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Effect of Utilizing of Quinoa, Rice and Corn Flours on Physicochemical Properties and Sensory Characteristics of Gluten Free Cupcake

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Abstract

Celiac disease is a common systemic disease related to a permanent intolerance to gluten and is often associated with different autoimmune and neurological diseases. Its mean prevalence in the general population is 1-2% worldwide .Cake and cupcakes are the most popular bakery products, thus, the current study aimed to produce functional gluten free cupcake from yellow corn flour and rice flour as well fortified with quinoa flour at 25 and 50%. Physical, chemical and sensory evaluations of gluten free cupcake were performed. Results revealed that, free gluten cupcake produced with quinoa flour had a high content of protein, ash, fat and fiber compared to control1(100% yellow corn flour) and control 2(100% rice flour). gluten Free cupcake produced from quinoa flour was good source of K, Ca, Mg, Fe and Zn compared to control samples. Sensory response showed that highly acceptable of gluten free cup cake with 25 and 50% quinoa flour. Results demonstrated that quinoa flour is considered as an important material for production highly quality bakery goods.

Keywords: gluten free cupcake, celiac disease, Quinoa flour, corn flour, rice flour, physical and chemical properties.

Introduction

Recently, there has been an increasing interest in functional foods, which may be defined as a food that may provide health benefits beyond basic nutrition. Functional foods contain biologically-active compounds as well as fiber supplementation could be used to improve the metabolic syndrome and related risk factors, such as hypercholesterolemia, hypertriglyceridemia, hyperglycemia (**Aleixandre and Miguel, 2016)**. So that, food producers have invested resources in the development of processed foods that may provide added functional benefits to consumers' well-being (**Granato *et al.*, 2020)**.

Celiac disease occurs in about 1% of the population worldwide, although most people with the condition are undiagnosed**(Tapia *et al.*,2012).**

Celiac disease is a common systemic disease related to a permanent intolerance to gluten and is often associated with different autoimmune and neurological diseases. Its mean prevalence in the general population is 1-2% worldwide **(Rodrigo *et al.*, 2011).**

Celiac disease is an autoimmune disorder of the small intestine in genetically predisposed individuals triggered by gluten proteins from wheat, barley and rye. Celiac patients should adhere to a lifelong gluten-free diet. Since wheat is one of the main ingredients of most baked products worldwide, compliance with the gluten free diet is challenging and may over whelm patients (**Turabi *et al.*, 2010).**

Gluten-free foods for celiac patients are produced under the regulations of the Codex Alimentarius Standard for Gluten-Free Foods adopted by the Codex Alimentarius Committee on Nutrition and Food for Special Dietary Uses. The "Revised Codex Standard" edited in March 2006 proposes a maximum level of 20 mg of gluten per kg for naturally gluten-free foods (e.g. based on rice or corn flours) and200 mg/kg for foods rendered gluten-free (e.g. wheat starch) **(Farage *et al.*, 2017)**.

Quinoa grains can be consumed whole or ground into flour for used in several forms such as flour, toasted and added to soups,**(Quiroga *et al.*, 2015),**cakes, cookies, biscuits and steamed bread**(Nowak, *et al.*, 2015 and Wang and Zhu, 2016),** crepes, muffins, pancakes and tortillas (**Wang, *et al.*, 2015 and Rizzello, *et al.*,2016**),

noodles (**Valencia, *et al.*, 2010),** pasta **(Schoenlechner, *et al.*,2010),** spaghetti **(Rosell, *et al.*, 2009),** extruded products **(Diaz, *et al.*,2013 and Elgeti, *et al.*, 2014),** breakfast cereals and flakes **(Wang, *et al.*,2015),** infant food **(Wang, *et al.*, 2015),** staple food **(Diaz, *et al.*,2015),** baby food and crackers **(Bonifacio, *et al.*, 2013)** and snacks **(Diaz, *et al.*, 2013)**,

Rice flour has been found to be one of the most suitable cereal grain flour for preparing foods for celiac patients. The suitability of rice flour is attributed to its low levels of prolamins(the peptides released from the breakdown of the wheat prolamins act as toxins for individuals suffering from celiac disease **(Gujral *et al.*, 2003).**

Gluten- free bakery products is corn flour (*Zea mays* L.) which is an important cereal even though its human consumption in the country is low. In the Andean region of crops has increased, including several varieties of corn, which are a source of income for rural farmers**(Gime´nez *et al.*, 2015).**

Cakes and free gluten cupcake have a high consumption demand around the world. The majority is made with wheat flour, which contains gluten protein (**Vici *et al.*, 2016**). However, gluten has negative health effects to patients with coeliac disease and other related-gluten disorders (**Gelinas and McKinnon 2016**). The symptoms of coeliac disease are diarrhea, stomachache, sleepless, hair loss, and anemia. The number of patients with gluten sensitivity is increasing every year around the world. One way to control this disease is to avoid consuming glutencontaining food products. To improve gluten free cupcake quality, hydrocolloids, i.e., guar gum, cellulose and xanthan gum are used to replace some functionality aspects of gluten protein. These products are also normally low in dietary fiber and protein and high in carbohydrate because most of gluten free products are produced from non-gluten cereal such as rice, maize, potato or cassava starches (**Capriles and Aereas, 2014**).

The aim of this study was produce of free gluten cupcake using quinoa flour, corn flour and rice flour. As well as assessing physical, chemical, characteristics and sensory quality.

Material and Methods:

Materials:

Quinoa flour (*Chenopodium quinoa*), corn flour *(Zea mays*) and rice flour (*Oryza sativa* L.) were purchased from Karfour market, Cairo, Egypt.

Ingredients:

Corn oil, fresh egg, dry milk powder, baking powder, xanthan gum, and vanilla were purchased from local market, Giza, Egypt. All chemicals i.e. hexane, acetic acid, methanol, toluene, sulfuric acid, sodium hydroxide, and sodium sulphate anhydrous were obtained from El-Gomhoria Company, Cairo, Egypt.

Methods.

2.1. Preparation of cup cake:

Free gluten cupcake was prepared according to the method described by **Doweidar, (2001)** with some modifications according to **Table** (1). The ingredients i.e., whole fresh eggs, sugar, corn oil and vanilla were whipped for 6 min with using a mixing machine (Braun M1000) at high speed made in Egypt. Add flour with dry milk powder, baking powder and salt to mixture and added gradually on the sugar-eggs-vanilla mixture and beaten for 3 min. using the mixing machine at low speed. Thirty grams of cake were poured in free gluten cupcake packages, then placed in a preheated oven and baked at (180±1ºC) for 35 min. After baking, free gluten cupcake samples were allowed to cool for 30 min in the packages at ambient temperature, then removed from the package and allowed to cool for another 30 min at room temperature (25±1ºC).

Table 1. The recipe formulation of free gluten cupcake.

Ingredients %	**Treatments%**					
	C1	**C2**	**T1**	**T2**	**T3**	**T4**
Quinoa flour	0.0	0.0	50	50	25	**25**
Yellow Corn flour	100	0.0	0.0	50	25	**50**
Rice flour	0.0	100	50	0.0	50	**25**
Whole fresh eggs	50	50	50	50	50	**50**
skimmed milk powder	10.0	10.0	10.0	10.0	10.0	**10.0**
Corn oil	30	30	30	30	30	**30**
Sugar	85	85	85	85	85	**85**
Baking powder	2	2	2	2	2	**2**
Salt	1	1	1	1	1	**1**
Vanilla	1	1	1	1	1	**1**
Xanthan gum	1	1	1	1	1	**1**
Water	120	120	120	120	120	**120**

C1 =100 % Yellow corn flour (YCF)C2 = 100 % rice flour (RF)
T1=50% Quinoa flour(QF) + 50 % Yellow corn flour (YCF)
T2= 50% Quinoa flour(QF) + 50 % rice e flour (RF)
T3= 25% Quinoa flour(QF) + 25 % Yellow corn flour(YCF) + 50% rice flour(RF)
T4 = 25 % Quinoa flour (QF) + 25 % rice flour (RF)+50 % Yellow corn flour(YCF)

2. Chemical Composition

Moisture, crude protein, crude fat, ash, and crude fiber contents were determined according to the methods described in the **AOAC (2016).** Available carbohydrate was calculated by difference. All determinations were performed in triplicates and the means were reported.

Total calories were calculated using the compositional data by the equation mentioned by **FAO and WHO (1974)** using the following equation:

E = 4(Carbohydrate % + protein %) + 9 fat %.

Where: E = Energy as calories per 100g sample.

Minerals elements: (Ca, Mg, Fe and Zn) were analyzed separately, using an atomic absorption spectrophotometer (Agilent technologies 4210 MP-AES) and (K) by using Flame photometer .according to **AOAC(2016).**

3. Physical properties of cupcake:

Volume (cm^3) and weight (g) of cupcake samples of each treatment were recorded. Specific volume (cm^3/gm) was calculated by dividing of the volume to weight according to the method described in **A.A.C.C. (2016)**.

4. Texture Profile Analysis;

A texture analyzer (Brookfield CT3 Texture Analyzer Operating Instructions Manual No. M08-372-C0113, Stable Micro Systems, USA) **A.A.C.C., (2016)** was used to measure the texture profile of cakes in terms of hardness (N), cohesiveness, gumminess (N), chewiness (mj), and springiness (mm) of the samples. The samples (2.5 cm height and 4 cm diameter) were compressed twice to 40% of the original height using settings as Test-TPA, Probe-36 mm. Cylindrical, Pre-test speed-2mm/s, Test speed-2 mm/s, Post-test speed-2mm. The experiments were conducted under ambient conditions at 0, 24h and 72h in the laboratories of Agricultural Research Center, Giza, Egypt.

5. Sensory evaluation:

Sensory evaluation (nine Hedonic scale) was performed according to **Lorenz and Coulter (1991)**. Ten trained panelists from the staff of Bread and Pastry. Res. Dep., Agri. Res. Center, Giza, Egypt, were asked to examine and score the different selected parameters of organoleptic properties for all experimental free gluten cupcake as follows: Appearance, color, taste, odor, texture and overall acceptability.

6. Statistical analysis

The obtained data were statistically analyzed by least significant difference (L.S.D) at the 5% level of probability procedure according to **Snedecor and Cochran (1980)** using version of costat 6.451.

Results and Discussion:

1. Sensory properties

Effects of different replacing levels of quinoa flour on sensory properties of gluten free cupcakes are presented in **Table** (2). It was showed that the sensory evaluation included color, taste, odor, texture and overall acceptability of gluten free cupcake treatments (C1, C2, T1, T2, T3 and T4). The highest value of odor was 8.9 in (T3) sample but the lowest value was recorded (6.50) in C2 sample. The highest value of taste, and overall acceptability, given by different treatments sample. Based on our results of sensory evaluation, we concluded that nutritious and healthy gluten free cupcakes can be produced by T1 and T2 formulas without negative effect on the general acceptability of free gluten cupcake. The highest value of taste 8.9 and 8.58 given by incorporating of T3 and T1 samples, followed by T2 and T4 samples with a value of 8.5 and the lowest value 5.6 and 6.4 was recorded by C1 and C2 samples. There was difference in overall acceptability of the control sample compared with the other treatments.

Table 2. Sensory properties of gluten free cup cakes formulas

Treatments	Properties				
	Color	Taste	Odor	Texture	Overall acceptability
C1	7.60±0.50^{b}	5.60 ±0.58^{b}	6.60 ±0.70^{b}	6.60 ±0.29^{b}	**6.60±0.42^{d}**
C2	7. 80±0.50^{ab}	6.40 ±0.50^{b}	6.50 ±0.20^{b}	7.00 ±0.49^{b}	**6.90 ±0.77^{cd}**
T1	8.80±0.50^{a}	8.58±0.50^{a}	8.50±0.00^{a}	8.50±0.53^{a}	**7.70±0.50^{bc}**
T2	8.70±0.50^{ab}	8.50±0.30^{a}	8.50±0.41^{a}	8.20±0.45^{a}	**7.80±0.53^{bc}**
T3	8.40±1.00^{ab}	8.90±0.37^{a}	8.90±0.00^{a}	8.50±0.33^{a}	**8.9^{a}±0.54^{a}**
T4	8.60±0.58^{ab}	8.50±0. 60^{a}	8.50±0.31^{a}	8.50±0.36^{a}	**8.30±0.40^{ab}**
LSD at 0.05	1.1304	0.8664	0.6472	0.7428	**0.9612**

C1 =100 % Yellow corn flour (YCF) **C2** = 100 % rice flou**r** (RF)
T1=50% Quinoa flour (QF) + 50 % Yellow corn flour (YCF)
T2= 50% Quinoa flour (QF) + 50 % rice e flour (RF)
T3= 25% Quinoa flour (QF) + 25 % Yellow corn flour (YCF) + 50% rice flou**r** (RF)
T4 = 25 % Quinoa flour (QF) + 25 % rice flour (RF)+50 % Yellow corn flour (YCF)
Means with the same letter in the same column are not significant different (P<0.05).

There were no significant differences in surface color values in control sample and other treatments. These results are in agreement with those obtained by **Kaur and Kaur (2017)** who reported that the quinoa flour substituted at 5 and 10% improved the taste of cakes, however. The taste was described as very pleasant and nutty in comparison with the flavor of the control cakes which was considered to be too sweet. Use of 20 or 30% of quinoa flour.

3.2. Proximate chemical composition of raw materials:

The chemical composition of quinoa, yellow corn and rice flours was shown in **Table (3).** It was found that moisture, protein, ash, fat, fiber, and carbohydrates were 10.41, 13.66, 2.47, 5.77, 10.14, and 67.96 %, for QF,10.00, 7.92, 1.45, 5.50, 6.00, and 79.13 %, and for YCF and6.50,6.25,0.81,0.45,0.99and 91.5%for RF, respectively. Fromthe obtained results, it could be noticed that QF contained significantly higher amounts from protein, ash, fat and fiber contents than those of YCF and RF, while YCF and RF contained significantly higher amounts from available carbohydrate. Additionally, the QF is well-known as functional ingredients due to its high fiber content. These results are in agreement with those obtained by **El-Hadidy *et al*.(2022) and Nascimento *et al*. (2014)** found that the chemical composition of quinoa flours contained 12.10% protein,11.8% moisture, 6.31% fat, 3.54 to10.4% fiber, and 2 to 2.01% ash.

Table 3. Proximate chemical composition of quinoa, yellow corn and rice flours: (g/100 g, on dry weight basis).

Component	Quinoa flour	Yellow corn flour	Rice flour
Moisture	10.41 ±0.8 [a]	10.0 ±0.5[a]	6.50 ±0.80 [b]
Protein	13.66 ±0.30[a]	7.92 ±0.27 [b]	6.25 ±0.20[c]
Ash	2.47 ±0.70 [a]	1.45±0. 41[b]	0.81 ±0.02 [b]
Fat	5.77 ±1. 99[a]	5.50 ±1. 50 [a]	0.45 ±0.42 [b]
Crude fiber	10.14 ±0.1 [a]	6.00±0.17 [b]	0.99 ±0.10[c]
Available carbohydrates*	67.96[c]	79.13[b]	91.50[a]

Means with the same letter in the same row are not significant different (p<0.05).
Mean of triplicate determination ± SD.
* Carbohydrates calculated by difference.

3.3. Minerals content of raw materials:

Statistical analysis appeared as shown in **Table** (4), significant (p≥0.05) differences between QF, YCF and RF. Quinoa flour recorded significant higher of K, Mg, Fe and Zn contents. While, YCF and RF flours had significantly content from potassium, calcium, magnesium, iron and zinc 280.0, 140.0, 138.0, 2.40, and 2.30 mg/100g for YCF and 90.0, 12.00, 50.00, 1.50 and 0.95mg/100g, respectively, which recorded 730.05, 138.05, 271.5, 15.00, and 6.00 mg/100g, respectively. These results are inagreement with those obtained by **Tang, *et al.*, (2016)** who reported that the quinoa is rich in certain types of micronutrients such as minerals (e.g., potassium).Also,**Konishi, *et al.*, (2004) and Abugoch James,(2009)** observed that quinoa(*Chenopodium quinoa Willd*) are rich in mineral nutrients (3.0%), and the K, Ca, Mg and Fe contents are much higher than those in cereals.

Table 4. Minerals content of quinoa, yellow corn and rice flours (mg/100g):

Elements	Raw materials			
	Quinoa flour	Yellow corn flour	Rice flour	LSD at 0.05
K	730.05 ±1.99[a]	280.0±1. 19 [b]	90.00 ±1.18 [c]	**3.28**
Ca	138.05 ±1.84[a]	140.0 ±1.85 [a]	12.00 ±0.50 [b]	**2.58**
Mg	271. 50 ±1.89[a]	138±0.50[b]	50.00 ±2.12[c]	**2.99**
Fe	15.00 ±0.99[a]	2.40±0.75[b]	1.500 ±.05 [b]	**1.43**
Zn	6.00±0.7[a]	2.30±0.62[b]	0.950 ±.06 [c]	**1.08**

Means with the same letter in the same row are not significant different (P<0.05).

3.4. Proximate chemical composition of gluten free cupcakes:

Proximate chemical composition of different blends of produce gluten-free cupcakes was presented in **Table** (5), and the results data in **Table** (5) that protein content was increase in the T1,T2,T4, and T3 samples compared to C1and C2 samples. Furthermore, ash content was high in T2 sample compared to other treatments samples. These results are in agreement with those obtained by **El-Hadidy *et al*.(2020)** who ascertained that addition quinoa flour to rice flour increased crude protein in bakery products.

Table 5. Chemical composition of free-gluten cup cake (g/100gm on dry weight basis).

Treatments	Moisture	Protein	Ash	Fat	Fiber	Available Carbohydrates	Energy (Cal.)
C1	11.50±0.30 [a]	17.50±0. 7 [cd]	7.8±0.70 [ab]	40.8±0.82 [a]	6.2[0]±0.99 [b]	27.70±0.70 [b]	548.00
C2	9.53 ±0.48 [b]	16.00±0.92 [d]	7.3±0.01 [b]	36.00±0.05 [c]	1.90 ±0.05 [d]	39.70± 1.99 [a]	546.8
T1	10.66±0.50 [ab]	20.51±0.77 [ab]	8.00±0.32 [ab]	40.65±0.081 [a]	8.90±0. 90 [a]	21.94±1.50 [c]	535.65
T2	10.70±0.50 [ab]	19.5±1.01 [abc]	8.24±0.2 [a]	38.11±0. 83 [b]	6.50[b]±0.1 [b]	27.65±1.51 [b]	531.59
T3	11.50±1.70 [a]	21.5±0.82 [a]	7.2±0.50 [b]	38.00±0. 80 [b]	4.40±0.60 [c]	28.90±1.82 [b]	543.60
T4	11.32±1.20 [a]	18.71±1.32 [bc]	8.00±0.72[ab]	39.3±0. 40 [b]	4.60±0.20 [c]	29.39±1.95 [b]	546.10
LSD at 0.05	1.2660	2.0176	0.89611	1.0699	1.0778	3.06887	

C1 =100 % Yellow corn flour (YCF) **C2** = 100 % rice flou**r** (RF)
T1=50% Quinoa flour (QF) + 50 % Yellow corn flour (YCF)
T2= 50% Quinoa flour (QF) + 50 % rice e flour (RF)
T3= 25% Quinoa flour (QF) + 25 % Yellow corn flour (YCF) + 50% rice flou**r** (RF)
T4 = 25 % Quinoa flour (QF) + 25 % rice flour (RF)+50 % Yellow corn flour (YCF)
Means with the same letter in the same column are not significant different (P<0.05).

3.5. Minerals content of free- gluten cup cake.

As shown in **Table** (6), the minerals content of free gluten cupcake was evaluated. The mineral content was increase significantly by increasing Quinoa flour in free gluten cupcake compared to control sample.T1significantly higher of K, Ca, Mg and Fe compared to other treatments, which recorded 360.00, 264.50, 218.00 and 13 mg/100g, respectively, while T3 recorded significantly higher of Zn compared to other treatments which contains 7.75mg/100g. Therefore, attention has been paid to replacing corn flour and rice flour with quinoa flour in some bakery products due to the high nutritional value of quinoa flour and its containment of important minerals in high content compared to corn flour and rice flour such as potassium, calcium, manganese and iron, respectively. These results are in agreement with those obtained by **Ávila *et al.*, (2017)** who reported that the contents of iron, potassium, magnesium and zinc showed in test formulation to be satisfactory.

Table 6. Minerals content of gluten -free cup cakes (mg/100g on dry weight basis).

Minerals	Treatments						
	C1	C2	T1	T2	T3	T4	LSD 0.05
K	405.00±.15[e]	215.00±0.59[f]	630.00±.03[a]	535 ±.13[b]	422.50±.58[c]	470±1.15[c]	1.04
Ca	250.00 ±. 40[a]	137.0±.16[d]	264.50±0.90[a]	200.50±0.93[c]	200.75±0.88[e]	232.75±0.92[b]	1.36
Mg	153.00±.77[d]	64.00±0.74[d]	218.00±.99[a]	174.00±1.04[b]	141.00±0.84[d]	163.00±0.73[c]	1.53
Fe	6.50±0.14[c]	5.50±.47[d]	13.00±.09[a]	12.25±.85[a]	9.13±0.50[b]	9.58±0.65[b]	0.93
Zn	4.90±0.50[c]	3.55±0.90[d]	6.70±0.67[ab]	6.07±.45b[c]	7.75b±0.78[c]	5.88±0.89[bc]	1.28

Means with the same letter in the same row are not significant different (P<0.05)
C1 =100 % Yellow corn flour (YCF) **C2** = 100 % rice flou**r** (RF)
T1=50% Quinoa flour (QF) + 50 % Yellow corn flour (YCF)
T2= 50% Quinoa flour (QF) + 50 % rice flour (RF)
T3= 25% Quinoa flour (QF) + 25 % Yellow corn flour (YCF) + 50% rice flou**r** (RF)
T4 = 25 % Quinoa flour (QF) + 25 % rice flour (RF)+50 % Yellow corn flour (YCF)

3.6. Physical properties of gluten free cupcakes.

Higher quality cakes are associated to light weight, spongy structure, high volume and low density. Physical properties of free gluten free gluten cupcake were shown in **Table** (7). It was found that the the highest weight (74.63g) was recorded in T1 sample, while, the lowest weight was recorded in T4 sample the opposite trend was observed for the volume in C1and C2 sample. Therefore, the volume was fixed in all treatments (150cm^3) while the volume was low in control treatments (145cm^3).These results are in agreement with those **Bozdogan, *et al.*, (2019).**

3.7. Textural profile analysis (TPA) of gluten free cupcakes:

Presents texture analysis results for fresh, in zero time, 24 and 72 hours stored in room temperature samples are presented in Table (8). The effect of quinoa flour on Cohesiveness, Gumminess, Chewiness and hardness were increased during storage periods was very dependent on the high fiber content in quinoa flour which used forgluten free cupcake making. The hardness recorded the highest value in C1 and C2 samples in zero time, 24 and 72 hours it was (44.13,47.67,53.38) and (40.96,44.73,49.50) respectively. While, the lowest value in T1 in zero time, 24 and 72 hours was20.70, 22.60 and 23.30, respectively. T2 in zero time, 24 and 72 hours 28.50,28.81and 28.99, respectively. T3 in zero time, 24 and 72 hours31.61, 37.36and 44.10, respectively. T4 in zero time, 24 and 72 hours 35.49, 36.82 and 37.03 respectively. A decrease in Springiness values with ageing was observed in the samples due to the increase in fiber in quinoa flour.

These results agreed with **Shevkani and Singh (2014)** who reported that the sample without quinoa flour exhibited the highest hardness value and the addition of quinoa flour caused a significant decrease in the maximum force during fracture, which correlates to hardness. Springiness of the cake crumbs had been related to the protein aggregation and indicates fresh, aerated and elastic product Springiness of the gluten free cakes slightly increased with the increasing quinoa flour which shows that quinoa flour improved the elasticity of the gluten free cakes because of the higher protein content.

Table 7. Physical properties of free-gluten cup cake samples.

Treatments	Weight (g)	Volume(cm^3)	Specific volume(cm^3/g)
C1	73.95	145	**1.96**
C2	74.00	145	**1.95**
T1	73.63	150.00	**2.04**
T2	73.36	150.00	**2.04**
T3	73.45	150.00	**2.04**
T4	73.13	150.00	**2.50**

C1 =100 % Yellow corn flour (YCF) **C2** = 100 % rice flou**r** (RF)
T1=50% Quinoa flour (QF) + 50 % Yellow corn flour (YCF)
T2= 50% Quinoa flour(QF) + 50 % rice e flour (RF)
T3= 25% Quinoa flour (QF) + 25 % Yellow corn flour(YCF) + 50% rice flou**r** (RF)
T4 = 25 % Quinoa flour (QF) + 25 % rice flour (RF)+50 % Yellow corn flour (YCF)
Means with the same letter in the same column are not significant different (P<0.05).

Table 8. Textural profile analysis (TPA) of gluten-free cupcakes:

Treatments	Textural Characteristics														
	Hardness(n)			Cohesiveness			Gumminess(n)			Springiness(mm)			Chewiness(mj)		
	Zero time	24 (h)	72 (h)	Zero time	24 (h)	72 (h)	Zero time	24 (h)	72 (h)	Zero time	24 (h)	72 (h)	Zero time	24 (h)	72 (h)
C1	44.13	47.76	53.38	0.46	0.44	0.41	21.68	24.38	25.88	4.64	4.50	4.34	100.10	122..25	**144.00**
C2	40.96	44.73	49.50	0.48	0.64	0.44	16.00	17.50	18.00	4.90	4.80	4.44	120.00	124.00	**130.00**
T1	20.70	22.6	23.3	0.47	0.45	0.43	12.95	13.40	13.65	5.50	5.49	5.39	55.00	63.20	**70.00**
T2	28.50	28.81	28.99	0.47	0.46	0.45	13.80	14.61	14.75	6.23	6.20	5.87	86.00	89.92	**92.90**
T3	31.61	37.36	44.10	0.46	0.45	0.43	13.43	14.69	15.90	6.92	6.67	6.38	95.10	97.59	**100.00**
T4	35.59	36.82	37.03	0.49	0.47	0.45	18.56	18.80	19.00	6.95	6.90	6.70	100.90	97.99	**95.00**

Means with the same letter in the same column are not significant different (P<0.05)
C1 =100 % Yellow corn flour (YCF) **C2** = 100 % rice flou**r** (RF)
T1=50% Quinoa flour (QF) + 50 % Yellow corn flour(YCF)
T2= 50% Quinoa flour (QF) + 50 % rice e flour (RF)
T3= 25% Quinoa flour (QF) + 25 % Yellow corn flour(YCF) + 50% rice flou**r**(RF)
T4 = 25 % Quinoa flour (QF) + 25 % rice flour (RF)+50 % Yellow corn flour(YCF)

Conclusion

Results demonstrated that functional gluten free cup cake to celiac disease from yellow corn flour and white rice flour as well fortified with quinoa flour at 25 and 50%. The gluten free cupcake which produced with from quinoa flour had a high content of protein, ash, fat , fiber and menials elements such as K, Ca, Mg, Fe and Zn samples revealed that the sensory evaluation showed that highly acceptable of gluten-free cupcake with 25 and 50% quinoa flour. Results demonstrated that quinoa flour an important material for production highly quality bakery goods for celiac disease.

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تأثير استخدام دقيق الكينوا والارز والذرة على الخصائص الطبيعية والكيميائية والحسية للكب كيك الخالى من الجلوتين

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تهدف هذه الدراسة إلى إنتاج كب كيك خالى من الجلوتين كغذاء وظيفى من دقيق الذرة الصفراء ودقيق الأرزوالمدعم بدقيق الكينوا بنسب إستبدال مختلفة (50٪ دقيق كينوا + 50٪ دقيق ذرة أصفر) ، (50٪ دقيق كينوا + 50٪ دقيق أرز) ، (25٪ دقيق كينوا + 25٪ دقيق ذرة أصفر + 50٪ دقيق أرز) , (25٪ دقيق كينوا + 25٪ دقيق أرز + 50٪ دقيق ذرة أصفر) , عينه كنترول (100% دقيق ذرة أصفر) , عينه كنترول 100% دقيق أرز). تم اجراء التقييم الحسي والتقديرالكيميائي والخواص الفيزيائية للكب كيك الخالى من الجلوتين. أوضحت النتائج أن الكب كيك الخالي من الجلوتين والمدعم بدقيق الكينوا إحتوى على نسبة عالية من البروتين والرماد والدهون والألياف مقارنة بعينة الكنترول (1 و2). وكانت عينات الكب كيك الخالي من الجلوتين المدعم بدقيق الكينوا مصدرًا غنيًا جيد للعناصر المعدنية (للبوتاسيوم ,الكالسيوم, الماغنسيوم, الحديد, الزنك مقارنة بعينة الكنترول(1و2)، وكانت قوالب الكب كيك الخالية من الجلوتين والمدعمة بـ 25 و 50٪ من دقيق الكينوا الأعلى كما فى درجة القابلية، كما أظهرت النتائج المتحصل عليها أنه يمكن انتاج منتجات مخابز عالية الجودة باستخدام دقيق الكينوا.

الكلمات الدالة: الكب كيك خالى الجلوتين – مرضى حساسية الجلوتين – دقيق الكينوا – دقيق الذرة الصفراء – دقيق الارز– الخواص الفيزيائية والكيميائية