The use of corn flour, chia and quinoa powders in preparing gluten-free products for celiac patients

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Abstract:

This study aims to prepare sablé biscuit and cake for celiac disease patient by replacement 10%, 20% of corn flour (CF) with quinoa (QP) and chia (ChP)powders. Results were indicated that (ChP) had recorded high percentage of protein, fiber and ash content 16.11, 9.03 and 3.42 %, respectively, than(CF)and (QP), fat content in ChP was (33.98%) more than 8 times of CF (3.97%), also data indicated that (QP) had highest content of mineral such as K, Ca, Mg, P and Zn (772, 578, 201, 563 and 7.45) respectively. The nutritional evaluations of CF, QP and ChP were investigated, ChP was recorded the highest content of energy 479.86 Kcal/100g, compared with CF and QP. The consumption of 100 g of ChP will cover 16.55 % of daily requirement of adult man in energy; while taking the same amount of CF or QP will almost cover 12 % of recommend daily allowance (RDA) of adult man in energy. Also, QP and ChP were recorded the high content of total phenol (2012.34 and 1894.35 mg GAE/100g dw, respectively), while the lower content was found in CF (271.65 mg GAE/100g, dw). Furthermore, results were appeared significantly improving the sensory characteristic of sablé biscuit and cake especially formulas (90%CF + QP 10%) and (80%CF + QP 20%). The Study recommend use pseudocereal such chia and qenua to prepare new food with high nutritional value for gluten intolerant and celiac disease

Key words: Gluten intolerance, antioxidants, antinutritional materials, sensory evaluation, composite flour.

1. Introduction

Cereals provide high amount of energy, protein and micronutrients in the human diet **(Dordevic *et al*., 2010)**. But, people with celiac disease (CD) couldn't consume cereal contains proteins defined as "gluten". CD is one of the most common lifelong disorders worldwide and courses small-intestinal villous atrophy which lead to malabsorption **(Lohi *et al*., 2007; Fasano and Catassi, 2012),** occurs in people genetically predisposed who present a constant intolerance to gluten which found in wheat and barley **(Pietzak *et al*., 2001; Dewar *et al*., 2004).** On other hand, cereals such as maize, rice and sorghum, also pseudocereals like quinoa and buckwheat didn't include gluten, so it suggested being safe for a gluten-free diet **(Demir, 2014).**

Quinoa *(Chenopodium quinoa, L.*) and Chia *(Salvia hispanica, L).* are two plants, which seeds have high concentrations of nutrients and bioactive components making them ideal effective functional grains **(Dutta *et al*., 2018).** Quinoa one of the pseudo cereal grains, native to South America (Andean regions) **(Gorinstein *et al*., 2008; Alvarez-Jubete *et al*., 2010)**. Quinoa seeds are small, round and various colors from white to red or black depending on the cultivar **(El Sohaimy *et al*., 2018).**

Quinoa seeds (QS) is considerable attention in the world in recently as an alternative crop and gluteen-free dite (GFD) in the future (**Caperuto *et al*., 2001)**. Also QS contains high quality protein with a wide amino acid such as lysine, as well as calcium and iron **(Samira *et al*., 2019)** and free from wheat gliadins protein which consider the toxic protein for celiac subjects **(Peñas *et al*., 2014)**. So that, QS considered a good source for human food products. Quinoa flour (QF) has ideal amount of the minerals such as calcium, potassium and magnesium about 127, 443and 174 mg/ Kg respectively and consider a good source of vitamins such as C, B3, B6 and B12 1.93, 0.15, 11.22 and 0.09 mg/ Kg respectively, content of total phenolic in QF 17.86 µg GAE/g, while total flavonoids was 14.82 µg/g dry weight **(El Sohaimy *et al*., 2018)**. Quinoa seeds content oil varies from 2 to 10% and it is rich in essential fatty acids **(Filho *et al*., 2015**). Also, it had high amounted of the essential unsaturated fatty acids such as (oleic, linoleic and erucic acids) **(Lamia and Mona, 2020).**

Chia seed (ChS) is belonging to *Lamiaceae* family and is one of the annual herbaceous plants, was grown in Southern Mexico and Northern Guatemala **(Ixtainaa *et al*., 2008),** also,ChS were used in nation medicines and traditional beverages **(Ayerza and Coates, 2005).** Nowadays, ChS are consided the golden seeds of the 21st century, have a great potential functional and nutritional properties for health-promoting, thus have been incorporating to food industry **(Kulczynski *et al*., 2019).** ChS are consumed as ingredients or additions to many baked products, salads, dairy drinks and fruit jucis **(Iglesias-Puig and Haros, (2013); Steffolani *et al.*, 2015).**

The European parliament have been acknowledged that ChS to be the new food source because that are packed with macro-nutrients (proteins, fibre,fats and carbohydrates), micro-nutients (vitamins and minerals) and bioactive compound such as polyphenols **(Orona-Tamayo *et al.*, 2017).** It has contain 15-24% non-gluten protein, 26-41% carbohydrates, 10% saturated fats and 30-35% fat mostly PUFAs (poly unsaturated fatty acids) **(Ullah *et al.*, 2016),** with high concentration of omega-3 fatty acids, minerals, natural antioxidants and dietary fiber (34.4g/100g) **(Giaretta *et al.*, 2017 ; Ayerza and Coates, 2011).** The defatted ChS flour had 40% total dietary fibers (TDF), lignin a main component **(Ullah *et al.*, 2016; Pizarro *et al.*, 2015).** ChS free from gluten and their protein were partition according to 9-14.5% glutelins, 52% globulins, 17.3% albumins and 12.7% prolamins, which can be digested by CD patients **(Sandoval-Oliveros and Paredes-Lopez, 2013).**

This work aims to suggest using pseudocereal such chia and qenua to prepare new GFD with interesting nutritional value and organoleptic like biscuit and cake due to the current demand of products especially designed for gluten intolerant and CD patients.

Also chemical, nutritional and organoleptic evaluation of the final product.

2. Materials and Methods

2.1. Materials

Corn Flour, chia, quinoa seeds and the rest ingredients were obtained from El- Raia hypermarket, Minia City, Minia Governorate, Egypt.

2.1.1. Reagents and chemicals

Phenolic standards were from Sigmae-Aldrich Chemical Co agent, Egypt. And all other chemicals and solvents were of analytical Grade and purchased from AlGomhoria Co., Cairo, Egypt.

2.2.Methods

2.2.1.Preparation of chia and quinoa powders

The chia and quinoa seeds were ground in mill (Toshiba ElAraby, Benha, Egypt) to pass through 60 mesh sieve (250 micron) filled in glass kilner jars and stored at 4°C until analysis and preparation the products.

2.2.2.Preparation of sablé biscuit

The recipe adopted for sablé biscuit preparation followed the process proposed by **Neveen and Amira, (2018)** with slight modifications as demonstrated in table (1). First butter and suger were mixed to obtain a creamy mixture. The rest of the ingredients were then added to form the dough, rolled out with a rolling pin to a uniform thickness of 0.6 cm and cut small heart, then baked in Ariston oven at 200 ◦C for 10 min. The biscuit were subsequently cooled used for sensory evaluation.

Table (1): **Formulation of Sablé biscuit**

Ingredients (g)	CF	Ch P	QP	Egg	Butter	Sugar	Salt	Vanilla
C F 100%	100	—	—	10	50	25	2	2
C F 90% + Q P 10%	90	—	10	10	50	25	2	2
C F 80% + QP 20%	80	—	20	10	50	25	2	2
C F 90% + Ch p 10%	90	10	—	10	50	25	2	2
C F 80% + Ch P20%	80	20	—	10	50	25	2	2

2.2.3. Preparation of cake

Cake was prepared according to **Pathan *et al.*, (2019)** with some modifications in the method will clarified in table (2). First mixed butter with sugar until becomes creamy, then adds eggs, vanilla and milk to the previous mixture, sieving dry material and adds them to the previous mixture, then placed mixture in cake mold and baked in Ariston oven at 170° C for 45 minutes.

Table (2): Formulation of cake

Ingredients (g)	CF	Ch P	QP	Egg	Butter	Milk	Sugar	Baking powder	Vanilla
CF 100%	100	—	—	150	65	65	70	5	4
CF 90% + Q P 10%	90	—	10	150	65 g	65	70	5	4
CF 80% + QP 20%	80	—	20	150	65 g	65	70	5	4
CF 90% + Ch p 10%	90	10	—	150	65 g	65	70	5	4
CF 80% +Ch P20%	80	20	—	150	65 g	65	70	5	4

2.2.4. Proximate chemical composition

Moisture, fiber, ash, fat and protein contents were determined according to **AOAC, (2005)**. Carbohydrate content was calculated by the following equation:

Carbohydrate (%) = 100 – (Fat + Moisture + Fiber + Ash + Protein)

The energy content estimated using the following equation:

Energy value (kcal /100 g) = (4 {protein % + carbohydrate%} + 9{fat%})

2.2.4.1. Determination content of total flavonoids, total phenolics and antioxidant activity

Total flavonoids content for CF, ChP and QP extracts was determined according to **Zhishen *et al.*, (1999)** method. The reagent Folin-Ciocalteu was used to find the total phenolics (**Singleton and Rossi, 1965)**. The antioxidant activity of the examined flour / powders extracts and standards (α-tocopherol, 50 mg/mL) were calculated following the procedure defined by **Marco, (1968)**.

2.2.4.2. Minerals Content

Phosphorus content (g/100g dry weight) was determined calorimetrically according to the method of **Jackson, (1958).** Magnesium, calcium, zinc and iron were determined by using Atomic Absorption Spectrophotometer, Pyeunican SP1900, according to **Brandifeld and Spincer, (1965)**.

2.2.5. Evaluation of sensory properties of sablé biscuit and cake

Sensory evaluation was conducted out with 20 panel tests at Home Economics Department, Faculty of Specific Education, Minia University. Prior to testing, the products were coded with a number and each panel tests received 5 sablé biscuit samples and cake in a sealed pouch coded with different numbers. All panelists were evaluating taste, odor, colour, texture and overall acceptance to the products using the scores scale 1-10.

2.2.6. Ethical approval

All experiments for this study especially the sensory evaluation ones were ethically approved by Ethics Committee the Scientific Research and intellectual property rights Faculty of Specific Education, Minia University, Minia, Egypt.

2.2.7. Statistical analyses

Data were analyzed with GLM (General le\Linear Model) program using statistical analysis system (**SAS, 2003**). Mean values were compared by Duncan's Multiple Test.

3. Result and Discussion

3.1.Chemical analyses and nutritional evaluation of corn flour and selected powders samples (quinoa and chia)

The proximate analysis and minerals content of corn flour, (quinoa and chia) powders are showed in table (3). Data indicated that chia powder had high percentage of protein, fiber, and ash content (16.11, 9.03 and 3.42 %respectively) than corn flour and quinoa powder. This data in accordance with that approved by **Carrillo e*t al*., (2018)** mentioned that protein content value in chia seeds was 19.78% and reported that the pervious studies found the content of protein in chia seeds ranged between 15–25%

As regard from result fat content for Ch P was (33.98%) more than 8 times of CF (3.97%). on other hand, Ch P contains relatively minor carbohydrate (27.40%) compare with corn flour (71.44%). Also results showed that moisture content varied from (12.44, 11.45 and 10.06 %) for QP, CF and Ch P respectively.

Also Data indicated that (QP) had highest content of mineral such as K, Ca, Mg, P and Zn (772, 578, 201, 563 and 7.45) respectively. **Abugoch, (2009)** indicated that quinoa had a high nutritive value for carbohydrate, protein and fiber (58.3, 13.5, and 9.5%) respectively, which agree with our result.

Table (3): Chemical composition and minerals content of corn flour and (quinoa & chia) powders

Parameters	CF	QP	ChP
Chemical composition ($g.100g^{-1}$):			
Moisture	11.45 ±0.88^{ab}	12.44 ±0.76^{a}	10.06 ±0.88^{b}
Total protein	9.03 ± 1.22^{c}	13.95 ± 0.35^{b}	16.11 ±0.47^{a}
fat	3.97± 0.77^{c}	7.48 ±0.11^{b}	33.98 ±0.14^{a}
fiber	2.94 ± 0.86^{c}	5.02 ±1.01^{b}	9.03 ±0.96^{a}
Ash	1.17 ±0.45^{c}	2.59 ± 0.43^{b}	3.42 ±0.32^{a}
Carbohydrates	71.44 ± 4.33^{a}	58.52 ± 3.45^{b}	27.40 ±1.05^{c}
Minerals content ($mg.100g^{-1}$):			
K	59 ±1.25^{c}	772 ± 11.3^{a}	202 ± 7.64^{b}
Na	55 ±2.5^{a}	49 ± 1.72^{b}	19 ±0.45^{c}
Ca	14 ±0.75^{b}	578 ±12.45^{a}	20.03 ±2.05^{b}
Mg	152 ±1.03^{c}	201 ± 3.77^{a}	165 ±1.03^{b}
P	68 ±0.75^{c}	563 ±17.53^{a}	321 ±11.34^{b}
Fe	2.67 ±0.32^{c}	5.12 ±0.57^{a}	3.87 ±0.43^{b}
Zn	3.87 ±0.02^{b}	7.45 ±0.98^{a}	2.76 ±0.12^{b}

Each value represents the mean of three replicates ±SD. Mean values with the different letters in the same column mean significantly different at $p \leq 0.05$.

Table (4): Nutritional evaluation of CF and selected powders samples (quinoa and chia)

RDA (1989)	Chemical composition (g/100g)	CF	QP	ChP
2900 Kcal	Energy (Kcal/100g)	357.61	357.20	479.86
	*G.D.R. (g)	810.94	811.87	604.34
	**P.S./100 g	12.33	12.31	16.55
63 g	Total protein	9.03	13.95	16.11
	G.D.R. (g)	697.67	451.61	391.06
	P.S./ 100 g	14.33	22.14	25.57
	Dry matter (%)	88.55	87.56	89.94

* G.D.R. (g): Grams consumed to cover the recommended daily allowance of adult man according to RDA (1989)

** P.S. /100 (%): Percent satisfaction of RDA of adult man when consuming 100g of corn flour, chia and quinoa powders.

The nutritional evaluation of corn flour and quinoa and chia powders were investigated in table (4). Chia powder was recorded the highest content of energy and protein (479.86 Kcal/100 g and 16.11g) compared with CF and QP.
The data in the same table accordance with that approved by **Abdellatif, (2018**) reported that quinoa contains 358.63 ± 0.12 of energy (Kcal/100g) and 14.73 ± 0.31 of crude protein, which resembles our results (357.20 Kcal/100g and 13.95 g) for energy and protein respectively.

From results above in table (4) it noticed that grams daily required of energy to obtains RDA varied from 604.34 gm Ch P to 810.94gm CF. The consumption of 100 gm of Ch P will cover (16.55, 25.57 %) respectively of daily requirement of adult man in energy and protein according to RDA, (1989), while taking the same amount of CF and QP will almost cover less than 10% of RDA of adult man in energy. Our results agree with **Alamri, (2020)** who reported that protein content in each 100 gm of chia seed was around 17 gm that equeal to nearly 30% of the recommended daily allowance for adults.

3.2.Chemical composition, minerals content and nutritional evaluation of CF and mixed with QP and ChP

There is challenge between food researchers to produce high-quality GF products for people with celiac disease useing cereals such sorghum, millet or buckwheat, quinoa and amaranth **(Schoenlechner *et al*., 2010)**. Our results proved that replacement for corn flours with other cereals powders like quinoa and chia led to boost the nutritional value of protein, fat, dietary fiber and minerals like calcium, iron and zinc. As regard from table (5) the substitution of CF with 20% QP led to increase protein, fat and fiber (from 9.03to 10.01%) and (3.97 to 4.71) and (from 2.94 to 3.41 %) respectively. This is due to that quinoa flour is rich in protein, fat and fiber content **(Abugoch *et al*., 2009)**.

Also, Table (5) presents the results of the chemical composition for the CF and blend with QP and ChP by different levels, mix led to increase the amount of the mineral such as Ca, K, Mg, P and Fe compare with CF. P was the predominant element followed by Mg and K. This result confirmed that 20 % QP and ChP can be included in food formulations as P resource. Blend CF with 20 % QP had highst content of K, Ca and P (199.98, 130.78 and 167 mg/kg respectively) compare with 20 % ChP was (90.05,15.78 and 120.86 mg/kg respectively).QF has ideal amount of the minerals such as calcium, potassium and magnesium about 127, 443 and 174 mg/ Kg respectively **(El Sohaimy *et al.*, 2018).**

Table (5): Chemical composition and minerals content of CF and composite with (QP& ChP)

Parameters	CF 100%	QP		ChP	
		10 %	20%	10 %	20%
Chemical composition ($g.100g^{-1}$):					
Moisture	11.45±1.03	11.61±2. 1	11.65±3.02	11.34±1.39	11.29±2.14
Total protein	9.03±0.89	9.53±1.11	10.01±1.09	9.71±1.17	10.45±2. 57
Fat	3.97±0.54	4.36±1.02	4.71±0.37	6.68±0.79	10.01±2.1
Fiber	2.94±0.24	3.17±1.11	3.41±1.00	3.55±0.23	4.16±0.15
Ash	1.17±0.3	1.35±0.14	1.53±.27	1.44±0.32	1.62±0.17
Carbohydrates	71.44±3.71	69.98±2.69	68. 69±4.11	67.28±3.98	62.48±4.13
Minerals content ($mg.100g^{-1}$):					
K	59±11	141.56±3.2	199.98±4.99	72.56±5.17	90.05±8.22
Na	55±5.17	55.60±6.42	53.80±17.31	52.00±10.15	47.80±4.93
Ca	14±2.15	70.40±4.21	130.78±9.17	14.60±2.11	15.78±1.98
Mg	152±11.14	155.90±21.12	161.80±20.17	152.93±9.77	154.60±6.15
P	68±3.14	117.50±11.91	167.00±7.12	93.30±11.21	120.86±20.03
Fe	2.67±0.32	2.92±0.11	3.21±0.67	2.79±0.52	2.91±0.73
Zn	0.41±0.11	1.11±0.21	1.84±0.17	0.65±0.10	0.91±0.21

Each value represents the mean of three replicates ±SD

Recommended daily allowances for energy represent the average needs of individuals from calories, if energy intake is consistently below or above a person's requirement, changes in body composition or body weight will occur and may adversely affect health **(NRC, 1989)**.

Table (6): Nutritional evaluation of CF and mixture with QP and ChP

RDA (1989)	Chemical composition (g/100g)	CF	Q p		Ch P	
			10%	20%	10%	20%
2900 Kcal	Energy (Kcal/100g)	357.61	357.28	357.21	368.08	381.78
	*G.D.R. (g)	810.94	811.69	811.84	787.86	759.60
	**P.S./ 100 g	12.33	12.32	12.32	12.69	13.16
63 g	Total protein	9.03	9.53	10.01	9.71	10.45
	G.D.R. (g)	697.67	661.07	629.37	648.82	603.10
	P.S./ 100 g	14.33	15.13	15.89	15.41	16.58
	Dry matter (%)	88.55	88.39	88.35	88.66	88.71

* G.D.R. (g): Grams consumed to cover the recommended daily allowance of adult man according to RDA (1989)
** P.S. /100 (%): Percent satisfaction of RDA of adult man when consuming 100 g of corn flour, chia and quinoa powders.

The results in table (6) reported that consumption 100 g of gluten-free flour which prepared by partial replacement of corn flour by QP and Ch P will cover average about (12.32% and 12.92 %) respectively of daily requirement for adult man from energy according to recommended dietary allowances (**NRC, 1989).**

Higher protein intakes help prevent loss of muscle mass, maximize athletic performance, improve satiety and may therefore serve as a successful strategy to help prevent obesity **(Phillips *et al*., 2016).** Most diets of people with celiac disease are unbalanced, rich in carbohydrates and lack other macromolecules and essential nutrients needed for a normal metabolism **Jnawali *et al*., (2016**), so our results suggested using flour (10 %, 20% QP and Ch P) at making gluten-free products that can provide children and adult with necessary protein and energy.

3.3.Bioactive compounds of CF, QP and ChP.

The total phenolics, flavonoids and antioxidant, also antinutritional materials (tannins, saponins and phytates) of CF, QP and ChP are shown in Table (7). The results appeared that high content of total phenol found in quinoa powder which record (2012.34 mg GAE/100g, d.b.), whereas the lower content was found in CF (271.65 mg GAE/100g, d.b.). Data in the same line with **Lin *et al*., (2019)** mentioned that quinoa had large number phenolic acid, flavonoids, terpenoids and steroids which play variouse cological and physiological roles against harmful microorganisms.

Antioxidant activity of quinoa and chia powders was almost equal and in the same time higher about twice than corn flour (89.55, 87.19 and 37.18%) respectively. Quinoa has the highest content of bioactive compounds and rich in antioxidants (polyphenols) compared with other cereals **(Hirose *et al.*, 2010).** Also chia seeds are a promising source of natural antioxidants such as chlorogenic, caffeic acids, quercetin and kaempferol **(Mohammed *et al.*, 2019).**

Table (7): Antioxidant and antinutritional compounds as well as antioxidant activity (AA) of CF, QP and Ch P

Compound	C F	QP	ChP
Antioxidant:			
Total phenolics (mg GAE/100g, d.b.)	271.65± 11.56[c]	2012.34 ± 20.63[a]	1894.35 ±17.98[b]
Flavonoids (mg RE/100g, d.b.)	23.81±2.76[c]	987.12±11.45[a]	714.22± 8.54[b]
Antinutritional :			
Saponins (mg GAE/100g, d.b.)	7.24 ±1.1[c]	398.19 ±11.3[a]	302.78 ±12.23[b]
Phytates (mg GAE/100g, d.b.)	489.89 ±7.55[a]	102.40 ±3.56[c]	114.53 ±5.20[b]
Tannins (mg VE/100g, d.b.)	24.16 ±1.26[c]	173.11 ±6.33[b]	189.23 ±3.52[a]
Trypsin inhibitory activity ((TU/mg, d.b.)	3.67 ±0.79	2.59 ±0.44	3.11 ±0.56
Antioxidant activity:			
AA (%), (α-tocopherol, 50 mg/mL)	37.18± 4.78[b]	89.55± 4.08[a]	87.19 ± 2.67[a]

Each value represents the mean of three replicates ±SD. Mean values with the different letters in the same column mean significantly different at $p \leq 0.05$

Anti-nutritional factors such saponins, tannins, and phytic acid is molecules which exert effects contrary to optimal nutrition, reacted with nutrients and effecting of their absorption (**Melini and Melini, 2021).** The result in table(7)shows that the highest proportion of saponins was found in quinoa powder (398.19mg GAE/100g, d.b.) , while the highest tannins were in chia (189.23 mg VE/100g, d.b.).

3.4. Sensory evaluation

3.4.1.Sensory evaluation of Sablé biscuit

The successful sensory evaluation in food products is achieve by linking sensory properties to chemical, nutrients properties and formulation which enables manufacturing food products with maximum consumer acceptance (**Sharif *et al.*, 2017).** In Table (8), samples made with QP and ChP were present significant differences than the control sample in sensory assessments. The sensory panelists reported that the sensory properties of the control sample showed as pleasant odor and fine-powdery texture. However, sablé biscuit samples prepared with QP and ChP treatment were fine-powdery texture close to control sample, pleasant odor, favorite color and taste.

Color is an important attribute of food choice and acceptance,for the value of color, sample prepared by QP (10 and 20%) had the highest color value (9.80) compared with samples prepared by ChP (10 and 20%) which had less score in terms of color (8.60 and 8.30) respectively, that is were significantly different from controls (9.75).

Table (8): Sensory evaluation (degree) of sablé biscuit samples

Sensory properties / Samples	Color	Texture	Odor	Taste	Overall acceptability
100% CF	9.75 ± 0.43^{a}	9.70 ± 0.56^{a}	9.75 ± 0.43^{a}	9.05 ± 0.8^{a}	9.03 ± 0.75^{a}
90% CF + 10 QP	9.80 ± 0.40^{a}	9.55 ± 0.59^{a}	9.45 ± 0.80^{a}	9.10 ± 0.98^{a}	9.13 ± 0.77^{a}
80% CF + 20 QP	9.80 ± 0.40^{a}	9.65 ± 0.48^{a}	9.50 ± 0.59^{a}	9.15 ± 0.96^{a}	9.05 ± 0.86^{a}
90% CF + 10 ChP	8.60 ± 0.58^{b}	8.90 ± 0.83^{b}	8.90 ± 0.62^{b}	8.25 ± 0.99^{b}	8.35 ± 0.63^{b}
80% CF + 20 ChP	8.30 ± 0.78^{b}	8.50 ± 0.87^{b}	8.50 ± 0.92^{b}	8.0 ± 1.09^{b}	7.95 ± 0.97^{c}

Each value represents the mean of twenty replicates ±SD. Mean values with the different letters in the same column mean significantly different at $p \leq 0.05$.

Picture 1. Photo of Sablé

Taste is a major parameter when evaluating the sensory properties of food products **Muhimbula** et al., (2011). The product might be attractive without good taste, so this product is potentially to be unacceptable. For the value of taste, there was a significant difference between the samples prepared with QP and ChP ($p\leq 0.05$). The samples QP (10 and 20%) had the highest value of (9.10 and 9.15) respectively, while sample (ChP) had the lowest value of taste (8.00). The samples with QP were more perfect than the samples with CF and ChP, also was found that increased levels of QP in sablé biscuit from10% to 20% increased score of taste. Results are agree with **Neveen and Amira, (2018)** who found that sablé made with 20 % quinoa flour have the highest score of sensory evaluations of appearance, taste, odor and overall acceptability.

3.4.2 Sensory evaluation of cake

Incorporated quinoa with wheat flour for bakery production as cake and biscuits led to enhance the nutritious, health benefits and increasing the sensory propeties as taste, aroma, texture and acceptability of the baked products **Atef *et al.*, (2015) and Ballester-S´anchez *et al.*, *(*2019)**. Functional cake which made by incorporating ChS with flour can provide a good supplement to a daily diet for children because cake enhanced the nutritional value with minerals, fat and protien **Dina *et al.*, (2020)**.

In table (9), samples with QP and ChP were present significant differences than control sample in sensory assessments, where control sample showed pleasant odor and fine-powdery texture. Also, data present that increased in levels of QP in cake formula led to increase in all sensory scores of cakes compared to both of control and ChP samples. On other hand the increase in levels of ChP in cake formula decreased the color score to (8.40) in product formula (80% CF + 20% ChP), also cake with ChP have high dark color than control sample, that is may be due to the high content of carotenoids in chia seeds **De Falco *et al.*, (2017).** In terms of taste values, there were a significant difference between samples prepared with QP and ChP ($p\leq 0.05$). The samples QP (10 and 20%) had the highest value (9.15 and 9.3) respectively, where sample (20% ChP) had the lower value of taste (8.25). Samples with QP were more perfect than samples with CF and ChP. Also, results found that increased of QP in the cake formula from10% to 20% increased the overall acceptability, and have the highest score of sensory evaluations (appearance, taste, odor and overall acceptability. Results are agree with **Aly and Sadeek (2018)** who found that cake made with 20 % quinoa flour have the high score of sensory evaluations of appearance, taste, odor and overall acceptability.

Table (9): Sensory evaluation (degree) of cake samples

Sensory properties / Samples	Color	Texture	Odor	Taste	Overall acceptability
100% CF	9.75 ± 0.44[a]	9.55 ±0.69 [a]	9.60 ±0.50 [a]	8.80 ±0.98 [b]	8.73±0.86 [ab]
90% CF + 10 QP	9.75 ± 0.44 [a]	9.40 ±0.73 [ab]	9.25 ±1.04 [ab]	9.15 ±0.85[ab]	9.18 ±0.86 [a]
80% CF + 20 QP	9.80 ± 0.40 [a]	9.60 ± 0.49 [a]	9.55 ± 0.50 [a]	9.3±0.7 [a]	9.2±0.68 [a]
90% CF + 10 ChP	8.45 ± 0.50 [b]	8.90 ±0.94 [b]	9.05 ±0.38 [b]	8.55 ±0.92[bc]	8.38± 0.57 [b]
80% CF + 20 ChP	8.40 ±0.67 [b]	8.50± 0.97 [c]	8.5± 0.92[c]	8.25 ±1.34[C]	8.10 ±0.99[C]

Each value represents the mean of twenty replicates ±SD. Mean values with the different letters in the same column mean significantly different at $p \leq 0.05$.

Picture 2. Photo of cake

4.Conclusion

Incorporation of chia and quinoa powders is beneficial for sablé biscuit and cake production because of the higher nutritional values and antioxidant compounds of these seeds. By considering all properties of the sablé biscuit and cake samples, it could be concluded that replacement of corn flour with quinoa powder increased the over excebility of all products formula. These study have shown the potential of developing free-gluten flour from corn, quinoa and chia powders and used it in biscuits and cake for celiac patient .

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استخدام دقيق الذرة ومساحيق الشيا والكينوا في تحضير منتجات خالية من الجلوتين لمرضى السلياك

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المستخلص

تهدف هذه الدراسة إلى تحضير البسكويت والكيك لمرضى الاضطرابات الهضمية باستبدال 10 و 20% من دقيق الذرة بمساحيق الكينوا والشيا. أوضحت النتائج أعلى محتوى للبروتين والألياف والرماد في مسحوق الشيا مقارنة بدقيق الذره ومسحوق الكينوا(16.11 ، 9.03 ، 3.42 %) على التوالي، ومحتوى مسحوق الشيا من الدهون (33.9%) أكثر بـــ 8 مرات من محتوى دقيق الذرة (3.97 %) كما أشارت البيانات إلى أن مسحوق الكينوه يحتوي على نسبة عالية من معادن البوتاسيوم والكالسيوم والماغنسيوم والفسفور والزنك (772 ، 578 ، 201 ، 563 ، 7.45) على التوالي. تم التقييم التغذوي لكلا من دقيق الذره ، مسحوق الشيا والكينوا حيث تم تسجيل أعلى محتوى من الطاقة لمسحوق الشيا (479.86 سعر حرارى / 100 جم) مقارنة بدقيق الذرة ومسحوق الكينوا، وان استهلاك 100 جم من مسحوق الشيا سيغطي حوالي (16.55 %) من الاحتياجات اليومية للرجل البالغ من الطاقة وفقًا للتوصيات اليومية RDAاحتياجات الراجل البالغ ، في حين أن أخذ نفس الكمية من دقيق الذرة ومسحوق الكينوا سيغطي 12% تقريبًا . وتم تسجيل أعلى محتوى للفينول الكلي في كلا من مسحوق الكينوا والشيا (2012.34 & 1894.35) مجم 100 / GAE جم على التوالي ، بينما وجد أقل محتوى في دقيق الذرة 271.65 مجم 100 / GAE جم. كما أظهرت النتائج تحسنًا ملحوظًا في الخصائص الحسية لبسكويت السابلية والكيك خاصة التركيبة (90% ذره + 10% كينوه)& (80% ذره + 20% كينوه). وتوصى الدراسة باستخدام الحبوب الشيا والكينوه والذره لإعداد اغذية جديد ذات قيمة غذائية عالية لمرض السلياك وحساسية الجلوتين.

الكلمات المفتاحية: عدم تحمل الجلوتين ، مضادات الأكسدة ، مضادات التغذية ، التقييم الحسي ، الدقيق المركب