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Chemical and Sensory Evaluation of Sablé and Tulumba Fortified with Quinoa Flour for Celiac patients

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Abstract

Celiac disease is a genetic autoimmune disease. It is induced by the consumption of gluten, which is found in wheat, barley, and rye. When celiac patients eat foods provide with gluten, their immune system responds by destructing the finger-like villi of the small intestine. Various types of natural protein-rich ingredients are added to a bakery based products to improve their protein content for health promotion like Quinoa that is an exceptionally nutritious food source. The aim of this study was to improve bakery products of Sablé and Tulumba (Balah Al Sham) fortified with Quinoa flour (QF) and to evaluate the effects on chemical properties and sensory acceptability. Dried Quinoa flour was used to substitute rice flour in Sablé and Tulumba formulations at different levels (0, 10, 20 and 30%). Chemical analysis and sensory evaluation were performed then; a comparison between different ratios of added QF to the mixture was investigated. The present results showed that protein contents had significantly increased in Quinoa flour and rice flour. Generally, it was found that the cereals content of some minerals such as magnesium (Mg), calcium (Ca) and iron (Fe) was particularly high especially in Quinoa flour. As for the sensory evaluation, QF affected the scores of the sensory property of Sablé and Tulumba samples. Addition of QF had a statistically significant effect $p \leq 0.05$ on appearance, taste, texture, color, and overall acceptability scores in Sablé samples. QF addition had a statistically significant effect $p \leq 0.05$ on texture, color, and overall acceptability in Tulumba samples. Both Sablé and Tulumba scored the highest score of 20% level. Conclusion, it is possible to produce multiple varieties of baked like Sablé and Tulumba fortified by Quinoa flour suitable for gluten-sensitive patients and nutritional enrichment.

Keywords: Sablé– Tulumba – Quinoa flour - Celiac disease – Quality.

1.Introduction

The Celiac disease (CD) is spread by the highly popular food-induced turmoil all over the world which caused by the ingestion of gluten-containing grains (i.e. barley, wheat, and rye) in genetically susceptible individuals with an indicated mean prevalence of 1% of the total population **(Lamacchia, *et al*., 2014; Ludvigsson *et al*., 2014)**,while the recent Finish study **(Vilppula *et al*., 2009)** explained the propagation of biopsy confirmed CD was 2.4% in the peoples over 50 years old. The frequency of symptomatic debut and the existence of typical gastrointestinal symptoms (i.e. abdominal pain, bloating, loose stools) and malnutrition in older adults occur in 25% of all cases, as compared to adolescents and children **(Vivas *et al*., 2015)**. CD in older peoples may often exist with extra intestinal manifestations (i.e. osteopenia, skin lesions, oral sores or malignancy), which definitely leads to delayed diagnosis or misdiagnosis **(Vivas *et al*., 2015)**. CD patients were at 60% increased the risk for gastrointestinal malignancies and 25% increased the risk for all malignancies **(Han *et al*., 2015). Marsh, (2013)** found wrong interpretation of biopsy results which can lead to a lateness in Celiac disease detection, it often leads to anemia and reduced levels of iron, folate, and ferritin in serum, lymphomas and intestinal adenocarcinoma **(Harper *et al*.., 2007)**, associated with mal absorption of vitamin D and calcium, leading a progressively to a reduction in bone mineral density that in turn, can lead to osteopenia or even osteoporosis (**Villanueva et *al*., 2012, Volkan *et al*., 2018)**. To date, the only mostly effected treatment for CD affected patients is a gluten-free diet. Cereals that are naturally considered gluten-free are maize, rice, and sorghum. Although, many gluten-free products based on the mentioned cereals are display lower nutritional quality **(O'Shea and Gallagher, 2014)**. Thus, the fortification of gluten-free products with cereal flour could improve their protein content and their protein nutritional value due to the complementation of cereal amino acid patterns **(Gularte *et al*., 2012)**. The type of products was unidentified, but the average of daily consumption was 332 g. **Vilppula *et al*., (2009)** mentioned that using gluten-free flours from 4-day food records of 16 children and 76 adults with CD and found a daily average of about 80 g flour in adults and 60 g in children. **Alvarez - Jubete *et al*., (2010)** found that gluten-free foods have attracted much research interest stimulated by the increasing market. In the gluten-free intolerance context cereals that are considered gluten-free are rice (*Oryza sativa*, L.), and maize (*Zea mays*, L.) which are distant relatives of wheat and are known to be safe for coeliacs available for providing gluten-free flours, while increasing the nutritional pattern of those products in the case of pseudo-cereals, As, Quinoa is rich in protein and show a fatty acid composition **(Hager *et al*., 2012)**. The substitution of gluten is a huge challenge **(Arendt and Moore, 2006).** Presently, using whole grains including rice, sorghum, corn, and Quinoa, since the majority of these is excellent fiber, vitamin B, and iron sources **(Thompson, 2009)**. **Alvarez-Jubete, *et al*., (2010)** reported that the pseudo-cereals are considered as potentially gluten-free cereals with an excellent profile of nutrient, capable of diversifying this rising market, these gluten-free cereals are formidable food alternatives for suffering celiac patients. **Moreno *et al*., (2014)** found that there is an increasing request for functional foods with bioactive compounds in the developed world. Many studies suggest protective effects against cancer and may reduce the risk of cardiovascular diseases **(Kris-Etherton *et al*., 2002)**. Rice flour is convenient for applications in bakery because of its white color, bland taste, hypoallergenic, and digestibility properties. Quinoa seeds (*Chenopodium quinoa*, Willd.) are an excellent raw material for healthy and tasty foods **(Diaz *et al*., 2015)**. It has high protein content, antioxidant compounds as carotenoids, amino acid as lysine and histidine, Also, It has high quantity of vitamins, minerals as iron and calcium **(Dini *et al.*, 2004; Repo-Carrasco-Valencia *et al*., 2011),** moreover, lipids are particularly rich in linoleate and linolenate **(Diaz *et al*., 2013)**. It is approaching the recommended ideal protein by the FAO **(Chillo *et al*., 2008; Rizzello *et al*., 2016)**. They are easy to digest and they have a well-balanced set of essential amino acids for humans. All of them are protective against a variety of diseases, allergy, and inflammatory diseases. The supplement replaces common cereal (corn, rice, and wheat) with a pseudo-cereal of higher nutritional value (such as Quinoa) is inherently beneficial to the public interests. Due to an increasing trend in the developed world, Quinoa can play an essential role in the applications of functional food. Although, sticking to a gluten-free diet for a lifetime can lead to a nutritional imbalance in patients. Therefore, there is an important need to develop gluten-free products that are highly nutritious and at the same time economical **(Jnawali *et al*., 2016).** The use of Quinoa was shown to be functional for the development of gluten-free Sablé and Tulumba. This research opens up new opportunities for the gluten -free bakery in Egypt. The aim of this study was a chemical and sensory evaluation of new products i.e. Sablé and Tulumba (Balah Al Sham) fortified with Quinoa flour at different levels (10, 20 and 30 g /100 g) for celiac patients, and to assess its function which suitable for gluten-sensitive patients and nutritional enrichment.

2. Materials and methods

2.1. Materials

Quinoa (*Chenopodium quinoa*, Willd.) was purchased from the Faculty of Agriculture- Ain Shams University. Quinoa seeds were ground in a lab mixer (Braun blender, Germany). The Quinoa flour was stored at 4 ^{O}C until use. Wheat flour (*Triticum aestivum*, L), rice flour (*Oryza sativa*), corn flour (*Zea mays*, variety 320) were obtained from Agricultural Research Center, Giza, Cairo. The raw materials are butter sugar, egg, salt, sunflower oil were purchased from local markets in Alexandria.

2.2. Chemicals

All chemicals were purchased from Sigma Chemical Co. (EL-Goumhorya Company for Chemicals, Drugs and Medical Instruments).

2.2 Methods

2.2.1 Chemical composition of raw materials.

Determination of moisture, and fat was according to **AOAC (1995)**. Fat content was extracted by the Soxhlet technique **AACC (1995)**. Protein determination was performed by the Kjeldahl technique **AOAC (2005)**. Ash content was performed in a muffle furnace by incineration at 910 ^{o}C **AOAC (2005)**. Total carbohydrate content was calculated by the difference **AOAC (2000).**

2.2.2 Determination of minerals of quinoa, rice, and wheat flour

Determination of mineral elements (Ca, Mg, and Fe) concentrations in wheat flour, rice flour, and Quinoa samples which were prepared as described in **AOAC (2000)**. Prepared samples were used for the determination of Ca, Mg, and Fe. Atomic absorption spectrophotometer PERKIN-ELMER 2380 was used to detect these heavy metals was according to **AOAC (2000).** At the Analytical Lab, Faculty of Science from the University of Alexandria

2.2.3 Preparation of products.

Sable and Tulumba products were prepared according to the methods mentioned by **Saba (1991)**.

2.2.3.1 Preparation of sable products.

Sable formulations are described in Table 1. For the batter preparation, mix the butter with the sugar until it is creamy, add the eggs with the vanilla and add them to the previous mixture, mix well, mix the flour and cornstarch and salt together and then add to the previous mixture and knead well, leave the dough to rest for about 10 minutes, divide the dough into small pieces equal weight 10 grams , and formed a round shape , bake in an electric oven at 160-180 ^{O}C during 15 -20 min after that, Sable cooled at room temperature for 75 min and saved for analysis **(Saba, 1991)**.

Table (1). Formulation of sable.

Ingredients (g)	Formulation (WF: RF: QF)				
	WF 100:0	RF 100:0	RF 90:10 QF	RF 80:20 QF	RF 70:30 QF
Wheat flour (g)	100	0	0	0	0
Quinoa flour (g)	0	0	10	20	30
Rice flour (g)	0	100	90	80	70
Corn flour (g)	50	50	50	50	50
Butter (g)	75	75	75	75	75
Sugar (g)	50	50	50	50	50
Egg (ml)	20	20	20	20	20
salt (g)	2	2	2	2	2

WF: Wheat flour, RF: Rice flour, QF: Quinoa flour.

2.2.3.2 Preparation of tulumba products.

Tulumba formulations are described in Table 2. For the batter preparation, boil the water with the oil and sugar in a bowl, add the salt to the flour and add to the previous mixture, stir the mixture vigorously until smooth, leave to cool, then add the eggs gradually until we get a smooth paste and soft, leave the dough for 10 minutes to rest, Fingers by the dressing cones, fry in relatively hot oil until we get the golden color, sprinkle with sugar powder or put in the syrup **(Saba, 1991)**.

Table (2). Formulation of tulumba.

Ingredients (g)	Formulation (WF: RF: QF)				
	WF 100:0	RF 100:0	RF 90:10 QF	RF 80:20 QF	RF 70:30 QF
Wheat flour (g)	100	0	0	0	0
Quinoa flour (g)	0	0	10	20	30
Rice flour (g)	0	100	90	80	70
sunflower oil (ml)	30	30	30	30	30
Sugar (g)	5	5	5	5	5
Egg (ml)	60	60	60	60	60
Salt (g)	2	2	2	2	2
Water (ml)	150	150	150	150	150

WF: Wheat flour, RF: Rice flour, QF: Quinoa flour

2.2.4. Sensory evaluation

Organoleptic properties of the control and gluten-free treatments (Sable and Tulumba) were conducted using 9-point hedonic rating scale **(Wichchukit and O'Mahony , 2015)** for acceptability by a group of 30 semi-trained Panelists who usually consume Sable and Tulumba, no one of them having celiac disease, Panelists among the staff and students of home economics department- Specific Education faculty - Alexandria University. Panelists were asked to evaluate the gluten-free Sable and Tulumba for appearance, taste, texture, color, odor, acceptability.

2.2.5. Statistical analysis

Statistical analysis of data was carried out using the IBM SPPS 23 statistics package program **(Kirkpatrick *et al*., 2012)**. Triplicate analyses were performed for all measurements for all samples. Differences between the means were compared by Duncan test at 5% of significance. The significance of the model was evaluated by ANOVA. The significance level (p) was fixed at 0.05 for all the statistical analysis.

3. Results and discussion

3.1. Chemical contents of Quinoa, rice, and wheat flour

The flours composition used in this study are discussed in Table 3. The raw Quinoa flour showed higher levels of fat, protein, and ash with respect to the rice flour and wheat flour. The results were in according to the recent research. The moisture content of Quinoa flour was 8.84%, protein content was 19.19%, fat content was 2.45%, ash was 2.24% and carbohydrates content was 67.27%. The present results are in accordance with the results of **Foste *et al*., (2014); Bilgiçli and Ibanoglu, (2015)**. For rice flour, the moisture content of rice flour was 10.5%, protein content was 5.47%, fat content was 0.736%, ash was 0.165% and carbohydrates content was 83.13%. These results are in agreed with **Reddy, *et al*, (2017)**. Concerning wheat flour, the moisture content of wheat flour was 11.44%, the protein content was 9.43%, while the fat content was 1.20%, ash content was 0.55% and carbohydrates content was 77.38%. The results are in agreement with **Yildiz and Bilgiçli (2012)**. The study is in accordance with **David *et al*., (2015)** who explained that wheat flour with fat was 1.33% and 10.23% protein

The moisture content of foods is affected by variety, type and storage condition **(Guy, 2012)**. The content of moisture of both wheat and rice flour were the highest and significantly different from Quinoa ($P \leq 0.01$). The protein and the fat contents of Quinoa flour were significantly higher than wheat and rice flour ($P \leq 0.01$). The results were in agreement with contributing significantly the diets that contains high-fat for the energy requirement for humans as reported by **David *et al*, (2015)**. The ash content of Quinoa flour was significantly higher than wheat and rice flour ($P \leq 0.01$) , ash content considered as an indication of mineral content of a food **(David *et al*., 2015)**, therefore, it is suggested that Quinoa flour could be important sources of minerals than rice flour and wheat flour. The carbohydrates content of rice flour was significantly higher than wheat flour and Quinoa flour ($P \leq 0.01$).The high carbohydrates content of rice flour lead to suggest that it could be used in managing the malnutrition besides there is a suitable quantity of carbohydrates to derive energy for the human body and save protein to be used for its primary function of building the body and repairing tissues **(Butt and Batool, 2010)**. Also, it is considered as good sources of energy, that a high quantity of it is desirable in breakfast meal; for that, rice flour would make it a suitable source of energy in breakfast meals **(Butt and Batool, 2010).**

Table (3) Chemical contents of Quinoa, rice, and wheat flour (in dry matter).

Treatments	Moisture	Protein	Fat	Ash	carbohydrates
Quinoa flour	$8.84^{a}\pm.010$	$19.19^{a}\pm.011$	$2.45^{a}\pm.017$	$2.24^{a}\pm.0017$	$67.27^{a}\pm.040$
Rice flour	$10.5^{b}\pm.017$	$5.47^{b}\pm.15$	$.736^{b}\pm.008$	$.165^{b}\pm.004$	$83.13^{b}\pm.317$
Wheat flour	$11.44^{c}\pm.014$	$9.43^{c}\pm.033$	$1.20^{c}\pm.057$	$.55^{c}\pm.011$	$77.38^{c}\pm.029$
F **P ≤ 0.05**	17.94^{*} (≤ 0.001)	56.94^{*} (≤ 0.001)	63.49^{*} (≤ 0.001)	77.87^{*} (≤ 0.001)	18.73^{*} (≤ 0.001)

F: F test (ANOVA),*: Statistically significant at $p \leq 0.05$
Different superscripts are statistically significant; Data was expressed by using mean ± SD.

3.2. The chemical contents of the Sable and Tulumba products

The chemical contents of Sable supplemented with different percentages of Quinoa flour is presented in Table 4. There was a significant difference between the (control A) 100% of wheat flour, (control B) rice flour and those fortified with Quinoa flour (C, D, E) in moisture ($p \leq 0.01$). The moisture content of all the Sable samples were different significantly ($p \leq 0.01$) and was in the ranged between 13.31- 6.60%. On the other hand, there were significant differences among the Sable samples in protein content ($p \leq 0.01$), the Sable with 30% QF inclusion was observed to have the highest protein content (8.45%), and this was followed by 20% Quinoa Sable (7.57%), while the Sable with rice flour inclusion had the lowest protein content was (5.16%). The fat content of the Sable samples did differ significantly as well and ranged between 30.43- 13.17% ($p \leq 0.01$). **Pareyt *et al*., (2009); Sciarini *et al*., (2013)** reported that fats found in large amounts, while moisture content found in low proportions (1-6 %) in the formulations of cookies. Fat has a very important role in baked products, and it is responsible for overall texture and mellowness of the final product improving structural integrity, lubrication, mouth feel, the combination of air, and extended shelf life **(O'Brien, 2008)**. The ash content of the Sable samples were different significantly and were in the ranged between 1.64 -2.27%. There were significant differences ($p \leq 0.01$) among the Sable in carbohydrates content. Sable with 10% Quinoa flour had the highest carbohydrates content (66.59%) followed by the one with (control A) (65.64%), while the Sable with rice flour had the lowest carbohydrates content (54.58%). Quinoa flour had richer chemical composition since it was produced from quinoa flour. Literature knowledge on the chemical composition of wheat flour and Quinoa flour confirmed the obtained results **(Watanabe *et al*., 2014)**. Moisture content is an important factor for the preservation, convenience in packaging. Moreover, moisture content comprises an identity standard **(Kaur *et al*., 2017)**. The increase of fat in the separated cookies was because of the adding 8% (Normal range) of sesame in the cookie, that was identified by different investigations for commercial cookies, with ranges of values between 8.7% - 25.6% **(Robinson *et al*., 2008)**. Also, the results can be explained for Tulumba supplemented with different percentages of Quinoa flour is presented in Table 4. The Moisture was a significant difference (p≤ 0.01) between wheat flour (control F) and rice flour (control G) and those fortified with Quinoa flour (H, I, J). All the Tulumba samples didn't change significantly (p≤ 0.01) and were in the range of 36.71- 39.12% in the moisture content. Also, there were significant differences (p≤ 0.01) among the Tulumba samples in protein content, the highest protein content (6.44%) was observed in the Tulumba with 30% Quinoa flour. This was followed by 20% Quinoa Tulumba (5.71%), while the Tulumba with rice flour inclusion had the lowest protein content (3.01%). The fat content of the Tulumba samples did differ significantly as well and ranged between of 25.37- 18.52%. The ash content of the Tulumba samples did differ significantly as well and ranged between of 0.272 - 0.944%. There were significant differences (p≤ 0.01) among the Tulumba in carbohydrates content. Tulumba with 10% Quinoa flour inclusion had the highest content of carbohydrates (39.11%), while the Tulumba fortified with 30% Quinoa flour (J) had the lowest carbohydrates content (35.30%). **Vidueiros *et al*., (2015)** showed that, in regard to nutritional composition, the composition of Quinoa flour didn't differ from unprocessed seeds. Therefore, Quinoa flour could be considered as a substitution ingredient in food formulations for people with a chronic celiac disease. Undoubtedly, Quinoa seeds can provide food diversification and creativity since products with satisfactory nutritional qualities were obtained **(Curti *et al*, 2017)**.In this study, the superiority of Quinoa as a functional ingredient to enhance the nutritional value of Sable and Tulumba has been elucidated.

Table (4): Chemical contents of the Sable and Tulumba products

		Moisture	Protein	Fat	Ash	carbohydrates
Sable	**Control A**	13.31[a]±.163	5.73[b]±.069	13.17[a]±0.60	2.15[b]±.140	65.64[c]±0.49
	Control B	6.60[b]±.248	5.16[a]±.183	30.43[d]±0.61	3.23[c]±.145	54.58[a]±0.82
	C 10 %	6.82[b]±.152	6.23[c]±.148	18.66[b]±0.64	1.68[a]±.087	66.59[c]±0.84
	D 20 %	6.70[b]±.363	7.57[d]±.026	22.23[c]±0.69	2.27[b]±.136	61.22[b]±1.14
	E 30 %	7.24[b]±.199	8.45[e]±.123	21.03[c]±0.77	1.64[a]±.067	61.63[b]±0.48
	F (p) ≤ 0.05	11.410 (≤ 0.001)	49.710 (≤ 0.001)	26.769 (≤ 0.001)	44.246 (≤ 0.001)	24.123 (≤ 0.001)
Tulumba	**Control F**	39.12[b]±.373	3.81[b]±.089	21.39[b]±0.46	.437[b]±.064	35.23[ab]±0.09
	Control G	36.71[a]±.152	3.01[a]±.029	25.37[c]±0.57	.272[a]±.027	34.63[a]±0.46
	H 10 %	36.98[a]±.290	4.86[c]±.366	18.52[a]±0.68	.528[b]±.017	39.11[c]±0.56
	I 20 %	36.99[a]±.300	5.71[d]±.205	20.03[ab]±0.22	.944[d]±.019	36.31[b]±0.32
	J 30%	36.89[a]±.319	6.44[e]±.094	20.65[b]±0.42	.716[c]±.044	35.30[ab]±0.11
	F (p) ≤ 0.05	148.67 (≤ 0.001)	120.01 (≤ 0.001)	88.108 (≤ 0.001)	28.774 (≤ 0.001)	35.442 (≤ 0.001)

F: F test (ANOVA),*: Statistically significant at p ≤ 0.05
Different superscripts are statistically significant; Data was expressed by using mean ± SD.

3.3 Minerals content of Quinoa, rice, and wheat flour

Rice flour and wheat flour had higher mineral content calcium (Ca) (1.239, 1.353 ppm/100g, respectively) when compared Quinoa flour (0.752 ppm/100g). In the other hand, Quinoa flour had higher mineral content magnesium (Mg) 0.478 ppm/100g when compared with rice flour and wheat flour (0.311, 0.232 ppm/100g, respectively). Also, Quinoa flour had higher mineral content iron (Fe) 4.013 ppm/100g when compared with rice flour and wheat flour (2.79, 1.341 ppm/100g, respectively). Celiac disease in many studies that suggest that it may be associated with some nutritional deficiencies due to the exclusion of gluten-containing cereals, which are rich in iron, fiber and B vitamins (**Penagini *et al*., 2013). Penagini *et al*., (2013)** suggested that celiac disease may be associated with some nutritional deficiencies as a result of the exception of gluten-containing cereals, which are rich in iron, fiber and B vitamins. The literature includes reports of decrease or increase of some minerals and vitamins concentration such as vitamin D, folic acid, magnesium, iron and calcium can have an impact on blood levels and in the development of anemia and osteopenia. His deficient intake is partly due to the lower fiber, thiamine, riboflavin, and niacin content of gluten-free foods **(Zuccotti *et al.*, 2013)**. In general, Quinoa flour can be used in Sable and Tulumba products that Prepared from rice flour for nutritional enrichment in minerals for celiac patients.

Table (5) Minerals content of Quinoa, rice and wheat flour (in dry matter).

	Units	**Calcium (Ca)**	**Magnesium (Mg)**	**Iron (Fe)**
Quinoa flour	(ppm)/100g	0.752	0.478	4.013
Rice flour	(ppm)/100g	1.239	0.311	2.79
Wheat flour	(ppm)/100g	1.353	0.232	1.341

3. 4. Sensory evaluation

3.4.1. Sensory evaluation of sable fortified with quinoa flour

Sensory evaluation is considered from the direct method to access the acceptability of cookies. Also, it is more effective, require a small sample size, less time and do not require a trained panel **(Kaur *et al.*, 2017)**. Sensory evaluation of Sable made with rice flour fortified Quinoa flour at 10%, 20%, and 30% of Quinoa flour present significant differences with the control sample (Table 6). The samples with Quinoa were described as Fig1.The sensory panelists described the organoleptic properties of the control as fine-powdery texture, whiter in color, and pleasant odor. However, a gluten-free treatment was fine-powdery texture, whiter in color, and pleasant odor. The whiter in color justifies the fact that rice flour. The sable elaborated with the formulation of 10%, 20%, 30% of Quinoa flour and rice flour as control was evaluated, considering appearance, taste, texture, color, odor and acceptability. According to table 6, the panelists graded the sable with an extremely high level of liking with scores falling between the averages of 7.27 and 8.50. For the value of appearance, there was a significant difference between the samples and two controls (A, B) ($p \leq 0.01$). Sample (D) had the highest value (8.33) but the rest of the samples compared with it except for the samples that were significantly different from two controls (8.03, 8.10, respectively). For the value of taste, there was a significant difference between the samples and two controls (A, B) ($p \leq 0.01$). The samples (C, D) had the highest same value of (8.27) but comparable with except for (E) sample (7.53) that was significantly different from the two controls. Taste is an essential parameter when evaluating the sensory characteristic of food. The product might be attractive and having high energy density without good taste, such a product is likely to be inadmissible **(Muhimbula *et al*., 2011)**.The samples with Quinoa flour were more liked than the samples with wheat flour and rice flour, it was observed that as the Quinoa flour increased in the mix the less its taste was liked. In the case of texture, there was a significant difference between the Sable formed from samples and the two controls ($p \leq 0.01$). The panelist preferred the texture of the Sable made from sample (C) (8.17) with Quinoa flour to (D, E) (7.97, 7.40, respectively) and the blends with the rice flour was slightly lower to the controls (A, B) (8.30, 8.27, respectively), though the Sable of the sample (C) still compared favorably with the controls. The texture is the prevailing textural characteristics of the product at the point of consumption that usually determines whether such food is swallowed able chewable **(Sanni *et al*., 2007)**. For the value of color, there was a significant difference between the samples and the two controls at ($p < 0.01$). Color is an important attribute of food choice and acceptance **(Muhimbula *et al*., 2011)**. The score of sensory evaluation indicates that some samples were highest in color (A, B, D) (8.50, 8.37, and 8.30, respectively).The Sable made from the samples that had wheat flour and rice flour were more colored in terms of color this could be attributed to the presence of wheat and rice that would have brightened its color a little, but the samples that had Quinoa were less appreciated in terms of color. For the value of odor, there was no significant difference between the samples and the controls ($p \leq 0.01$). The controls (A, B) and sample (D) had the highest values of (8.50, 8.37, and 8.30, respectively) and the rest of Sable made from the other samples comparable with them. Smell is related to taste and general acceptance of the food. therefore, It is an essential parameter when testing the acceptability of formulated food **(Muhimbula *et al*., 2011)**. From this study, the Sable produced from 20% sample performed better than the samples with 10%, 30%. For the value of overall acceptability, there was a significant difference (p≤ 0.01) between Sable made from the samples blends and two controls. Although all the Sable made from the samples compared favorably with two control (A, B) (8.10, 8.40, respectively) which has already gained popularity for acceptability, the sample (D) (8.17) has gained for acceptability. This study shows that all the flour samples could be used and the products will have good organoleptic acceptability. In a study conducted by **Kaur *et al*., (2017)** that the highest scores of overall acceptability was 7.66 for biscuits with 15% flaxseed and after this level of substitution a decrease in acceptability scores was observed. **Hooda and Jood, (2005)** mentioned that cookies are considered one of the most desirable snacks for different ages due to their suitability, long shelf life, good eating quality and ability to serve as a vehicle for important nutrients. While **Demir, (2014)** mentioned that cookies hold an important position among the bakery products and in snack foods due to variety in taste, crispiness, digestibility and longer shelf life.

Table (6). Sensory evaluation of Sable fortified with 10%, 20%, and 30% Quinoa flour.

Sable	Appearance	Taste	Texture	Color	Odor	Acceptability
A (100)	$8.03^{c}±.669$	$8.20^{ab}±.714$	$8.30^{a}±.750$	$8.50^{a}±.630$	$8.47^{a}±.730$	$8.10^{a}±.712$
B (100:0)	$8.10^{b}±.607$	$8.20^{a}±.551$	$8.27^{a}±.583$	$8.37^{b}±.556$	$8.00^{a}±.587$	$8.40^{ab}±.675$
C (90:10)	$7.90^{ab}±.662$	$8.27^{a}±.828$	$8.17^{ab}±.699$	$8.00^{a}±.587$	$8.30^{a}±.750$	$8.03^{a}±.615$
D (80:20)	$8.33^{b}±.606$	$8.27^{c}±.640$	$7.97^{a}±.718$	$8.30^{c}±1.05$	$8.00^{a}±.743$	$8.17^{b}±.691$
E (70:30)	$7.37^{a}±.490$	$7.53^{b}±.507$	$7.40^{c}±.498$	$7.27^{c}±.450$	$7.93^{a}±.740$	$7.33^{b}±.547$
F **(p) ≤ 0.05**	10.454 (≤ 0.001)	6.865 (≤ 0.001)	9.535 (≤ 0.001)	15.444 (≤ 0.001)	3.164 NS	11.335 (≤ 0.001)

F: F test (ANOVA),*: Statistically significant at p ≤ 0.05, NS= de note not significant
Different superscripts are statistically significant; Data was expressed by using mean ± SD.

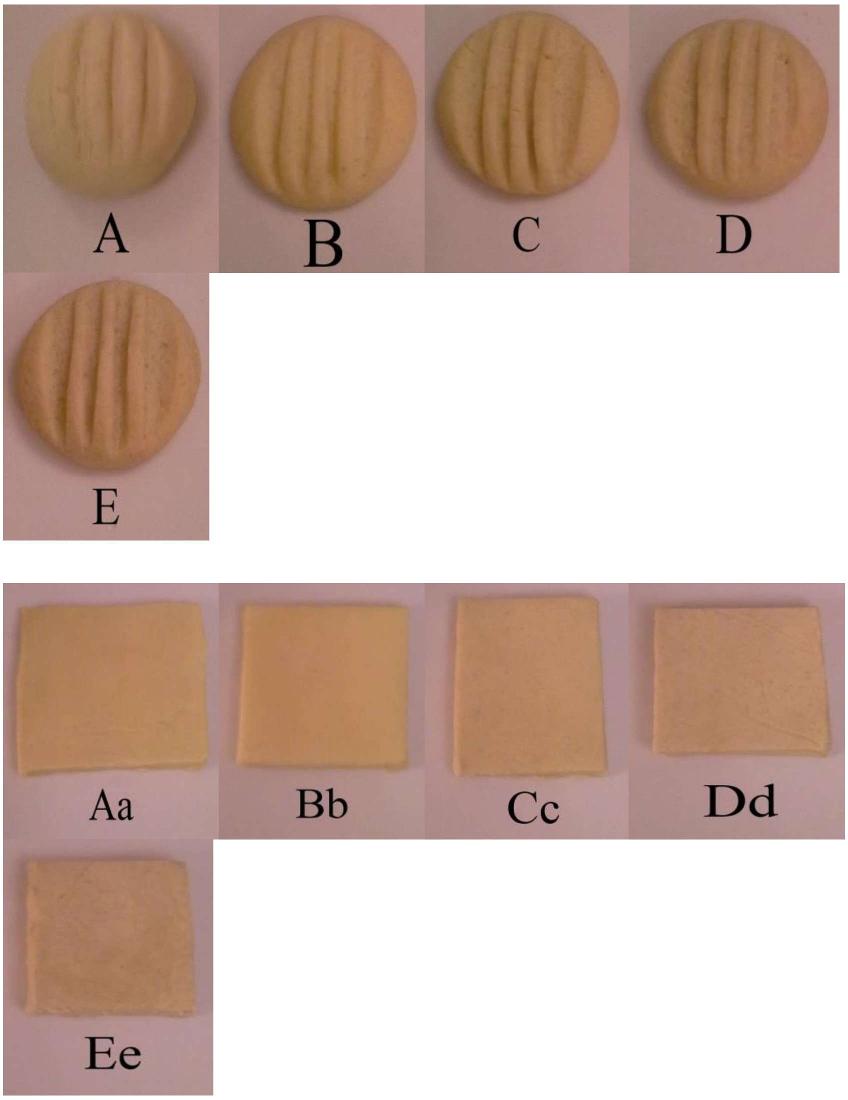


Fig 1: Samples of Sable and its dough fortified with different percentages of Quinoa flour.

3.4.2. Sensory evaluation of Tulumba fortified with Quinoa flour

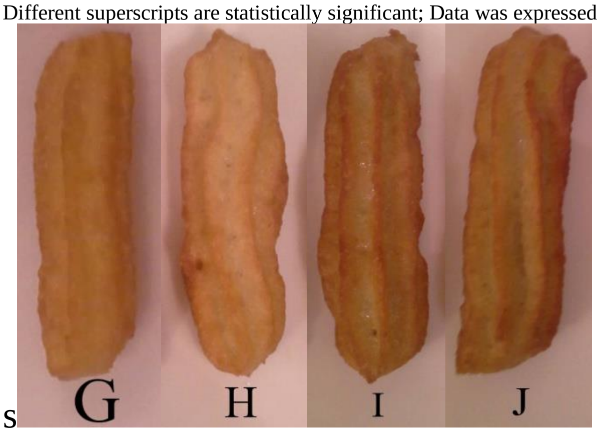
Sensory evaluation of Tulumba made with rice flour fortified Quinoa flour at 10%, 20%, and 30% of Quinoa flour with control samples show significant differences (Table 6). The samples of Tulumba were described as Fig1. For the value of appearance, there was no significant difference between the samples ($p \leq 0.01$), and two controls (F, G), the sample (I) had the highest value (8.30) but the samples (F, H) had the same value of 8.10. For the value of taste, there was no significant difference between the samples and two controls (F, G) ($p \leq 0.01$). The samples (G, I) had the highest value (8.30, 8.47, respectively) but the rest of the samples the same value (8.17). In the case of texture, there was a significant difference between the Tulumba samples formed from samples and the two controls ($p \leq 0.01$). The panelist preferred the texture of the Tulumba made from the sample (H) (8.43) with Quinoa flour but the same value of rest samples (F, I) was 8.07. The slightly lower samples were (7.77, 7.23, respectively) samples (G, J). For the value of color, there was a significant difference between the samples and the two controls ($p \leq 0.01$). A result indicates that some samples were highest in color (F, G, and H) (8.27, 8.47, and 8.60, respectively). The slightly lower samples were samples (I, J) (8.17, 7.57, respectively). Quinoa includes pigments such as carotenoids and chlorophyll that give the seeds their color **(Ruffino *et al*., 2010)**. For the value of odor, there was no significant difference between the samples and the controls ($p \leq 0.01$). The samples (H, I, J) had the highest same values (8.30) and the rest of Tulumba samples were the two controls (F, G) (8.23, 8.37, respectively). For the value of general acceptability, there was a significant difference between Tulumba samples made from the samples blends and two controls ($p \leq 0.01$). Although all the Tulumba made from the samples as compared favorably with two control (F, G) which has already gained popularity (8.43, 8.33, respectively) for acceptability, the sample (H, I) (8.37, 8.40) has gained for acceptability. From this study the Tulumba produced from10% and 20% sample performed better than the samples with 30%. This study shows that all the flour samples could be used for quinoa flour and products will have good organoleptic acceptability. The consumers, producers, and the scientific community are keeping an increasing interest to the increase in the amount of high protein in vegetables deriving from pseudo-cereals to food **(Wang and Zhu, 2016; Rizzello *et al*.,**

2017). These results show that more satisfying Tulumba can be manufactured using Quinoa flour up to levels at least 20% (Table 7)

Table (7). Sensory evaluation of Tulumba fortified with 10%, 20%, and 30% quinoa flour.

Tulumba	Appearance	Taste	Texture	Color	Odor	Acceptability
F (100)	8.10^{a}±.712	8.17^{a}±.699	8.07^{a}±.740	8.27^{a}±.640	8.23^{a}±.568	8.43^{a}±.504
G (100:0)	8.23^{a}±.626	8.30^{b}±.596	7.77^{b}±.679	8.47^{b}±.730	8.37^{b}±.718	8.33^{ab}±.547
H (90:10)	8.10^{a}±.548	8.17^{a}±.648	8.43^{ab}±.504	8.60^{b}±.498	8.30^{b}±.535	8.37^{a}±.615
I (80:20)	8.30^{a}±.651	8.47^{ab}±.571	8.07^{c}±.691	8.17^{c}±.747	8.30^{b}±.651	8.40^{b}±.621
J (70:30)	7.90^{a}±.548	8.17^{c}±.648	7.23^{c}±.679	7.57^{d}±.504	8.30^{b}±.702	7.87^{b}±.571
F(p)	1.837 NS	1.311 NS	13.652 (≤ 0.001)	11.928 (≤ 0.001)	.163 NS	4.999 (≤ 0.001)

F: F test (ANOVA),*: Statistically significant at p ≤ 0.05, NS= de note not significant,
Different superscripts are statistically significant; Data was expressed by using mean ± SD.

s 

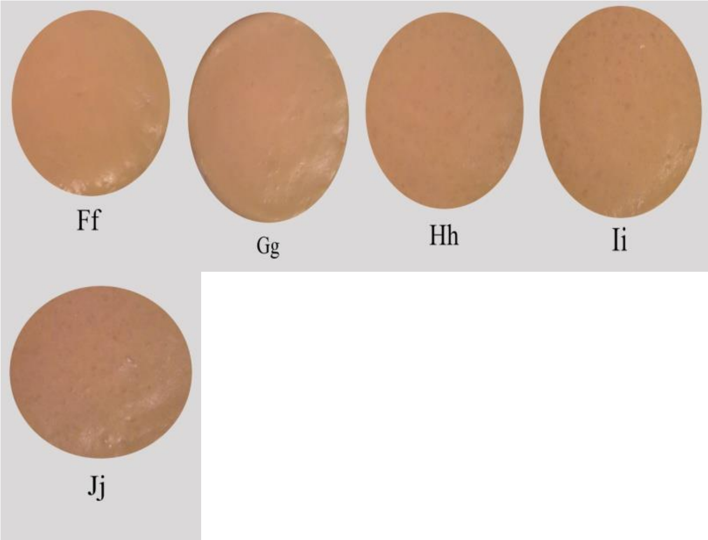


Fig 2: Samples of Tulumba and its dough fortified with different percentages of Quinoa flour.

4. Conclusions

Several recent studies have shown the successful formulation of pseudo-cereal containing cereal-based products. In this study, possible use of quinoa flour as a pseudo-cereal was investigated in Sable and Tulumba production. Quinoa flour was successfully incorporated into Sable and Tulumba formulation. In a conclusion, chemical properties of Sable and Tulumba improved with addition Quinoa flour. Additions Quinoa flour increased the protein, ash, fat, and mineral contents. Also, sensory properties of Sable and Tulumba samples were enhanced by the addition of Quinoa flour. As the result, wheat flour can be replaced with Quinoa flour in Sable and Tulumba formulations, increasing the nutritional value of products in consideration of minerals, proteins, and healthy fats, it is suggested that Quinoa with rice are a nutritious and functional substitute for wheat for celiac patients.

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التقييم الكيميائي والحسي للسابليه وبلح الشام المدعم بدقيق الكينوا لمرضى حساسية الجلوتين

نيفين أحمد الوردانى ، أميرة أحمد شتيوى
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المستخلص العربى
مرض حساسية الجلوتين (الاضطرابات الهضمية) هو أحد أمراض المناعة الذاتية الوراثية الخطيرة. يتم استحثاثه عن طريق استهلاك بروتين يسمى الجلوتين، والذي يوجد في القمح والشعير والشوفان. عندما يتناول الأشخاص المصابون بمرض الاضطرابات الهضمية الأطعمة المحتوية على الجلوتين، يستجيب نظامهم المناعي عن طريق إتلاف الأهداف الشبيهة بالأصابع الصغيرة. تتم إضافة أنواع مختلفة من المكونات الغنية بالبروتينات الطبيعية إلى منتجات مختبرة لتحسن محتوى البروتين الخاص به من أجل تعزيز الصحة مثل دقيق الكينوا الذي يعتبر مصدرًا غذائيًا بشكل استثنائي. الهدف من هذه الدراسة هو تطوير منتجات المخبوزات (مثل السابليه وبلح الشام) المدعمة بدقيق الكينوا وتم تقييم الاضافات على الخواص الكيميائية والقبول الحسي. تم استخدام دقيق الكينوا المجفف ليحل محل دقيق الأرز في السابليه وبلح الشام على مستويات مختلفة (٠، ١٠، ٢٠ و٣٠٪). تم إجراء التحليل الكيميائي والتقييم الحسي بعد ذلك، تمت المقارنة بين النسب المختلفة من دقيق الكينوا المضافة إلى الخليط مع عينات الكنترول، أظهرت النتائج المتحصل عليها أن محتويات البروتين قد زادت بشكل كبير في دقيق الكينوا ودقيق الأرز بشكل عام، وجد ان محتوى الحبوب من بعض المعادن مثل الماغنسيوم، الكالسيوم، والحديد كان مرتفع وخاصة مع الكينوا . أما بالنسبة للتقييم الحسي، فقد أثر اضافة دقيق الكينوا على درجات التقبل الحسيى في عينات السابليه وبلح الشام ، وجدت فروق معنوية عند $P \leq 0.05$ عند إضافة دقيق الكينوا على المظهر والمذاق والملمس واللون ودرجات القبول العام في عينات السابليه ، كما وجد فروق ذات معنوية عند $P \leq 0.05$ عند إضافة دقيق الكينوا على الملمس واللون والقبول العام في عينات بلح الشام. وسجل كل من السابليه وبلح الشام المدعمين بنسب مختلفة من دقيق الكينوا أعلى درجة تقبل فى هذه النسب كان عند مستوى ٢٠ ٪. ويستنتج من الدراسة انه من الممكن إنتاج أصناف متعددة من المخبوزات مثل السابليه وبلح الشام المدعمة بالكينوا وتكون مناسبة لمرضى الحساسية للجلوتين وكذلك لزيادة القيمة الغذائية.

الكلمات المفتاحية: السابليه - بلح الشام - دقيق الكينوا - مرض حساسية الجلوتين – الجودة.