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Preparation of functional cupcake by nontraditional fruit (*Carica papaya* L.) to reduce glycemic index

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ABSTRACT

This research aims to investigate the effect of substitution of different levels (25, 50 and 75%) of papaya (*Carica papaya* L.) puree as partially substitute for sucrose on nutritional indicators, sensorial, physical, microbiological characteristics and glycemic index on the prepared functional cupcake (PFCC).The sensorial evaluation data showed that partial replacements of sucrose by papaya puree at levels of 25 and 50 % were improved color, flavor and taste, while proximate analysis showed that increased dietary fiber, vitamin A and C. But, the caloric value was decreased gradually with increased the level of substitution in (PFCC) as compared to control cupcake. Physical characteristics showed a decrease in (PFCC) volume, specific volume with progressive inclusion of the papaya puree 25% replacement of sucrose has a similar texture to control cupcake. Papaya puree levels in (PFCC) as 50 and 75% affected at texture profile analysis, it gave PFCC2 and PFCC3 less firmness, cohesiveness, gumminess, chewiness, springiness and resilience values comparing with control cupcake. Whilst, 25 % papaya puree in (PFCC1) showed an increase in chewiness, springiness and resilience values compared to control cupcake. Microbiological analysis showed that substituted sucrose by papaya puree in (PFCC) blends inhibit and controlled the microbial and fungal growth at three days storage at room temperature (25 ̊c). A reduction in glycemic index was achieved with the partial replacement of sucrose with the different levels of papaya puree in (PFCC).In conclusion: our results found that the replacement of sucrose in PFCC up to 50% of papaya puree was suitable for increasing vitamins A, C and dietary fiber. Also, it had an acceptable effect on sensorial, physical properties and textural profile in PFCC. In addition, it had a positive effect in lowering the glycemic index. Therefore, we recommend shed more light and study more applications on the papaya fruit for its importance in the field of therapeutic nutrition and its success in preparing baked goods.

Keywords: *Carica papaya* fruit, Nutritional indicators, Dietary fiber, Sensorial evaluation, Specific volume, Blood glucose response, Glycemic index.

Introduction

The consumption of bakery products is increasing worldwide. Indeed, the cake is one of the most tasteful and appreciated bakery products which consumed by people of different ages (Douati *et al.,* 2017). Their sensory quality, practicality, and convenience can be pointed as the major factors of the high consumption, since consumers are increasingly seeking easy-to-prepare meals that satisfy their sensory expectations (Manisha *et al.,* 2012).

Recently, the public health programs of some countries, are seeking for solutions in the great matter of high caloric foods, especially rich in sugar in order to prevent from diabetes and its complications (Carrillo *et al*., 2012). As a result of that, the consumption of reduced-calorie cakes has been rising, however this has presented challenges to be overcome concerning the reformation of their structure when the sucrose is substituted by alternative sweeteners, gums or thickening agents (Hicsasmaz *et al*., 2003 and Cavalcante and Silva, 2015). On the other hand, food products with the partial or total replacement of sucrose have their quality impaired including texture, volume and appearance (Manisha *et al.,* 2012 & Pareyt *et al*., 2009). Furthermore, the substitution of a type of sugar by another had typically been studied in food products with the objective of finding a level of replacement that will improve the product's characteristics. Replacement of natural materials and artificial components has been employed to provide sweetness for the diet (Vatankhah *et al.,* 2014).

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Carica papaya (L.) one of the most powerful nutritional fruits cultivated around the tropical and subtropical regions of the world (Basalingappa *et al.,* 2018), and the most economically important fruit plant in the caricaceae family. Papaya is considered a plenty source of vital nutrients such as vitamin C, A, E, folate, pantothenic acid, potassium, magnesium and fiber (Noshad and Anjum, 2018). It is low in calories and being as one of the richest sources with natural bioactive compounds such as isothyocynate, lycopene compounds and some proteolytic enzymes like chymopapain and papain which has antioxidant activities that make it a great healthy fruit which used all over the world. In addition, papaya used as sources of many potent and powerful drugs with medicinal activities for anthelmintic, diuretics, hypolipidemic, anti hypertensive, wound healing, anti diabetic, anti bacterial and anti fungal (Verma *et al.,* 2017). Scientists consider papaya as one of a robust cancer fighting agent and that are highly effective against various types of cancer cells and their high bioactive components property makes papaya one of the powerful treatment in medicinal and cosmetic field (Ramadan *et al.,* 2015 and Tarun and Yash, 2015).

Based on this, the present work aimed to investigate the effect of replacing sucrose with different levels (25, 50 and 75%) by papaya puree in the sensorial, physicochemical, physical, microbiological characteristics and glycemic index on prepared functional cupcake (PFCC).

Material and Methods

Materials

Papaya fruits (*Carica papaya* L. Solo), commercial wheat flour (72% extraction), sucrose, skim milk, vanillin, egg, baking powder, salt and margarine were purchased from local market of different areas in Mansoura City, Egypt.

Preparation of papaya puree

Ripe papaya fruits were washed thoroughly in tap water, peeled and the seeds were removed then sliced manually to 10 mm thickness and it steamed for 20 min with commercial steamer, then mashed into puree according to the method of Selvakumaran *et al.* (2017), and all the samples were stored in airtight containers and kept at 3–4° C until using.

Preparation and formulation of functional cupcake (PFCC) samples

Prepared functional cupcake (PFCC) formulations (Table 1) were prepared. Sucrose was substituted by 25, 50 and 75% papaya puree. Cupcake was prepared according to the method of Penfield and Camphell (1990 a,b)

Table 1: Formulation of prepared functional cupcake (PFCC).

Ingredients	Dough preparation (%)			
	Control	PFCC1	PFCC2	PFCC3
Wheat flour (72% extr.)	29.65	29.65	29.65	29.65
Sucrose	16.17	12.13	8.08	4.04
Margarine	16.85	16.85	16.85	16.85
Whole egg	18.19	18.19	18.19	18.19
Skim milk	1.5	1.5	1.5	1.5
Baking powder	1.35	1.35	1.35	1.35
Salt	1.35	1.35	1.35	1.35
Vanilla	0.27	0.27	0.27	0.27
water	14.67	12.61	6.95	3.47
Papaya puree	-	6.1	15.81	23.33

PFCC1: sucrose substituted with 25% papaya puree, PFCC2: sucrose substituted with 50% papaya puree, PFCC3: sucrose substituted with 75% papaya puree

Nutritional analysis

Moisture, dietary fiber contents were analyzed based on AOAC (2000). Vitamin C, titratable acidity, PH value, total sugars and total soluble solids were determined according to the method of AACC (2000). Vitamin A was determined according to the method of Neeld and Pearson (1963), minerals (Ca, Mg & K) were determined by using Atomic Absorption Spectrometry (pyeunicm Model 3300) at 422nm according to the procedure of AOAC (2005).

Sensorial evaluation of prepared functional cupcake (PFCC)

Hedonic test was used to determine the degree of overall liking for (PFCC) Fifteen panelists of staff members and students of Home Economics Dept. at Faculty of Mansoura University were given four random samples (1 cm x 1 cm x 1 cm) from prepared functional cupcake (PFCC) that had been held at room temperature for 24 h. (PFCC) were evaluated for crumb color, crust color, flavor, tenderness, softness, moistness and taste according to McCullough *et al.* (1986).

Physical measurements

The specific gravity of prepared functional cupcake (PFCC) batter formulae was determined according to method of Penfield and Campbell (1990b). PH value of the batter was determined by direct immersion of PH electrode at the room temperature (~ 25℃) using the Digital PH meter (Jenway, Model 3020, Dunmow, Essex, UK) (Khalil 1998). The height (cm) was measured in the center of the baked cupcakes. Volume of baked cupcakes samples was measured by rapeseed displacement according to the method of AACC, (2000). The baked PFCC samples were weighted after removed from the pan and the specific volume was also calculated (cupcake volume / cupcake weight).

Texture profile analysis of prepared functional cupcake (PFCC) samples were carried out with universal testing machine (Cometech, B type, Taiwan) .Provided with software. Back extrusion cell with 35 mm diameter compression disc was used. Two cycles were applied, at a constant crosshead velocity of 1 mm/s, to 30% of sample depth, and then returned. From the resulting force–time curve, the values for texture attributes include Firmness, Gumminess, Chewiness, Adhesiveness, Cohesiveness, Springiness and Resilience were calculated from the TPA graphic according to Bourne (2003).

Microbiological examination

The total bacterial count was recorded as colony numbers per 1.00 g of sample according to the method of Difico- Manual (1985). Fungal count determined according to Martins (1950).

Glycemic index measurement

Test of glycemic index, this study used 10 volunteers from student's faculty. One day prior to the experiment, the subjects fasted for 10 hours and were allowed to drink water. The criteria for subjects were fasting blood glucose <110mg/dl and age) 20-25 years. The capillary blood of the subjects was taken to measure fasting glucose levels. Furthermore, volunteers were asked to consume pure glucose as control ref and prepared functional cupcake with papaya puree. Blood samples were taken every 30 minutes (0, 30, 60, 90, and 120) after testing the food for 2 hours. Each treatment was given within three days to avoid bias. The glycemic index test was carried out using a glucometer (Auto-coding OSANG, Korea). Glycemic index calculated by find the incremental area under curve by the trapezoidal rule from zero time to 30 min (FAO 1998).

Statistical analysis

Data were analyzed by ANOVA (Analysis of variance) using Duncan's multiple range test and $p<0.05$ was used to indicate significance between different treatments. All the analyses were done with SPSS (Statistic Program Sigmastat, Statistical Soft-Ware, SAS Institute, Cary, NC).

Results and Discussion

Nutritional indicators of prepared functional cupcake (PFCC)

Data in (Table 2) showed that moisture content was (20.33±0.24) for control cupcake and for prepared functional cupcake (PFCC) with different levels of papaya puree ranged from (20.40±0.17 to 22.11±0.03). Dietary fiber showed statistical differences ($p<0.05$), it has the tendency to increase according to the increments of papaya puree in the prepared functional cupcake (PFCC) formulae and the highest dietary fiber values were found in the samples of PFCC3 followed by PFCC2, PFCC1 which recorded (3.92±0.04, 2.55±0.04 and 2.22±0.04), respectively in comparison with control cupcake that had the less content of dietary fiber (1.30±0.02).

Table 2: Physiochemical characteristics of different prepared functional cupcake (PFCC).

Parameters	Control	PFCC1	PFCC2	PFCC3
Moisture	20.33±0.24 ^{ab}	20.40±0.17 ^{ab}	21.94±0.04 ^{a}	22.11±0.03 ^{a}
Dietary fiber	1.30±0.02 ^{d}	2.22±0.04 ^{c}	2.55±0.04 ^{b}	3.92±0.04 ^{a}
Total sugars %	30.03± 1.09 ^{a}	21.90±0.61 ^{b}	19.46±0.23 ^{b}	17.43±0.23 ^{c}
TA %	0.49±0.04 ^{d}	0.59±0.03 ^{c}	0.70±0.05 ^{b}	0.81±0.01 ^{a}
TSS %	11.12±0.02 ^{a}	10.89±0.04 ^{b}	10.21±0.03 ^{b}	9.67±0.04 ^{c}
PH	7.05±0.02 ^{a}	6.36±0.02 ^{b}	6.05±0.03 ^{c}	5.91±0.02 ^{c}
Vitamin C (mg/100g)	1.41±0.04 ^{d}	13.41±0.20 ^{c}	35.90±1.26 ^{b}	48.81±0.88 ^{a}
Vitamin A (mg/100g)	5.67±0.72 ^{d}	206.67±1.22^{c}	291.33±1.44^{b}	361.67±1.44^{a}
Caloric value (*Kcal)*	361.60	351.64	344.80	341.49

Values are expressed as mean ± SD, n=3, Mean values in each column having different superscript are significant at P < 05. TA: Titratable Acidity, TSS: Total soluble solids. PFCC1: sucrose substituted with 25% papaya puree, PFCC2: sucrose substituted with 50% papaya puree, PFCC3: sucrose substituted with 75% papaya puree.

Data show the physicochemical composition of different prepared functional cupcake produced (Table 2). The obtained results indicated that total sugars in prepared functional cupcake samples was significantly affected ($p<0.05$) by the addition levels of papaya puree. Using papaya puree as a sugar replacer up to replacement level of 75% had significant effect ($p<0.05$) on the total sugars of prepared functional cupcake samples. Values of total sugars being 17.43, 19.46 and 21.90 % for PFCC3, PFCC2 and PFCC1, respectively, compared to control cupcake that recorded 30.03%. Both sugars and acidity are important items, which provide the characteristic of taste and flavor of fruits and their products (Athmaselvi *et al.,* 2014). It is worth noting that total soluble solids (TSS) for PFCC1, PFCC2 and PFCC3 cupcake recorded (10.89, 10.21 and 9.67%), respectively compared with control cupcake (11.12%). The PH value decreased gradually in all prepared functional cupcake samples, and the values ranged from (5.91 to 6.36). It could be observed that PH value of control cupcake was the highest (7.05) than all prepared functional papaya cupcakes (PFCC3, PFCC2 and PFCC1) that recorded (5.91, 6.05 and 6.36) respectively. These finding are similar to the data indicated by Yusufu and Akhigbe (2014) as they reported that there is correlation between titratable acidity content and the pH value as the percentage of papaya substitution increases. As can be seen in Table 2, the prepared functional papaya cupcake samples had valuable vitamin C and vitamin A content ranged from (13.41 to 48.81mg/100g and 206.67 to 361.67 IU/100g). Previous data stated papaya as one of the most nutritional fruits which rich in vitamins and dietary fiber, make it as alternative favorable source for use in different baked goods (Ramadan *et al.,* 2015 and Varastegani and Yang 2013).

However, caloric values ranged from (341.49 to 361.60 *kcal).* As can be seen control cupcake gained the highest energy value which recorded (361.60 *kcal).* However, prepared functional cupcake with different levels of papaya puree decreases the energy values that reach to (341.49 *kcal*) in PFCC3 formula; the presence of dietary fibers was primarily caused such decrease. These results at parallel

with (Wiese and Duffrin 2003) who reported that incorporated papaya pulp in baked products associated with reduction of caloric value and increase overall nutritional quality.

Mineral content of different prepared functional cupcake (PFCC)

The presented data in Figure 1, illustrated the mineral content in control and prepared functional cupcake sweetened ascendingly by papaya puree. From the results, it could be noticed that the mineral content were gradually increased in different prepared functional cupcake blends by the increase of papaya puree substitution in cupcake formula compared to control cupcake. Potassium (K) was the predominant element among analyzed minerals, prepared functional cupcake PFCC3 (75% papaya puree) had significantly higher K concentrations (315.27 mg/100g) followed by PFCC2 and PFCC1cupcake samples that recorded (289.53 and 170 mg/ 100g). Meanwhile, the control cupcake recorded the lowest level of K (119.50 mg/ 100g).

In the present study, high calcium (289.97±3.58 mg/100 g) and magnesium (27.97±0.29 mg/100 g) values were observed in prepared functional cupcake sample (PFCC3). These results are in agreement with the findings observed by other authors (Aravind *et al.,* 2013 and Maisarah *et al.,* 2014) who reported that papaya fruit is a rich source of mineral content.

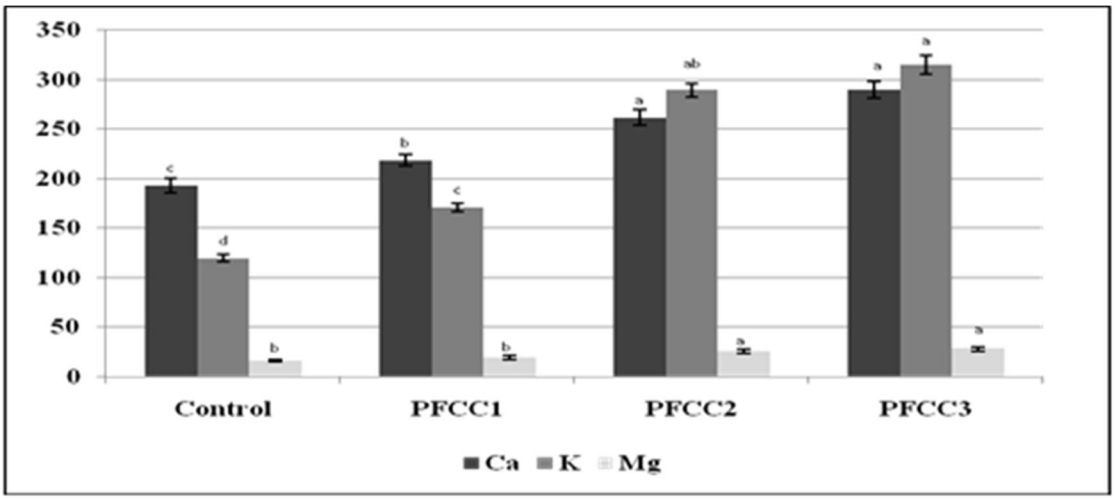

Fig. 1: Mineral content in control and (PFCC) samples (mg/100g) (w/w).Values are expressed as mean ± SD, n=3, Mean values in each bar having different superscript are significant at ($p<0.05$). PFCC1: sucrose substituted with 25% papaya puree, PFCC2: sucrose substituted with 50% papaya puree, PFCC3: sucrose substituted with 75% papaya puree.

Sensorial attributes of prepared functional cupcake (PFCC)

The sensorial evaluation scores of control and the prepared functional cupcake (PFCC) formulae presented in Figure 2. As can be seen, sucrose substitution of 25%, 50% and 75%% by papaya puree had a significant ($p<0.05$) effect on all sensory attributes of the tested prepared functional cupcake (PFCC) formulae. Data show that control cupcake recorded the highest scores for crumb color, crust color, moistness, softness, tenderness and taste. Meanwhile there was no significant difference between control and PFCC1 sample in all attributes. According to ANOVA, crumb color and crust color were not significantly ($p<0.05$) different in CP2 and CP3. Furthermore, it could be noticed that cupcakes made at 25% (PFCC1) and 50% (PFCC2) papaya puree replacement with sucrose gave similar less scores when compared with control cupcake. While, it could be noticed that (PFCC3) made by 75% papaya puree replacement was decreased in flavor, moistness, softness, tenderness and taste when compared with cupcake control, but was still acceptable (sample rated very good to good for different parameters). These data in accordance with the finding of Gao *et al.* (2016) who reported that the quality of food products impaired with the partial replacement of sugar. Overall data showed that PFCC1, PFCC2 and PFCC3 cupcake samples with 25, 50 and 75 papaya puree were acceptable in cupcake

blends. These results in the same trend with the finding of Adubofuor and Michael (2012) as they reported that using papaya pulp in bakery products improved the sensory attributes.

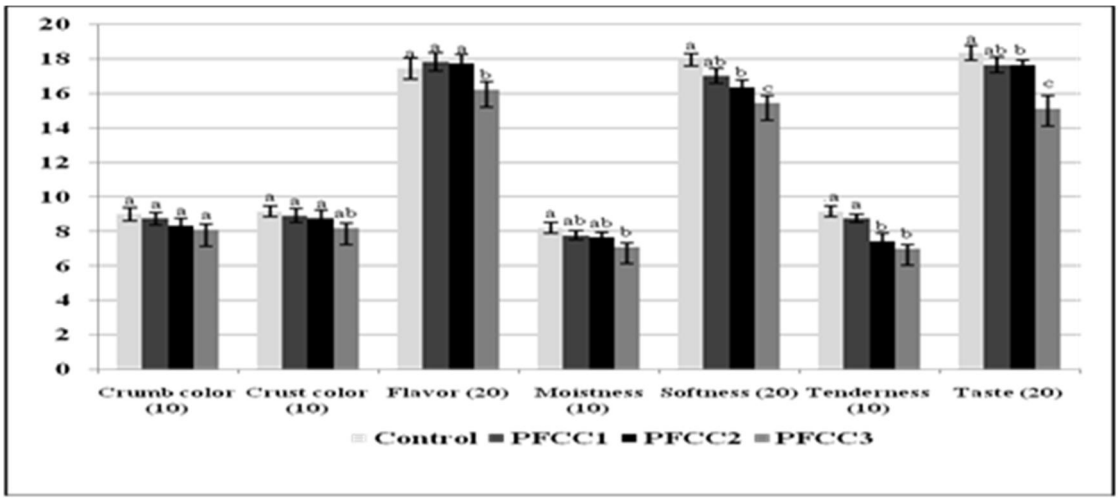

Fig. 2: Sensory attributes of control and (PFCC) samples. Values are expressed as mean ± SD, n=15, Mean values in each bar having different superscript are significant at ($p<0.05$). PFCC1: sucrose substituted with 25% papaya puree, PFCC2: sucrose substituted with 50% papaya puree, PFCC3: sucrose substituted with 75% papaya puree.

Physical properties of batter and prepared functional cupcake (PFCC)

Results of physical characterizes of batter (specific gravity and PH value) and prepared functional cupcake (PFCC) blends including height, volume and specific volume are indicated in Table 3. As shown, substitution of papaya puree in formulae of (PFCC) caused significant increase ($p<0.05$) of specific gravity of batter of tested (PFCC). According to previous report by Rosell *et al.* (2009), partial substitution of papaya caused a heavier batter comparing with control cake batter.

Table 3: Physical characteristics of batter and different prepared functional cupcake (PFCC).

Parameters	Control	PFCC1	PFCC2	PFCC3
Batter				
Specific gravity	1.11±0.02 ^{c}	1.13±0.04 ^{c}	1.16±0.03 ^{b}	1.20±0.03 ^{a}
PH	7.56±0.04 ^{a}	7.49±0.12 ^{a}	7.13±0.11 ^{b}	7.03±0.13 ^{b}
Baked cupcake				
Height (cm)	5.1±0.03 ^{a}	5.0±0.02 ^{ab}	4.9±0.01 ^{b}	4.7±0.03 ^{b}
Volume (cm^3)	104.33±0.04 ^{b}	105.32±0.04 ^{b}	102.84±0.01 ^{b}	99.97±0.07 ^{c}
Specific volume (cm^3/g)	1.96±0.02 ^{b}	1.94±0.04 ^{b}	1.92±0.03 ^{b}	1.84±0.17 ^{c}

Values are expressed as mean ± SD, n=3, Mean values in each column having different superscript (a, b,c,..) are significant at $p<0.05$. PFCC1: sucrose substituted with 25% papaya puree, PFCC2: sucrose substituted with 50% papaya puree, PFCC3: sucrose substituted with 75% papaya puree.

In the other hand Gómez *et al.,* (2010) suggested that the addition of insoluble fiber increased cake batter density. Moreover Majzoobi *et al.,* (2015) reported that the batter density negatively correlated with the air quantity found in the batter and with increasing the fiber level, batter density increased. While PH value of prepared functional cupcake batters decreased significantly ($p<0.05$) as the substitution level of papaya puree increased in comparison with control batter. The PH values in different prepared functional cupcake batter blends were within optimal levels (7.03 to 7.56) these results are similar to Hussein *et al.,* (2011).

As can be seen (Table 3), the lowest height was 4.7 cm that obtained for 75% prepared functional cupcake (PFCC3). There was no significant difference in volume and specific volume between control,

PFCC1 and PFCC2 cupcake samples. While prepared functional cupcake (PFCC3) sample of 75% has the lowest volume and specific volume. A report by Ronda *et al*. (2005) also found a reduction in specific volume in cakes with less sucrose, compared to the standard blend (with total sucrose).

Texture profile analysis

Textural properties of prepared functional cupcake (PFCC) substituted with sucrose at 25, 50 and 75% by papaya puree were presented in Table 4. Firmness, cohesiveness, gumminess, chewiness, springiness and resilience of prepared functional cupcakes reduced significantly ($p<0.05$) with substitution up to 75% sucrose (PFCC3). However, cohesiveness, chewiness, springiness and resilience for 25% sucrose substitution (PFCC1) did not differ from parameters of control cupcake sample. This showed that those parameters were significantly affected until to the ratio of 50% papaya puree substitution, whereas higher substitution (75%) showed further changes on those textural properties. Additionally, springiness of PFCC3 with 75% papaya puree increased 14% from the control cupcake, whereas resilience decreased significantly with 36% reduction from the control cupcake. Increased moisture content in prepared functional cupcake samples after inclusion of papaya puree could be the major reason affecting these textural changes. The increased moisture content with addition of papaya puree may overcome the effect of increased fiber in 25, 50 and 75% prepared functional cupcakes, resulting in reduced hardness in cupcake. The firmness value varied from 4.130 to 3.060 in prepared functional cupcake samples. These results in parallel with Pareyt *et al.* (2009) who stated that reduced sugar content in baked products caused a decrease in firmness. In general, the blends containing papaya puree had a lower firmness than the control sample produced with total sugar. This fact can probably be associated to the low inherent solubility of composing units of papaya puree in comparison to sugar which can lead to an open inhomogeneous network microstructure in the prepared functional cupcake and thus a low resistance to load forces.

Table 4: Texture characteristics of control and different prepared functional cupcake (PFCC).

Parameters	Control	PFCC1	PFCC2	PFCC3
Firmness	4.340 ^{a}	3.730b ^{b}	3.500 ^{b}	3.060 ^{b}
Cohesiveness	0.820 ^{a}	0.775 ^{ab}	0.724 ^{b}	0.649 ^{b}
Gumminess	3.483 ^{a}	2.880 ^{b}	2.550 ^{b}	2.020 ^{e}
Chewiness	1.536 ^{a}	1.6404 ^{a}	1.144 ^{b}	0.856 ^{b}
Springiness	0.444 ^{b}	0.584 ^{a}	0.439 ^{b}	0.418 ^{b}
Resilience	0.366 ^{b}	0.5305 ^{a}	0.295 ^{b}	0.244 ^{b}

Values are expressed as mean ± SD, n=3, Mean values in each column having different superscript (a, b,c,..) are significant at $p<0.05$. PFCC1: sucrose substituted with 25% papaya puree, PFCC2: sucrose substituted with 50% papaya puree, PFCC3: sucrose substituted with 75% papaya puree

Total bacterial and fungal count at room temperature (25°C)

As shown in Table 5, after three days at room temperature (25 ̊c), a low bacterial counts were detected in prepared functional cupcake samples, the highest total bacterial and fungi count were observed in control cupcake that reached to 42.33×10^3 and 13×10^3 followed by PFCC1 sample recorded 11.67×10^3 and 3.66×10^3, followed by PFCC2 recorded 10×10^3 and 2.33×10^3, while PFCC3 that recorded 8.33×10^3 and 1.66×10^3 respectively. The total viable bacterial count is widely used as an indicator to microbiological quality of various kinds of food. Actually, the three levels used in preparing cupcake were effective against bacterial pathogens however PFCC3 sample showed best results against bacterial pathogens. It could be noticed that adding papaya puree to cupcake inhibit and controlled the bacterial and fungi growth in prepared functional cupcake samples. This effect was obtained with the three levels of papaya puree in storage period of three days at room temperature (25 ̊c). These results are in parallel with the finding of Aravind *et al.* (2013); Arumugam *et al.* (2014) and Marshall *et al.* (2015) who reported that *Carica papaya* fruit contained phytochemicals and bioactive

nutrients that caused positive inhibitory effects and antimicrobial properties against the pathogenic bacteria. Otherwise, Lopez-Malo *et al.* (2002) stated that fungi are more resistant to these natural antimicrobials when incorporated in different food products.

Table 5: Total bacterial and fungal count in control and different prepared functional cupcake (PFCC) after 3 days storage at room temperature (25 °C).

Samples	Parameters	Total bacterial count	Total fungal count
Control	$\times 10^3$ /g	42.33	13
	Log cfu/g	4.11	4.11
PFCC1	$\times 10^3$ /g	11.67	3.66
	Log cfu/g	4.07	3.56
PFCC2	$\times 10^3$ /g	10.00	2.33
	Log cfu/g	4.00	3.367
PFCC3	$\times 10^3$ /g	8.33	1.66
	Log cfu/g	3.92	3.220

Data are average of three triplicate analyses

Blood Glucose Response of different prepared functional cupcake (PFCC)

Variations in the blood glucose response concentration of different prepared functional cupcake (PFCC) samples in healthy subjects are shown in Figure 3. The blood sugar tests showed that there was an increase at the first 30 minutes of consumption of control and prepared functional cupcake samples and continue to decrease gradually. An increment in blood glucose lowering corresponded with increase the substitution of papaya puree in different prepared functional cupcake blends. The highest blood glucose increment showed with consumption of pure glucose and the lowest concentration occurred after consuming PFCC3 cupcake. The blood glucose response after consumption of control cupcake and PFCC1 was higher after 30 and 60 minutes compared to PFCC2 and PFCC3 which lower after 90 and 120 minutes and this condition owed to papaya dietary fiber as the highest fiber consumed the lower blood glucose response (Rimbawan and Siagian 2004).

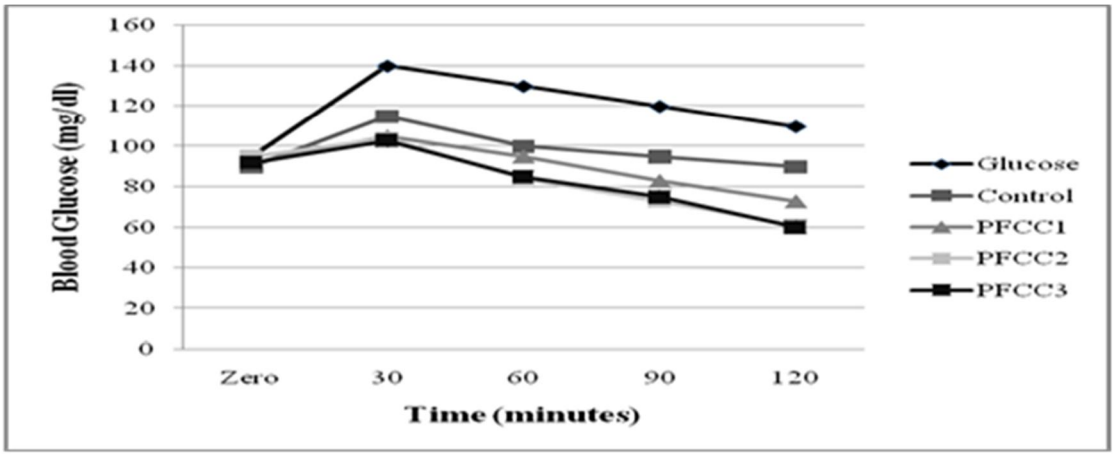

Fig. 3: Blood glucose response graph of glucose and (PFCC) blends. Values are expressed as mean of 10 subjects, PFCC1: sucrose substituted with 25% papaya puree, PFCC2: sucrose substituted with 50% papaya puree, PFCC3: sucrose substituted with 75% papaya puree.

Glycemic Index of different prepared functional cupcake (PFCC)

The glycemic index of different prepared functional cupcake samples are obtained from the average values of the 10 subjects, glycemic index is shown in Figure 4. The PFCC3 had lower GI

(68.79) followed by PFCC2 (69.62) compared to the control cupcake (81.20). The glycemic index values of prepared functional cupcake samples were divided as medium glycemic index (55-70) (Oba *et al.,* 2013). The low glycemic index value of PFCC2 sample might be caused by papaya puree (50%) added into formulation. High dietary fiber papaya puree could affect the glycemic index value due to its basic role as hurdle in the digestion process (Gallagher 2012). Dietary fiber caused to increase viscosity process, supplies longer repletion, reduce macronutrients absorption, effect and change of glycemic index value, and lowers postprandial blood glucose. Adequate dietary fiber consumption could be advantageous in managing and controlling blood glucose concentration (Nisviyati 2006). Moreover, the addition of fiber to diet has hypoglycemic effect as it cause to slow down gastric-emptying and diffusion of glucose and the absorption of glucose so it reduces the increment of blood glucose (Gropper *et al.,* 2009). Furthermore, starch gelatinization formation is affected by high temperature condition which make digestion is difficult, and causing to lower the glycemic index value (Riany 2006).

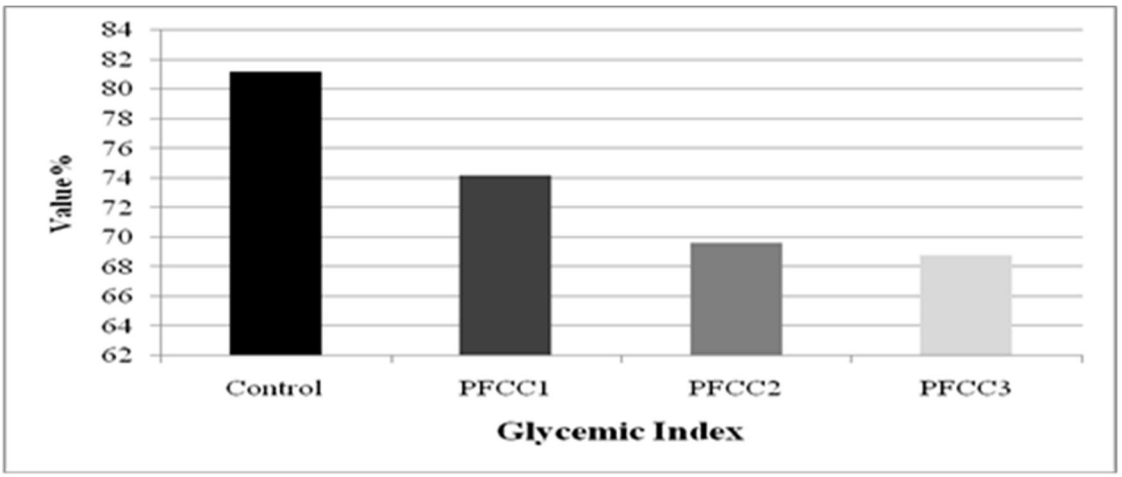

Fig. 4: Glycemic index of (PFCC) blends. Values are expressed as mean of 10 subjects, PFCC1: sucrose substituted with 25% papaya puree, PFCC2: sucrose substituted with 50% papaya puree, PFCC3: sucrose substituted with 75% papaya puree.

Conclusion

Substitution of sucrose by papaya puree increased moisture, dietary fiber, and specific volume on prepared functional cupcake (PFCC). Cupcake which containing papaya puree has an appropriate potential in preventing diabetes because of reduced calorie content and increase dietary fiber which caused to lower glycemic index of prepared functional cupcake (PFCC). On the other hand, the prepared functional cupcake (especially sample PFCC1) not only has no adverse effects on the quality of the cupcake but also improve some quality attributes of cake including flavor, chewiness, springiness, resilience. Microbiological analysis showed that substituted sucrose by papaya puree in (PFCC) blends inhibit and controlled the bacterial and fungal growth at three days storage period at room temperature (25 ̊c). However, further research work should be focused on how to improve the organoleptic qualities of papaya puree cupcake and incorporate it in others products.

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