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Improvement of Physicochemical and Nutritional quality of sponge cake fortified with microwave- air dried quince pomace

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Abstract

In the present study, the effects of addition of quince pomace powder (0- 15%) and water content (25- 35%) on the batter rheological properties, physicochemical characterizes and sensory properties of sponge cake were evaluated. The results showed that increasing substitution of quince pomace increased the viscosity and consistency batter and the dietary fiber, firmness, overall acceptability of cake and reduced the moisture content, and density of cake. Results of RSM based desirability function showed cakes formulated with 12.56% of quince pomace powder and 29.62% of water content had the most and desired physicochemical quality. Total phenol content (7.71 mg/g), iron (0.263 mg/Kg dry weight) and calcium (340 mg/Kg dry weight) of the control sponge cake was improved to 8.32 (mg/g), 0.361 (mg/Kg dry weight) and 1160 (mg/Kg dry weight) in the optimal sponge cake, respectively. SEM results showed the quince powder increased in the number of cavities in the cake's structure and the uniformity of these cavities.

Key words: Physicochemical properties, Quince pomace, RSM, Sponge cake.

Introduction

Bakery products are widely consumed all over the world and among them; cakes are particularly popular and associated in the consumer’s mind with a delicious product with particular organoleptic characteristics (Hafez, 2012; Matsakidou *et al*., 2010). Cakes are favorite foods but of low fiber content and refined wheat flour lack the natural bioactive components found in dietary fiber and consequently may yield lowered health benefits compared with whole wheat, Therefore, increasing the fiber content of the cakes can enhance the nutritional quality of these products (Kim *et al*., 2012; Majzoobi *et al*., 2015).

Dietary fiber functions as a bulking agent and increases the intestinal mobility and moisture content of the feces and lack of fiber in the diet has been associated with constipation, diverticulitis, diabetes, obesity, cardiovascular disease, and cancer (Sudha *et al*., 2007).

Many reports have highlighted that the intake of dietary fiber is much lower than the recommended value, resulting in a number of serious diseases such as cancer, obesity, diabetes, blood pressure, and cardiovascular problems (Mellen *et al*., 2008; Nouri *et al*., 2017). Besides this, fibers can be used for technological purposes because of its functional properties. As functional additives, their usage can range from bulking agent to fat substitute (Fissore *et al*., 2007).

Different sources of dietary fiber have been added to the cakes to increase the dietary fiber content such as Opuntia ficus indica (Ayadi *et al.,* 2009), cross-linked resistant rice starch (Ren and Shin, 2013), Oat Fiber (Majzoobi *et al*., 2015) and Carrot(Salehi *et al*., 2016), have been added to increase dietary fiber content of bakery products.

Quinces (*Cydonia oblonga*) have received attention in the last ten years because of their high content in biologically active phytochemicals and antioxidant capacity. Several studies have recently described antioxidant properties (Wojdyło *et al*., 2014), phenolics compounds (Carvalho *et al*., 2010),

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antimicrobial activity (Fattouch *et al*., 2007; Silva and Oliveira, 2013), antiallergic (Shinomiya *et al*., 2009), antihemolytic (Costa *et al*., 2009), and antiproliferative properties (Carvalho *et al*., 2010) of quince. Besides, quince has low fat content and it is an important source of organic acids, sugars, crude fiber and minerals, such as potassium, phosphorous and calcium (Carbonell- Barrachina *et al*., 2015). However, this pomace is quite susceptible to deterioration due to its relatively high moisture content and enzymes such as those accelerating non-enzymatic browning reactions (Noshad *et al*., 2011). Drying is a common preservation method, mainly because of water removal and consequently reduction in enzymatic deterioration. Using the microwave- assisted drying can improve the physicochemical quality of the dried powder (Hernández- Ortega *et al*., 2013).

To our knowledge the effect of quince pomace (QP) powder dried in microwave-assisted drying on the properties of sponge cake have not been studied yet. Therefore, the current work was to optimize and evaluate the efficacy of QP in production of a sponge cake in order to improve its quality and nutritional value.

Materials and Methods

Fresh quinces (Isfahan variety) with approximately same size and ripen were bought from a local market in Ahvaz, Iran**.** The ingredients used in the formula of sponge cakes were cake flour (Ard jonob Company, Iran), white fine sugar, sunflower oil (with commercial name of Oila, Iran), fresh whole eggs, baking powder (containing sodium bicarbonate and tartaric acid), vanilla (with commercial name of Zamen, Iran), water and nonfat dry milk powder (Pegah Company, Iran) were purchased from locally market.

Microwave drying of quince pomace

The quince pomace consisted of the peel and pulp remaining after juicing. The quince pomace was kept in air tight plastic bottles and stored at a temperature of 4°C until the drying process. microwave oven dryer (Rotosynth, Milestone s.r.l., Italy) were used for quince pomace drying (Anvar et al., 2017). Microwave drying conditions of quince pomace optimized with respect to quality attributes (moisture content, color change and consumer acceptance) using response surface methodology (RSM) (Anvar *et al*., 2017). The dried quince pomace was ground to powder to pass through 35 mm sieve (AS 200 Basic model, Retsch, Haan, Germany).

Sponge cake preparation

First, sucrose and sunflower oil were mixed for 4 min. Whole egg was added to the bowl, and then mixed for 2 min. The quince pomace (QP) powder (0- 15 g/100 g samples of wheat flour), cake flour (100- 85 (g)), baking powder (2 g/100 g samples of wheat flour), vanilla (0.5 g/100 g samples of wheat flour) and nonfat dry milk powder (2 g/100 g samples of wheat flour) was gradually poured into a bowl, and mixed for 4 min. Water was added to the bowl, and then mixed for 1 min (Salehi *et al*., 2015). For each cake, 334 g of cake batter was poured into a cake pan and baked at 180°C (top) or 160°C (bottom) for 30 min in an oven toaster (Noble, Model: KT- 45XDRC) (Salehi *et al*., 2016). After baking, the cakes were removed from the pans and allowed to cool for 1 h at room temperature. The cooled cakes were packed in plastic zipper bags at room temperature before quality parameters analyses.

Determination of physicochemical properties of cakes

The physicochemical properties of sponge cakes, including moisture base on a wet weight, pH and ash, were determined by Movahed *et al* (2011) method (Movahed et al., 2011). The total dietary fiber(TDF) were also determined by Alharbi *et al* (2015) methods (Alharbi *et al*., 2015). The baking loss rate (%) of each type of sponge cake was calculated based on the percentage of cake weight lost after baking and the weight of the sponge cake batter (Turabi *et al*., 2008). The density of the sponge cake was determined by the rapeseed displacement method from four replications(Eriksson et al., 2014).

Determination of cakes textural properties

The texture analyzer (TA-XT-PLUS, Micro stable system, made in English) at room temperature with a 36 mm diameter cylindrical probe, 25 % compressing and a test speed of 0.25 mm s^{-1}, time interval of 10 s, pre- test speed 5.0 mm s^{-1}, post-test speed 5.0 mm s^{-1} and trigger force 5 g was used to evaluate the texture of samples (Torbica *et al.*, 2010).

Sensory evaluation

Cakes were evaluated for their organoleptic characteristics (color, flavor, taste, texture, and overall acceptability) by performing a five-point hedonic test using trained panelists. The panelists were asked to evaluate the samples and score them between 1 (most disliked) to 5 (most liked) (Stone *et al.*, 2012).

Color determinations of sponge cake

Crumb and crust color of fresh cake was measured with a Konica Minolta (model CR-400, Japan) set for Hunter L (lightness), a (redness), b (yellowness) values. The results of the Hunter L, a, and b values were averaged from 10 replications.

Evaluation Antioxidant Activity

Determination of total phenol content

Total phenolic contents analysis was determined according to the method of (Sudha *et al.*, 2007) as follow: 1 g of defatted sample (after refluxing with chloroform and petroleum ether, (1:1 v/v) followed by drying) was mixed with 10 mL of water for aqueous extraction. Similarly, for methanol extraction, 1 g of defatted sample was mixed with 10 mL of methanol, stirred and centrifuged at 2000g for 15 min. The above supernatants were referred as WE and ME, respectively. Sample aliquot of 20–100 mL were added to 900 mL water, along with 1 mL of Folin– Ciocalteau reagent and 2 mL of 10% sodium carbonate solution were together mixed and incubated for 1 h at room temperature. The absorbance was measured at 765 nm with a Shimadzu UV– Visible Spectrophotometer (Shimadzu, Germany). The total phenolic content was expressed as milligram gallic acid equivalent (GAE) per gram sample (Sudha *et al.*, 2007).

Determination of DPPH radical-scavenging capacity

The antioxidant activities were determined on the quince pomace flour, optimized and control baked products by measuring their capacity to scavenge the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) as a free radical. Antioxidant solution in methanol (0.1mL) was added to 3.9 mL of a 6×10^{-5}mol/L methanol DPPH solution (Brand- Williams *et al.*, 1995).

$$DPPH = (\text{blank Absorption} - \text{sample Absorption}/\text{ blank Absorption})\times 100 \qquad (1)$$

Scanning Electron Microscopy (SEM) of Sponge Cake

The method of Scanning Electron Microscopy (SEM) was based on the report of (Shyu and Sung, 2010). The sponge cake was frozen in liquid nitrogen. Once the samples were completely frozen, they were cut into small chunks with a size about 0.8 ×0.8 ×0.3 cm and then were freeze-dried for about 2 days. After drying, the surface of the sample was sputter coated with an electrically conductive layer of gold (LADD No. 30800 Sputter Coater, Vermont, USA). The microstructure of the sample was scanned with a Scanning Electron Microscopy (SEM) (Hitachi S-2500 Scanning Electron Microscopy 20 kV, Tokyo, Japan).

Determination of mineral

The mineral analysis was determined according to the AOAC (2007) method using atomic absorption device (Model ContorAA300, Germany). Wavelengths 248.3, 213.9 and 324.7 nm in order to read iron, zinc and copper was used (Ooi *et al.*, 2012).

Experimental Design

Response Surface Methodology (RSM) was used to find the best formulation of sponge cake. The independent factors were quince pomace (0- 15%) and water content (25- 35 %). The responses were moisture content (Y_1), color crust (Y_2), fiber (Y_3), hardness(Y_4), chewiness (Y_5), cohesiveness (Y_6), overall acceptability (Y_7). Minitab Version 16 was used for optimization; the models fitted in this study could also be utilized for optimization purposes using the desirability function.

Results and discussion

Proximate composition and physicochemical characteristics of sponge Cakes-

As shown in table 1, the linear effects of adding QP powder on the fiber content, moisture content and pH were statistically significant ($p \leq 0.05$) and linear effect of water content on the moisture content were statistically significant ($p \leq 0.05$). Measuring the physicochemical characterization of sponge cakes supplemented with different levels of QP powder showed that the pH ranged from 7.01 to 6.52 and was significantly decreased upon addition of QP powder ($P<0.0001$). The ash ranged from 1.05 to 1.66 and was not significantly increased upon addition of QP powder ($P>0.05$). The moisture contents of the sponge cakes significantly increased with increasing QP powder level ($P<0.05$). On the other hand, total dietary fiber content (TDF of cake containing QP powder was as high as 2.425% while it was 0.026% for control cake. This clearly indicates that QP powder can be an alternative source of dietary fiber in cake making.

The density of the cakes increased from 0.569 to 0.651 g/ml, which is also, reflected in the texture measurement values. (Sudha *et al.*, 2007) reported that addition of 0 to 30% apple pomace to the sponge cake reduced cake volume and increased cake density possibly due to the high ability of the apple pomace to preserve water. Uniformity index (UI) and symmetry of the cake, increased significantly ($p<0.0001$) with increasing pomace level.

Baking loss is of concern for the structural transformation of cake and decreases the shelf life of products (Kim *et al.*, 2012). In the present study, water capacity is believed that have increased as a result of the dietary fiber in the quince powder, and baking loss is believed that have decreased as the addition of quince powder increased, causing good effects in terms of texture and the unique quality of bakery products and affecting the initial water holding capacity for volume during the baking process.

Table 1- Regression models for the response variables: fiber, pH, moisture, ash, baking loss, uniformity index, and symmetry

	Fiber	Density	pH	Moisture	Ash	Baking loss	Uniformity index	Symmetry
p (Model)	0.002**	0.000****	0.01*	0.346^{ns}	0.053*	0.000****	0.001****	0.001**
β_0	7.51	0.8	1.71	0.346	0.053	3.17	0.13	3.39
Quince pomce(β_1)	-0.031****	0.008****	-0.029^{ns}	-0.042*	0.004**	-0.13	-0.002****	0.07****
Water(β_2)	-0.033^{ns}	-0.01^{ns}	-0.048^{ns}	0.011^{ns}	0.287^{ns}	0.05^{ns}	-0.006^{ns}	0.13^{ns}
$\beta_1 \beta_1$	-6.64^{ns}	-1.72^{ns}	0.004**	0.297^{ns}	-0.808^{ns}	-0.004*	0.0002****	-9.43^{ns}
$\beta_2 \beta_2$	0.0005^{ns}	0.00^{ns}	0.0009^{ns}	0.975^{ns}	2.701^{ns}	-0.001^{ns}	9.8^{ns}	-0.002^{ns}
$\beta_1 \beta_2$	0.0004^{ns}	-4.28^{ns}	-0.001^{ns}	0.708^{ns}	0.904^{ns}	0.002^{ns}	2.66^{ns}	-5.73^{ns}
p (Lack of fit)	0.599^{ns}	0.12^{ns}	0.0.579^{ns}	0.636^{ns}	0.154^{ns}	0.99^{ns}	0.61^{ns}	14.25^{ns}
R^2	90.46	93.69	84.21	97.07	89.34	94.22	95.93	89.21
Adj-R^2	83.64	89.19	72.92	92.70	93.37	90.09	93.02	81.50
CV (%)	0.86	0.81	6.52	2.95	2.39	7.84	7.54	0.56
PRESS	0.071	0.002	0.07	10.317	6.61	0.32	0.0001	0.32

Texture profile analysis of sponge cake (TPA)

The magnitude of F values in table 2 indicates the linear effects of adding QP powder on Springiness and chewiness were statistically significant ($p \leq 0.05$. The linear effects of water content positive significant effect on the cohesiveness. As expected, table 2 shows that increase in quince powder level and water content decreased the cohesiveness, gumminess and chewiness whilst increased the hardness. the quadratic terms of quince powder positive effect on hardness, Springiness and cohesiveness, and the quadratic terms of water content positive effect on hardness, Springiness and chewiness, the interactions of ' quince powder and water content' has not significant effect on the all responses. Kim et al. (2012) reported that the firmness of cake was directly related to the density of tested materials (indirectly to its volume). Overall, as the percentage of quince powder increased, hardness and gumminess increased whereas cohesiveness and chewiness decreased.

Table 2-Regression models for the response variables: gumminess, cohesiveness, chewiness, springiness, and hardness

	Gumminess	Cohesiveness	Chewiness	Springiness	Hardness
p (Model)	0.002^{**}	0.235^{ns}	0.927^{ns}	0.18^{ns}	0.99^{ns}
β_0	-0.127	59.74	4.89	1.00	8.77
Quince pomace(β_1)	0.023^{****}	0.66^{ns}	0.042^{*}	-2.20^{*}	0.86^{ns}
Water(β_2)	0.019^{ns}	0.039^{*}	0.792^{ns}	-9.90^{ns}	0.8^{ns}
$\beta_1\beta_1$	0.02^{**}	0.045^{*}	0.768^{ns}	-2.20^{*}	0.038^{*}
$\beta_2\beta_2$	-9.74^{ns}	0.45^{ns}	0.036^{*}	1.65^{**}	0.044^{*}
$\beta_1\beta_2$	-3.47^{ns}	1.00^{ns}	0.75^{ns}	1.43^{ns}	0.848^{ns}
p (Lack of fit)	0.133^{ns}	0.163^{ns}	0.944^{ns}	0.837^{ns}	0.817^{ns}
R^2	90.34	96.04	95.12	59.38	92.09
Adj-R^2	83.44	94.63	91.00	60.36	90.00
CV (%)	4.80	1.31	1.15	0.00	1.33
PRESS	0.012	0.04	0.36	2.90	2.03

Color measurement

The magnitude of F values in table 3 indicates the only just linear effects positive contribution of quince powder on the all responses. As shown in table 4 with the increase in quince powder and water content, for crumb color, the L* and b* value decreased but the a* values increased, indicating that a darker, redder, and more yellow crumb was obtained as a result of quince powder substitution. This is probably due to the QP powder contains some sugar and protein which was a synergistic agent for Millard reaction to produce dark red and reddish compounds and also due to present pigments in the QP powder. The crumb of the control sample was lighter and more yellow than any of the other cakes. Kim et al. (2012) also reported that for crumb color, the addition of green tea powder or chive powder caused L* and b* values to decrease while a* value increased. Browning degrees by amino carbonyl reactions and pyrolysis are reported to influence the chromaticity of prepared cake.

Table 3. Regression models for the response variables: colorimetric crust, crumb

	Crust			Crumb		
	L^*	a^*	b^*	L^*	a^*	b^*
p (Model)	0.000^{****}	0.000^{****}	0.001^{****}	0.000^{****}	0.000^{****}	0.009^{****}
β_0	20.14	-3.04	38.68	89.83	-6.77	19.35
Quince pomce(β_1)	-2.88^{****}	0.81^{****}	-1.43^{****}	-1.39^{****}	1.37^{***}	-0.86^{****}
Water(β_2)	2.98^{ns}	0.11^{ns}	0.75^{ns}	-1.34^{ns}	-0.27^{ns}	1.15^{ns}
$\beta_1\beta_1$	0.05^{ns}	-0.04^{**}	0.002^{ns}	0.003^{ns}	-0.05^{**}	0.01^{ns}
$\beta_2\beta_2$	-0.05^{ns}	-0.003^{ns}	-0.01^{ns}	0.02^{ns}	0.002^{ns}	-0.02^{ns}
$\beta_1\beta_2$	0.02^{*}	0.004^{ns}	0.008^{ns}	0.01^{ns}	0.004^{ns}	0.004^{ns}
p (Lack of fit)	69.67^{ns}	25.91^{ns}	0.63^{ns}	18.79^{**}	1.99^{ns}	177.01^{****}
R^2	94.17	91.78	92.83	98.80	97.23	84.54
Adj-R^2	90.00	85.90	87.71	97.95	95.25	73.49
CV (%)	0.71	7.39	4.81	0.8	-13.19	0.5
PRESS	172.137	21.58	76.56	71.93	16.86	90.63

Sensory evaluation

Sensory evaluation and consumer acceptance is one of the most quality factors. As shown in table 4, the linear effects of quince powder were statistically significant ($p \le 0.05$) effect on all responses and linear effect of water content has positive effect on overall acceptability ($p \le 0.05$). As shown in table 4 with the increase in quince powder and water content, the chewiness, flavor, texture, taste, and overall acceptability increased. This is probably due to the flavor of quinces's pomace. While, Salehi *et al.* (2016) reported that the addition of carrot pomace reduced the overall acceptance of cake.

Table 4- Regression models for the response variables: texture, hardness, flavor, chewiness, overall acceptability

	Texture	Hardness	Flavor	Chewiness	Overall Acceptability
p (Model)	0.000^{****}	0.002^{ns}	0.003^{**}	0.001^{**}	0.024^{*}
β_0	5.05	2.56	4.24	4.96	10.22
Quince pomace(β_1)	0.1^{****}	0.06^{****}	0.15^{****}	0.089^{****}	0.007^{**}
Water(β_2)	-0.14^{ns}	0.03^{ns}	-0.105^{ns}	-0.10ns	0.023^{*}
$\beta_1\beta_1$	-0.008^{**}	-8.26^{ns}	0.001^{ns}	-0.0038^{*}	0.327^{ns}
$\beta_2\beta_2$	0.002^{ns}	-8.60^{ns}	0.002^{ns}	0.0012^{ns}	0.399^{ns}
$\beta_1\beta_2$	0.004^{ns}	0.0006^{ns}	-0.002^{ns}	0.0013^{ns}	0.182^{ns}
p (Lack of fit)	0.045^{ns}	0.005^{ns}	0.244^{ns}	0.598^{ns}	0.33^{ns}
R^2	94.19	90.84	89.35	91.94	92.45
Adj-R^2	90.04	84.30	81.75	86.18	85.78
CV (%)	2.18	1.25	3.15	3.58	8.33
PRESS	1.09	0.93	0.63	0.38	3.64

Optimization procedure and verification of results

In this study, second order polynomial models were utilized for each response in order to determine the specified optimum conditions. These regression models are valid only in the selected experimental domain. By applying desirability function method, solution was obtained for the optimum covering the criteria. At this point, 12.56% for quince pomace and 29.62% for water content.

The amount of Total phenol content, DPPH radical-scavenging capacity, Scanning Electron Microscopy (SEM) and mineral elements including Iron, Copper, Zinc, Phosphorus and Calcium of optimum cake was evaluated.

Total phenol content of the optimized formulation

The results of evaluation of phenolic cake control, optimum cake, wheat flour and quince powder are shown in table 5. The results of the evaluation showed that both the aqueous and methanolic extracts of the quince powder had a higher phenol than wheat flour. The crust and crumb optimum cake extract also showed higher levels of phenol than the control cake. Although baking or drying at 50°C is considered as undesirable because of induction of oxidative condensation or thermal decomposition of compounds such as phenol (Sudha *et al*., 2007). The existence and amount of phenol quince powder is consistent with the results (Khoubnasabjafari and Jouyban, 2011) (table7). The higher amount of phenolic content in the optimized cake can also be due to components derived from quince pomace and the formation of intermediates such as enediols and reductions during baking process, which interferes with the colorimetric assay *(Sudha et al.*, 2007).

Table 5. Phenol content of wheat flour, QP powder, control cake and optimized cake

Sample	Water extract (mg/g)	Methanol extract (mg/g)
Wheat flour	2.12 ± 0.01^{E}	3.12 ± 0.001^{F}
Quince pomace	6.14 ± 0.01^{A}	6.16 ± 0.001^{A}
Control cake crust	2.83 ± 0.01^{F}	3.42 ± 0.001^{B}
Control cake crumb	3.44 ± 0.01^{D}	4.26 ± 0.001^{C}
Optimized cake crust	3.48 ± 0.01^{C}	3.81 ± 0.001^{D}
Optimized cake crumb	3.89 ± 0.01^{B}	4.43 ± 0.06^{B}

The different letters in each column show a significant difference at $p<0.05$

DPPH radical- scavenging capacity of the optimized formulation

The results of the DPPH radical-scavenging capacity are shown in table 6. The results of the study showed that the optimized cake had more the percentage of radical- scavenging capacity (RCS) than control cake. This is due to the presence of several compounds with antioxidant properties in quince powder. (Alesiani *et al.*, 2010) examined the DPPH radical inhibitory capacity in a research into the antioxidant activity of the quince peel. The results of this study showed the strongest antioxidant capacity for quercetin flavone and 3-o-rutinoside. In particular, quercetin reduced the DPPH radical by 56.7%. Also, the quince acid derivatives, chromogenic acid and neochlorogenic Acid determined an average DPPH radical reduction of 35.0% respectively (Alesiani *et al*., 2010).

Scanning Electron Microscopy (SEM) of the optimized formulation

Figures. 1. Shows the structure of the pores of the optimized and control cake. The results of the study showed that the addition of QP powder caused the formation of fine, the uniformity cavities and increase in the number of cavities in the cake's structure. The reason for this difference, the presence of quince powder in the optimized cake structure and its effect on the wheat flour gluten network (Bhat and Anju, 2013).

Proximate composition of mineral elements characteristics of the optimized formulation

Table 7 shows the results of atomic absorption of the quince powder, the control and the optimized cake. Measurement of mineral elements by atomic absorption device showed that the mineral elements of quince powder and cake were better than the control cake sample. According to research results, (Carbonell- Barrachina *et al*., 2015), fruit is an important source of minerals such as iron, phosphorus and calcium, which is consistent with the results of this study (Carbonell-Barrachina *et al*., 2015).

Table 6- DPPH radical-scavenging capacity

Sample	DPPH (%)
Quince pomace	67.62± 0.81 ^{A}
Control cake	0.07±0.01 ^{C}
Optimized cake	18.5±1.69 ^{B}

The different letters in each column show a significant difference at p<0.05

Table 7- The amount of minerals, quince powder, the control cake and the optimized cake (mg/l)

Mineral	Quince powder	Control cake	Optimized cake
Fe	0.386±0.04^{a}	0.263±0.03^{b}	0.361±0.07^{a}
Cu	0.072±0.01^{a}	0.002±0.001^{c}	0.010±0.004^{b}
Zn	0.129±0.05^{a}	0.066±0.006^{b}	0.128±0.003^{a}
P	0.145±0.02^{a}	0±0.00^{c}	0.01±0.001^{b}
Ca (mg/kg dry Weight)	1920±5.14^{a}	340±2.47^{c}	1160±4.98^{b}

The different letters in each row show a significant difference at p<0.05

Conclusion

Response surface methodology was an efficient statistical tool to model the influence of quince pomace and water contact of sponge cake on quality, chemical, sensory and image properties of sponge cake and fiber characteristics. Quince pomace having high amount of TDF can function as a valuable source of dietary fiber in cake making. Addition of quince pomace in cake making can avoid the addition of other flavoring ingredients as the cakes prepared with quince pomace had pleasant fruity flavor. Quince pomace also has the potential for use in cake making as a good source of polyphenols which has antioxidant properties. These results also suggested that by modifying the proportion of these components, a large range of variations may be obtained.

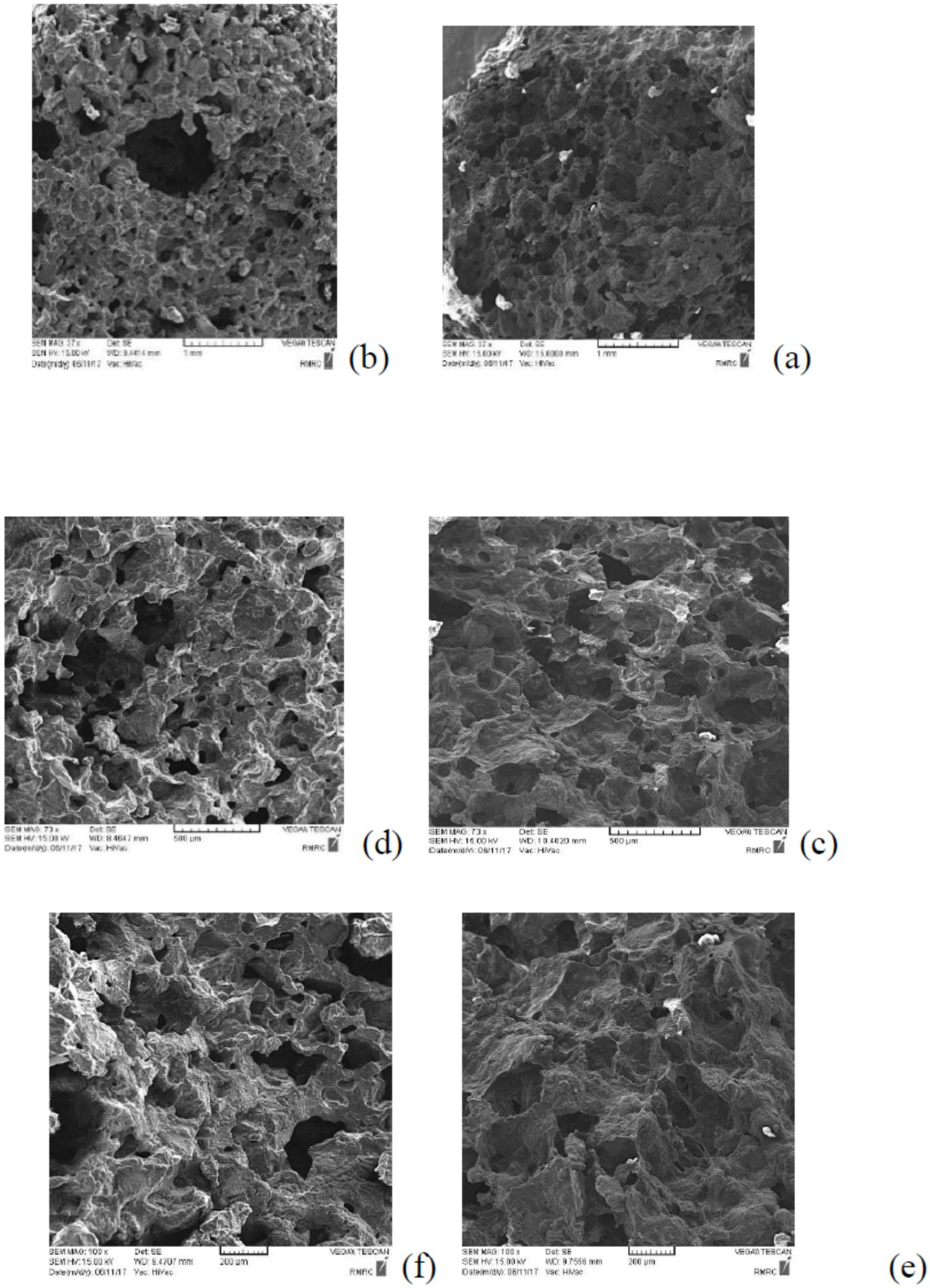

Fig. 1. Scanning electron microscopy ((a) (×37) of optimized cake; (b) (×37) Control cake; (c) (×73) of optimized cake; (d) (×73) Control cake; (e) (×100) of optimized cake (f) (×100) Control cake .

In addition to establishing best formulation, the image processing and texture analysis have been shown to be useful tools to investigate, approximate and predict a large number of cake properties. This study was preliminary and needs to be studied at molecular level in detail.

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بهبود ویژگی‌های فیزیکوشیمیایی و ارزش تغذیه‌ای کیک اسفنجی با استفاده از پسماند میوه به

عادیه انور[1]- بهزاد ناصحی[2*]- محمد نوشاد[3]- حسن برزگر[4]

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چکیده

در این پژوهش، تأثیر افزودن پودر پسماند به (15-صفر درصد) و مقدار آب (25 -35 درصد) بر خصوصیات فیزیکوشیمیایی و حسی کیک اسفنجی مورد مطالعه قرار گرفت. نتایج نشان داد که افزایش مقدار پسماند به باعث افزایش فیبر رژیمی، سفتی و پذیرش کلی کیک و کاهش مقدار رطوبت و دانسیته نمونه‌ها شد. همچنین افزایش پودر پسماند میوه به سبب افزایش ویسکوزیته و قوام خمیر شد. براساس روش تابع مطلوبیت، کیک تولید شده حاوی 12/56 درصد پودر پسماند میوه به و 29/62 درصد آب دارای بهترین و بیشترین کیفیت فیزیکوشیمیایی بود. کیک تولید شده با فرمول بهینه دارای (8/32 mg/g) ترکیبات فنلی، (0/361 mg/Kg dry weight) آهن و (1160 mg/kg dry weight) کلسیم بود. نتایج SEM نشان داد که افزودن پودر پسماند میوه به باعث افزایش تعداد حفرات و یکنواختی حفرات در ساختمان کیک شده است.

واژه‌های کلیدی: کیک اسفنجی، پسماند میوه به، ویژگی‌های فیزیکوشیمیایی، RSM

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