J. Food and Dairy Sci., Mansoura Univ., Vol. 9 (7): 221 - 227 , 2018

Utilization of Quinoa Seeds to Produce Gluten-Free Pan Bread

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ABSTRACT

The effect of replacing rice flour with quinoa seeds (*Chenopodium quinoa)* flour on the proximate chemical composition, physical properties and sensory evaluation of free gluten pan bread were investigated. Baking trials were conducted at different levels of substitution (25, 50, 75 and 100% quinoa seeds flour). Results indicated that moisture, crude protein, lipids, ash and dietary fiber content were increased in substituted levels of quinoa seeds . While, total carbohydrates decreased by increasing in quinoa levels. Also, gluten-free pan bread samples prepared from rice flour(RF) and 25% quinoa flour (QF) proved to be of lower content in macro mineral (K, Ca, Mg, Na & P) and micro mineral (Fe, Mn & Zn) content ,while(G.F.P) bread samples prepared from 100% quinoa flour(qf) recorded high contents of all mineral under investigation. Weight (g) gradually increased infree gluten (G.F.P) bread samples parallel to the increase in substitution levels by quinoa flour(QF). On the other hand, volume and specific volume (cm^3/g) of free gluten pan bread gradually decreasing by increasing levels of quinoa flour(QF). Organoleptic properties indicated that there were no significant differences*($P < 0.05$)* between control gluten-free pan bread sample (RF) and test sample containing QF at 25% level in most sensory characteristics with the exception of the color of crust and crumb in this sample which was significantly reduced *($P<0.05$)* when compared with control bread(RF). Also, there were non-significant differences in bread samples containing 50% quinoa flour(RF) with other samples, softnes,crumb structure and over all acceptability . On the other hand, the gluten-free pan bread samples containing 75 and 100% QF were significantly differences *($P<0.05$)* in all sensory properties and had less judging scores as compared to the control pan bread(RF) and the other pan bread sample containing 25% and 50%QF, except gluten free pan bread samples containing 50% showed non significant difference with samplas containing in crumb color and taste properties.

Keywords: Free Gluten, Rice Flour, quinoa Flour, Pan Bread and Sensory Evaluation. Celiac Disease.

INTRODUCTION

Celiac disease results in damage to the small intestine and five persons out of thousand has been suffering from this disease and other studies have indicated that the majority of this disease is 1 in 100 all over the world (Castassi and Fasano). 2008Since 1950, there has been no renewal in the examination of pathogenic pathogens because of improvements in the gluten sensitivity test, increasing the number of people with gluten sensitivity by increasing people's awareness of the disease. (Alvarez-Jubete *et al*., 20o9)

Eating foods containing gluten, for example in wheat, for people with gluten allergy causes damage to the small intestine (Alvarez-Jubete *et al*., 2010). the only solution to get rid of This chronic disease is adherence stickiness to gluten-free products. But this is very hard as many products contain gluten (*Motrena et al., 2011*). the reaction to gliadin in wheat prolamin and high molecular glutenin are the main causes of Celia disease subunits of gluten protein results in inflammation and damage to the small intestine and causes malnutrition (Demirkesen *et al*., 2010).

The main food for many countries is rice, it comes after wheat and providing 21% of the food energy needed in the world. It is known as king among cereal after wheat. Rice is characterized by low sodium, high digestible carbohydrate contents , insipid taste, low prolamin and hypoallergenic activity, which is suitable to be incorporated into celiac disease diets (Phimolsiripol *et al*., 2012).

Quinoa (*Chenopodium quinoa* Willd.) is a pseudograin native to South America. It has high content of good-quality protein and, its contain amino acid look like that of casein, are high compared to those of true cereals. Quinoa is organic seeds and is not allergenic because of free of gluten (Berti *et al.* 2004)

Quinoa seeds are avery nutritive cereal when compared to well- known cereals such as corn,wheat and barley. It has a relatively high content of good-quality protein and it is a good source of bioactive compounds like phenolic compound and dietary fiber (Repo-Carrasco and Serna, 2011).

Bread is a main diet that is consumed every day and its quality and sensory evaluation are highly interested by consumers. But the quality of the gluten-free pan bread may be different than heat bread because of the absence of gluten (Motrena *et al.,* 2011).

Elgeti *et al.* (2014) reported that quinoa seeds flour was used to replace 40-100% of the rice flour in a gluten-free control recipe, they showed that, quinoa flour improved the color of crumb and crust. Thus, (G.F.P) bread with quinoa flour had more resemblance to traditional tin loaf.

So,the aim of this investigation was to preparation (G.F.P.bread) by utilization of quinoa seed flour with other cereal grains like ric to nourish gluten sensitive patients

MATERIALS AND METHODS

Materials

Quinoa seeds were obtained,Egyption company for natural oil naser city Egypt,Rice flour was obtained from Sky Live Co. for Food Industry, Giza, Egypt.other ingredients such as Instant active dry yeast (*Saccharomyces cerevisiae*), was imported by AKMAYA Co., Turkey was obtained from local market at Mansoura city,Egypt.,.corn oil, fresh hen eggs and sugar (sucrose), salt and Xanthan gum were obtained from local market at Mansoura city,Egypt.

All chemicals analytical grade were purchased from sigma company for medical materials, Gaza, Egypt

Methods

Preparation of quinoa seeds flour

Quinoa seeds were cleaned by removing foreign matters, then washed by cold water several times to remove possible saponin residues and conditioned at 16% moisture in order to improve the separation of the botanical seeds tissues (endosperm from pericarp). Seeds were then milled by protein laboratory mill 3100 to whole quinoa meal. The whole quinoa meal was then sieved through a 50-mesh screen, then packaged in plastic bags and stored at 7˚C until used.

Preparation of gluten free pan (G.F.P)bread blends

Different composite flour samples were prepared by partially substituting of quinoa flour by different ratios of rice to prepare different blend samples which used in preparation of gluten free pan bread samples as presented in the following table. Table (1): Ingredients used in production of gluten-free bread

Table 1. Percents of ingredients used in production of gluten-free (GF) bread.

Ingredients	%
RF, CF or its blends*	55.98
Xanthan Gum	0.60
Sugar	2.41
Salt (sod. chloride)	1.44
active dry yeast	1.33
Fresh Egg	5.42
Vegetable Oil	6.75
Water	As Required
	100

*** RF: Rice flour, CF: Corn flour.**

Chemical analysis

Moisture, crude protein, ash, crude fiber and lipids were determined according to the method described in A.O.A.C (2000).Total carbohydrates were calculated by difference from the sum of the protein, fat, ash and crude fibers content.Mineral contents were determined by wet acid-digested, using nitric acids mixture ($HNO3$: $HClO4$, 5:1 w/v) ccording to the method described by Chapman and Pratt (1978). Then the total amounts of K, Ca, Mg, Na, P, Fe, Mn and Zn in the digested sampleswere determined by atomic absorption spectrophotometry.(PEKMAN)

Rheological measurement of dough samples

The Rheological measurement of dough samples were performed by Mixolab (Chopin, Tripetteet Renaud, Paris, France) according to A.A.C.C. (2010) standard.

Preparation of gluten-free pan bread(G.F.P.bread)

All samples were prepared according to method of (Barbone, 2012). And (Zannini *et al.,* 2012).

Physical properties

The weight of gluten free pan bread loaves was determined after cooling for one hour. gluten free pan bread loaves volume was measured by rape seed displacement method as described by A.A.C.C. (2000).(G.F.pan bread Specific volume of bread was calculated by dividing volume of the loaves (cm^3) by their weights (g).

Determination of alkaline water retention capacity (AWRC %)

The staling rate of gluten-free pan bread samples were determined by alkaline water retention capacity as described by Kitterman and Rubanthaler (1971).

Sensory evaluation

Samples of preparation glutin free pan bread were organoleptically evaluated for appearance, color (crumb and crust), taste, odor, softness, crumb structure and overall acceptability according to the methods described by Lazaridou *et al*. (2007).

Statistical Analysis

The results were analyzed by method as described by Snedecor and Cochran (1989). Means were separated using Duncan test at a degree of significant *($P \leq 0.05$)*.

RESULTS AND DISCUSSION

Proximate chemical composition of Gluten-free pan bread:

Data presented in Table (2) indicate that substitution of gluten-free pan bread prepared from rice flour (control) or rice flour substituted by increasing levels of quinoa flour resulted in parallel increases of moisture content (from 30.28% at quinoa flour sample to 38.37% at 100% QF sample). In this concern, crude protein content increases from 9.85% at 25% QF to 16.80% at 100%QF as compared with (7.62%) in control RF sample. These increases in crude protein content were compensated by decreases in carbohydrate content. This behavior is due to the fact that quinoa flour is rich in protein content. Also, Data recorded that increasing in lipid content by increasing in replacement percent of quinoa flour (from 5.34% at control RFsample to 8.72% at 100%QFsample). Concerning, As shown in Table (2), there were a noticeable increase in ash and crude fiber content in all(G.F.P) bread samples with increasing of quinoa flour levels from 25% to 100% in flour blends used for (G.F.P) bread preparing . On the other hand, total carbohydrates were decreased progressively when the quinoa flour ratios increased in all(G.F.P) bread samples which were decreased from 80.85% to 65.39 % in substituted samples by quinoa flour as compared to 85.91% for control (RF) sample. These results are approximately similar to those obtained by Alvarez-Jubete *et al.* (2009), Föste *et al.* (2014) and, Kahlon and Chiu (2015) who found that the replacement of rice flour with quinoa flour resulted in increase the protein and fat content of gluten-free bread and also

Table 2. Proximate chemical composition of preparation gluten-free pan bread with or without substitution rice flour with quinoa flour (% on dry weight basis).

Constituents (%) Bread Samples	Moisture	Crude protein	Lipids	Ash	Dietary fiber			Total carbohydrates
					total	soluble	Insoluble	
Control (RF)	30.28	7.62	5.34	0.65	0.76	0.24	0.52	85.91
75%RF+25%QF	32.15	9.85	6.25	1.72	2.81	0.56	2.25	80.85
50%RF+50%QF	34.72	12.10	7.06	2.44	5.64	1.03	4.61	75.84
25%RF+75%QF	36.41	14.46	7.981	3.85	8.35	1.47	6.88	70.10
100% QF	38.37	16.80	8.72	4.86	10.42	1.85	8.57	65.39

(RF)Rice flour (QF)quinoa flour

Caperuto *et al.* (2001); Rosell *et al*. (2001) and Calderelli *et al*. (2010) indicated that substitution of ban-bread flour by quinoa flour resulted in improvement of its nutritional value as chemical composition of gluten-free bread except the decreasing in the total carbohydrate content.

Minerals content of preparation Gluten-free pan bread

The minerals content of gluten-free pan bread samples prepared from rice flour (control sample) as compared to samples prepared from substituted rice flour with different levels (25, 50, 75 and 100% of quinoa flour) are presented in Table (3). From the obtained results, it could be observed that control (RF)samples proved to be of lower content in all minerals under investigation such as K, Ca,mg, Na, P, Fe, Mn and Zn which found to be as 127.34, 92.58, 97.60, 1240.25, 137.47, 1.08, 0.82 and 0.68 mg/100g; respectively. While, 100%(QF)sample recorded high contents of Mg (285.72 mg/100g), Ca (205.32 mg/100g), P (412.50 mg/100g), K (867.90 mg/100g), Fe (8.86 mg/100g), Mn (2.87 mg/100g) and Zn (4.96 mg/100g). These results prove to the high mineral content of quinoa flour when compared with rice flour (Nascimento *et al.*, 2014).The present results are in accordance with those previously recorded by many investigators; including Lilian and James (2009), Vitali, *et al.* (2010) and Valcárcel-Yamani and da Silva Lannes (2012).

Table 3. Minerals content of preparation gluten-free pan bread with or without substitution rice flour with quinoa flour (mg/100g on dry weight basis):-

Constituents	Macro elements (mg/100g)					Micro elements (mg/100g)		
Bread Samples	K	Ca	Mg	Na	P	Fe	Mn	Zn
Control (RF)	127.34	92.58	97.60	1240.25	137.47	1.08	0.82	0.68
75%RF+25%QF	312.68	126.36	142.43	1286.72	204.62	2.85	1.29	1.75
50%RF+50%QF	502.49	168.29	186.19	1324.34	268.29	4.62	1.74	2.82
25%RF+75%QF	683.26	182.77	235.80	1365.00	357.43	6.90	2.30	3.59
100% QF	867.90	205.32	285.72	1428.58	412.50	8.86	2.87	4.96

(G.F.Pbread)gluten free pan bread

Mixolab properties of dough behavior of rice flour and its blends with different levels of quinoa flour

The rheological properties of dough samples prepared by using rice substituted by 25, 50, 75 and 100% of (QF) were evaluated by Mixolab apparatus. From Table(4)it could be seen The following estimates demonstrate the amount of water absorbed by the dough to produce torque of (1.1), dough development time (min)or the time to reach the maximum torque at (30c) , dough stability (min)or time until the loss of consistency is lower than 11% of the maximum consistency reached during the mixing ,dough developmentc1 (nm) or initial maximum consistency used to determine the water absorption ,protein break down C2(nm)thermal weakening torque at the end of the holding time at 30c(nm)and protein weakening (C1C2)(nm) or the torque difference between C1 and C2

The results presented in Table (4) and illustrated in Figure (1) showed the effect of substitution of rice flour with 25, 50, 75 and 100% quinoa flour, the first part of the Mixolab curve refers to the protein characteristics of the systems and it is characterized determination of the following parameters: water absorption (WA); dough development time; dough development (C1); dough stability and C2 value which is related to the protein weakening due to mechanical and thermal constraints.

From the obtained data, it could be noticed that the water absorption of rice flour was gradually increased as the level of substitution with quinoa flour increased which reached to 71.7, 75.0, 76.1 and 82.6% for rice flour dough's replaced with 25, 50, 75 and 100% of quinoa flour, respectively in compared to 70.1% for the control (RF) dough. The increased in water absorption of the dough which prepared by using quinoa flour probably due to the higher fiber and protein contents of quinoa flour than rice flour. These results are in agreement with Chen *et al.* (1988); Abd El-Moniem and Yassen (1993) & Rodriguez-Sandoval *et al*. (2012).

Also, from the same Table, it could be revealed that dough development time (min) in blended samples with quinoa flour slightly increased from 1.07 to 3.10 min as the substitution level increased from 25 to 75% respectively. Meanwhile dough development time for control rice flour was 0.90 min. As for dough development (C1) the results indicate by increasing the substitution levels of rice flour by quinoa flour, the dough development increase in all flour blends from 1.070 (Nm) for control (RF)to 1.150 (Nm) in 100% (QF). These results may be related to increasing level of quinoa flour which more time required for complete hydration of the material, and could be related to the composition and characteristics of protein and starch (Ruales and Nair, 1994).

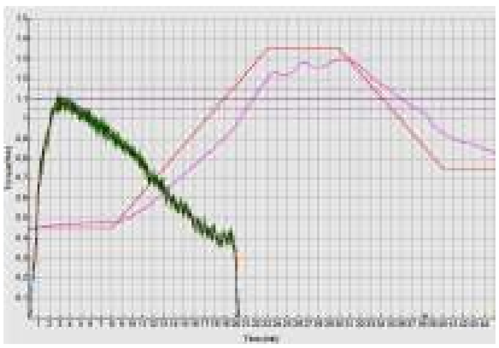
According to the values presented in Table (4), it can be concluded that dough stability (min) was progressively decreasing parallel to the increase of replacement levels with quinoa flour. Quinoa flour addition increased from 25 to 100% tested blends, while dough stability recorded 5.73, 4.83, 2.38 and 1.37 min as the replacement rate increased from 25 to 100% of quinoa flour in the blends respectively, as compared to 9.02 min for control (RF) These results are in agreement with those mentioned by Ruales and Nair (1994); Morita et al. (2001) & Rodriguez-Sandoval et al. (2012). who reported that gradual increase of dough stability (min)was associated with increasing the level of quinoa flour (QF) replacement.

Concerning the degree of minimum torque (C2) or dough breakdown, it could be remarked that the degree of dough weakening decreased as the substitution level of quinoa flour increased. This values decrease from 0.050 to 0.030 Nm when the substitution levels increased from 25 to 100% quinoa flour as compared to 0.053 Nm for control (RF) sample. In addition, Protein weakening increased from 1.050 to 1.120 Nm when the substitution levels increased from 25 to 100% quinoa flour as compared to 1.027 Nm for control(RF) sample .These results are in agreement with Mariotti *et al*. (2008); Angioloni and Collar (2009). They mentioned that the minimum torque parameters were affected significantly by the type of substituted flour (quinoa), which was found to be lower value in quinoa-wheat composite flour and close to 0.45Nm.

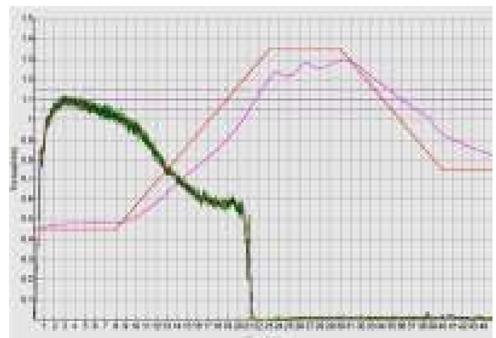
Table 4. Effect of substitution rice flour with different levels of quinoa flour on mixolab parameters

Flour Blends	Mixolab parameter					
	Water absorption (%)	Development Time (min)	Dough Stability (min)	Dough development C1 (Nm)	Protein breakdown C2 (Nm)	Protein weakening (C1-C2) (Nm)
Control (RF)	70.1	0.90	9.02	1.080	0.053	1.027
75%RF+25%QF	71.7	1.07	5.73	1.100	0.050	1.050
50%RF+50%QF	75.0	2.57	4.83	1.103	0.050	1.053
25%RF+75%QF	76.1	3.10	2.38	1.107	0.037	1.070
100% QF	82.6	3.32	1.37	1.150	0.030	1.120

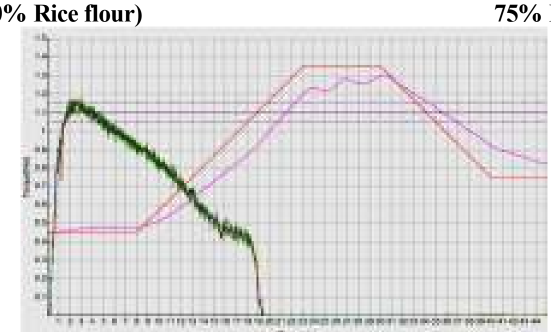
***RF: Rice flour & QF: Quinoa flour.**



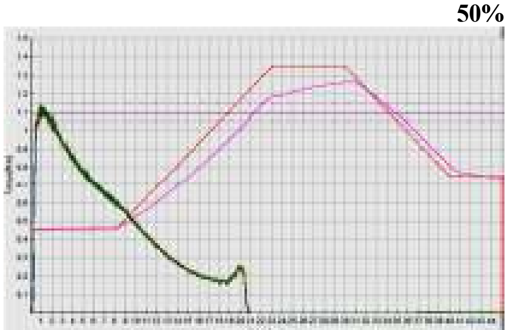
Control (100% Rice flour)



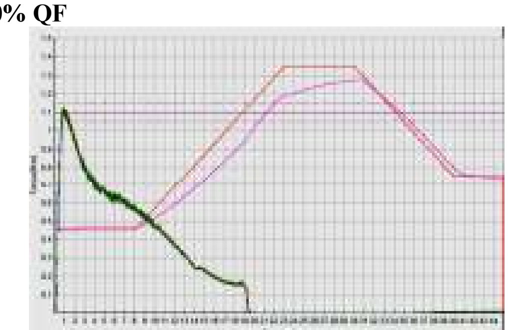
75% RF + 25% QF



50% RF + 50% QF



25% RF + 75% QF



100% Quinoa flour

Fig. 1. Effect of substitution rice flour with different levels of quinoa flour on mixolab parameters

Physical properties of preparation Gluten-free pan bread substitution with or without rice flour and quinoa flourat

The effect of partial and complete replacement of rice flour by quinoa flour at levels 25, 50, 75 and 100% on physical characteristics including (weight, volume and specific volume) of prepared gluten-free pan bread are presented in Table (5) Weight (g) gradually increased in (GF) pan bread samples parallel to the increase in substitution levels by quinoa flour. Weight increased from 260.22 to 273.08 (g) and 281.37 when pan bread samples substituted byin creasing levels with

25 to 75% quinoa flour; respectively. Meanwhile weight of (G.F.P) bread sample containing 100% quinoa flour was 290.45 (g) as compared to 252.14 (g) in control pan bread sample. (RF) 100%

On the other hand, volume (cm^3) of pan bread as shown in Table (5) indicated that by increasing of substitution levels quinoa flour, the volume (cm^3) was parallely decreasing in all(G.F.P) bread samples. Samples volumes were 358, 340, 334 and 317 (cm^3) of bread samples substituted by 25, 50, 75 and 100% quinoa flour; respectively, as compared to 375 (cm^3) in the control sample (RF). In this concern, specific volume (cm^3/g) of (G.F.P)pan bread gradually decreasing by increasing levels of quinoa flour whach recorded 1.38 cm^3/g at 25% QF > 1.25 cm^3/g at 50% QF , 1.19 cm^3/g at 75% QF ,cm^3/g and 1.09 cm^3/g at 100% QF, as compared with control RF sample (1.49 cm^3/g). These results may be due to the fact that composite flours apparently form aggregates with increased numbers of hydrophilic sites available for competing for the limited free water in bread dough and higher water absorption capacity of quinoa flour as illustrated in the rheological properties flour blends Elgeti *et al.* (2014) who reported that increasing of substitution levels of quinoa flour the volume (cm^3) was decreasing in sampls and Weight increased .

It is worth to mention that quinoa flour (QF) is particularly suitable for increasing the volume of gluten-free bread and might lead to better customer satisfaction when it is incorporated by rice flour. The obtained results are in good agreement with those found by many authors Elgeti *et al.* (2014) , Föste *et al.* (2014) and Iglesias-Puig *et al.* (2015). who reported that the replacement of rice flour by 40% whole grain quinoa flour significantly increased bread volume, while addition of the same amount of quinoa bran significantly decreased loaf volume.

Table 5. Effect of substitution rice flour with or without quinoa flour on physical properties of preparation gluten-free pan bread

Bread samples	Average Weight (g)	Average Volume (cm^3)	Specific volume (cm^3/g)
Control (RF)	252.14	375	1.49
75%RF+25%QF	260.22	358	1.38
50%RF+50%QF	273.08	340	1.25
25%RF+75%QF	281.37	334	1.19
100% QF	290.45	317	1.09

(G.F.Pbread)gluten free pan bread

Alkaline water retention capacity (AWRC %) of gluten-free pan bread

Results presented in Table (6), indicated the effect of partial and complete replacement of rice flour by quinoa flour (QF) at levels 25, 50, 75 and 100% on Alkaline water retention capacity (AWRC %) of gluten-free pan bread. Alkaline water retention capacity (AWRC %) gradually decreased in all pan bread samples parallel to the increase in storage periods. AWRC % decreased from (137.58% - 119.35%) at substituncy levels of 25 % QF, (139.22% - 126.19%) at 50% QF, (141.37% - 128.41%) at 75% QF and (164.51% - 144.32 %) at 100% QF, this decrease at period from zero time to 3 days.

Table 6. Alkaline water retention capacity (AWRC %) of gluten-free pan bread prepared by partial replacement of rice flour with quinoa flour

Bread samples	Storage periods (days)			
	Zero time	1	2	3
Control (RF)	136.62	131.00	122.89	115.45
75%RF+25%QF	137.58	133.42	126.48	119.35
50%RF+50%QF	139.22	135.63	130.54	126.19
25%RF+75%QF	141.37	137.82	133.17	128.41
100% QF	164.51	158.99	150.73	144.32

(G.F.Pbread)gluten free pan bread

Sensory evaluation of Gluten-free (GF) pan breads

Sensory evaluation is an important factor in judging food stuffs quality. consumer is a major factor for selecting a product with good quality the main characteristics related to quality are surface color, odor, taste and texture (Pereira *et al.,* 2013).

Data in Table (7) indicated that the organoleptic properties (appearance, crust color, crumb color, softness, crumb structure, taste, odor and overall acceptability) of gluten-free pan bread containing different levels of quinoa flour (25, 50, 75 and 100%) as compared with the control pan bread (100% RF). from the obtained data there were asignificant differences between control gluten-free pan bread sample (RF) and test sample containing QF at level 25% in most sensory characteristics with the exception, of taste and crumb structure in this sample which was significantly reduced (P < 0.05) when compared with control (RF) Also, there were asignificant differences in (G.F.P)bread samples containing 50% quinoa flour in all organoleptic with the control sample (RF)properties.

Table 7. Sensory evaluation of preparation gluten-free pan bread substitution with or without rice flour and rice flour substituted by different levels of quinoa flour

Bread samples	Appearance (20)	Color of crust (10)	Color of crumb (10)	Softness (10)	Crumb structure (10)	Taste (20)	Odor (20)	Over all acceptability(100)
Control (RF)	17.60±0.78^{a}	8.77±0.29^{a}	8.43±0.37^{a}	8.89±0.15^{a}	7.73±0.23^{a}	17.54±0.47^{a}	17.80±0.26^{a}	86.76±1.47^{a}
75%RF+25%QF	16.71±1.47^{ab}	7.88±0.13^{b}	7.88±0.16^{b}	8.26±0.22^{ab}	7.55±0.47^{a}	17.16±0.21^{a}	16.90±0.11^{ab}	82.34±0.92^{ab}
50%RF+50%QF	16.55±0.47^{ab}	7.57±0.49^{bc}	7.47±0.50^{bc}	7.86±0.15^{b}	7.32±0.41^{ab}	16.70±0.26^{ab}	16.52±0.67^{ab}	79.99±0.21^{b}
25%RF+75%QF	15.85±0.13^{b}	6.80±0.26^{bc}	6.71±0.25^{bc}	6.95±0.04^{bc}	7.06±0.05^{b}	16.60±0.63^{ab}	15.60±0.52^{b}	75.57±0.31^{c}
100% QF	13.66±0.44^{c}	6.77±0.30^{c}	6.50±0.65^{c}	6.20±0.26^{c}	6.88±0.16^{c}	15.90±0.13 ^{b}	15.56±0.56^{b}	71.47±0.43^{d}

Means followed by different letters in the same Colum are significantly by Duncan's multiple test(P < 0.05)

On the other hand, the gluten-free pan bread samples containing 75 and 100% QF were significantly differences (P < 0.05) in all sensory properties except color and had less judging scores as compared to the control(RF) pan bread and the other sample containing 25% QF, while (G.F.P)pan bread samples containing

50% were acceptable to some extent to panelists in color crumb and taste properties. These results are in accordance with those results obtained by Stikic *et al.* (2012); Chlopicka, *et al*. (2012) and Elgeti *et al.* (2014) they noticed that incorporation of quinoa flour in bread at high ratios caused relatively dark color of the crust and crumb. Also, Valcárcel-Yamani and Lannes (2012) indicated that no significant differences were obtained in the acceptability of the pseudocereal-containing gluten-free breads in comparison with the control.

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الاستفادة من بذور الكينوا فى انتاج خبز القوالب الخالى من الجلوتين

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تم دراسة تاثير استبدال دقيق الارز بدقيق الكينوا على التركيب الكميائى ووالخصائص الفيزيائية والطبيعية والتقيم الحسي للخبز وكانت نسب الاستبدال التى تم استخدامها هى (٢٥- ٥٠- ٧٥- ١٠٠) من دقيق بذور الكينوا. واوضحت النتائج ان معدلات الرطوبة والبروتين الخام والدهون والرماد والالياف الغذائية بزيادة نسب الاستبدال من دقيق بذور الكينوا وفى المقابل انخفضت معدلات الكربوهيدرات بالزيادة فى نسب الكينوا ايضا اثبتت ان عينات خبز القوالب الخالى من الجلوتين المستحضر من دقيق الارز بنسب ٢٥% من دقيق الكينوا يحتوي على محتوى قليل من المعادن الكبيرة مثل (البوتاسيوم- الكالسيوم –المغنسيوم –صوديوم –فسفور) ومن المعادن الصغرى (حديد –المنجنيز –الزنك). بينما سجلت عينات الخبز المستحضرمن دقيق الكينوا بنسبة ٥٠% بمحتواها العالى لكل المعادن قيد البحث .يزداد الوزن (ج) تدريجيا فى عينات الخبز القوالب الخالى من الجلوتين بالتوازى مع الزيادة فى مستوى نسبه دقيق الكينوا .ومن جهة اخرى فان الحجم والحجم النوعى لخبز القوالب الخالى من الجلوتين ينخفض تدريجيا بنسة (cm3/g) عند زيادة نسب دقيق الكينوا . واشار التقيم الحسي عدم وجود اختلافات كبيرة بين عينات الكنترول لخبز القوالب الخالى من الجلوتين وعينة الاختبار التى تحتوى على دقيق كينوا ٢٥% فى معظم الخواص الحسية بستثناء لون قشرة الخبز وكسرة الخبز لهذة العينة التى انخفضت بشكل كبير عند مقارنتها بعينة خبز الكنترول .ايضا . ليس هناك اختلافات ملحوظة فى عينات الخبز المحتوية على دقيق الكينوا بنسة ٥٠% مع العينات الاخرى من حيث النعومة (الليونة) كسرة الخبز ومقاومات القبول الاخري على الجانب الاخر فان عينات خبز القوالب الخالى من الجلوتين المحتوى على دقيق كينوا بنسة ٧٥% و١٠٠% مختلف بشكل كبير فى الخواص الحسية وسجلت اقل نقاط تحكيمية بالمقارنة بخبز الكنترول اما بنسبة للعينات الاخري لخبز القوالب الخالى من الجلوتين والتى تحتوي على دقيق كينوا بنسبة ٢٥,٥٠% فانها تبين اختلافات ملحوظة لتلك العينات التى تحتوى على دقيق كينوا بنسبة ٧٥% من حييث لون قشرة الخبز وصفات التذوق

الكلمات الدالة : خالى من الجلوتين- دقيق الارز – دقيق الكينوا – خبز القوالب - التقيم الحسي-مرض السليك