cake with 50% Avocado powder (F_4) which recorded (57% and 41.9%), respectively.

Texture profile analysis (TPA):

Texture profile was an indicator to determine some properties of dough "namely (gumminess, firmness, springiness, chewiness, cohesiveness and resilience) were showed in Table (10).

Results of texture profile analysis of cup cake showed that, gumminess of the cup cake increased with addition of 100% avocado puree (F_1) (2.010),while the other sample which prepared with 50% Avocado powder (F_4) was (2.732) higher than those of control one. Firmness of cup cake decreases with addition of avocado puree or avocado powder (table 10).The cup cake without avocado puree or avocado powder softer than those cup cakes made with avocado puree or avocado powder this results similar to (Marina, 2016) .Firmness in control cup cake have the highest value from all cakes processed with 100% avocado puree (F_1) or 50% Avocado powder (F_4) which recorded (9.970, 7.700 and 5.200); respectively. Springiness is related to the height that the food recovers during the time that elapses between the end of the first bite and the start of the second bite (Nur Huda & Lzyan. 2019), in this study springiness of cup cake crumbs has the highest value in cup cake prepared with 50% avocado powder (F_4) it was (0.529) well-aerated and elastic cup cake, with high values of springiness, are perceived as fresh and of high quality (Sanz et al., 2009) followed by control cup cake sample (0.483), while the lowest value was found in cup cake prepared with 100% avocado puree (F_1) (0.355), also the lowest value in the resilience of cup cake which prepared with 100% avocado puree (F_1) followed by cup cake prepared with 50% avocado powder (F_4) which recorded (0.186 and 0.215); respectively, while in cup cake control sample was (0.249). Resilience of the cup cake increased with addition of 50% avocado powder make product has softer crumbs structure and good quality Rodríguez-García et al. (2014). Cohesiveness is defined as the ratio of the positive force during the second compression to that during the first compression (Nur Huda & Lzyan. 2019). The highest value of cohesiveness was found in cup cake prepared with 50% avocado powder (F_4) (0.525) while in the other sample with 100% avocado puree (F_1) was (0.261), this parameter is the strength of internal bonds which make up the body of the product (Sarıçoban et al., 2009). Chewiness was defined as the energy required masticating a solid food to a state ready for swallowing (Karaoğlu and Kotancilar, 2009). Chewiness of cup cake increased with the addition of 100% avocado puree (F_1) to (0.713) and the prepared sample with 50% Avocado powder (F_4) (1.445) comparing with control sample as mentioned in Table (10).

Table 10. Texture profile analysis for Cup cake:

properties cup cake sample	Firmness	Cohesiveness	Gumminess	Chewiness	Springiness	Resilience
F_0	9.970^{a}	0.124^{c}	1.235^{c}	0.597^{b}	0.483^{a}	0.249^{ab}
F_1	7.700^{b}	0.261^{b}	2.010^{b}	0.713^{b}	0.355^{b}	0.186^{b}
F_4	5.200^{c}	0.525^{a}	2.732^{a}	1.445^{a}	0.529^{a}	0.215^{a}

a, b, c:Means with different letters in each row are significantly different at 5%.
F_0: Control sample F_1: 100% Avocado puree (as fat replacer).
F_4: 50% Avocado powder (as fat replacer).

Staling rate of cap cake:

Results presented in Table (11) and fig. (3) Indicate the effect of partial replacement of avocado puree or powder by butter in cup cake at level (100% Avocado puree and 50% Avocado powder) on alkaline water retention capacity (AWRC %) of cup cake from zero time up to the end of the storage period. The value of AWRC was increased (high freshness) in sample with 100% Avocado puree (F_1) which recorded (337) up to (324) after three days, while in the addition of 50% avocado powder (F_4) the value of (AWRC %) decreased gradually from (295) at zero time up to (272) after three days. This may be due to the increase in water absorption content. From these data, it could be noticed that, there was gradual decrease in alkaline water retention capacity values for all different cup cakes samples during storage period; these may be due to the decrease in crumb moisture during storage (as moisture migrates from crumb toward crust) as mentioned by (He and Hoseney, 1990).

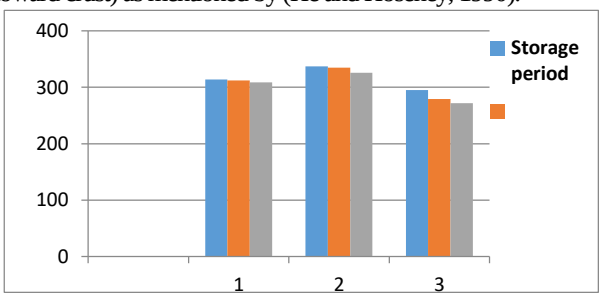


Fig. 3. Staling rate of cup cake samples stored at room temperature as determined by alkaline water retention capacity (AWRC %).

Table 10. Alkaline water retention capacity of cup cake from wheat flour with addition of avocado:

Storage period/day Cake samples	Zero time	One day	Two days	Three days
F_0	314	312	309	305
F_1	337	335	326	324
F_4	295	279	272	272

F_0: Control sample F_1: 100% Avocado puree (as fat replacer).
F_4: 50% Avocado powder (as fat replacer)

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تاثير اضافه الافوكادو على الصفات الفيزيائيه والريولوجيه والكميائيه والمواد الفعاله للكب كيك

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قسم الصناعات الغذائيه- كليه الزراعة–جامعه المنصورة

يهدف البحث الى دراسه تاثير استبدل الدهن بهريس أومسحوق الافوكادو على الصفات الحسيه والريولوجيه والفيزيائيه والكميائيه للكب كيك.لم تظهر نتائج التقييم الحسى لعينات الكب كيك المحضره من هريس او مسحوق الافوكادو اى اختلافات معنويه مقارنه بعينه التحكم .أظهرت نتائج الاختبارات الفيزيائيه لجميع عينات الكب كيك المصنعه بالاستبدال من الدهن وجود اختلافات معنويه مقارنه بالعينه كنترول .كما أظهرت نتائج الاختبارات الريولوجيه (الفارينوجراف والاكستنسوجراف) تحسن فى صفات الدقيق الناتج مثل قيم ثبات العجين وقيم المرونه وقيم الطاقه بالاضافه للانخفاض الملحوظ فى امتصاص الماء ودرجه ليونه العجين مقارنه بالعينه الكنترول.أدت اضافه مسحوق أو هريس الافوكادو لعينات الكب كيك الى ارتفاع ملحوظ فى قيمه الفينولات والفلافونيد ونشاط مضادات الاكسده الكليه لعينات الكب كيك التى تحتوى على 100% من الافوكادو المهروس أو50% من مسحوق الافوكادو الى (2.177 و0.133 ملجم/جم80.2 %) او(3.069 و 2.667 ملجم/جم و57%) مقارنه بالعينه الكنترول (1.536 و 4.933 ملجم/جم و41.9%) لذلك ، ينصح بإضافة مسحوق أو هريس الأفوكادو إلى الكب كيك لتحسين خصائصه الوظيفيه والريولوجيه .