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Physical and Nutritional Properties of Gluten Free Biscuits Formulated with Multi Grains and Roasted Sweet Potato

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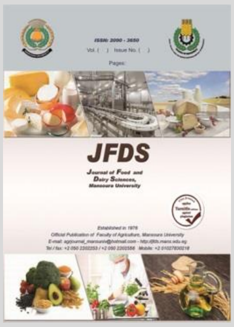

ABSTRACT

The present investigation was undertaken to study the preparation of gluten free biscuits from multi grains flour blend consists of rice (80%), maize (5%), and roasted chickpea (10%) as well as mashed roasted sweet potato (5%). These ratios of blend are constant and considered as control, while the Rice flour in other treatments was replacement with different ratio of quinoa flour (5, 10, 15 and 20%). The baked biscuits were evaluated for proximate composition, amino acid pattern, sensory attributes and calcium (Ca), iron (Fe), potassium (K) and zink (Zn) contents. The results showed that the substitution of rice flour with quinoa flour improved the biscuits nutritional value where, the protein, ash, Fe, Zn, Ca and K contents were increased. Likewise, amino acids values were increment except tyrosine and methionine, which didn't affect by the replacement process, whereas the values of proline and valine were decreased. All samples of baked biscuits were acceptable and no differences were detected in the sensory characteristics on the hedonic scale in terms of, colour, texture, odor, taste, chewing and overall acceptability.

Keywords: Gluten free biscuit, Rice, Quinoa, Sweet potato, Maize, Chickpea Minerals, Amino acids.

INTRODUCTION

Celiac disease is a lifelong autoimmune disorder in which the patient becomes intolerant to "gluten parts", which are named depending upon each cereal. It is called gliadin in wheat, hordein in barley, secalin in rye and avenin in oats. In addition to malt which is a fermented barley product also represents a fraction of gluten, so all those aforementioned products contain gluten should be avoided from celiac patients. Certain amino acid sequence in gliadin proteins has the ability to activate the disease in the affected persons. They suffering from damaging their villi, so can't get adequate nutrients, whatever how much they eat (Sdepanian *et al.*, 1999 and Morishita *et al.*, 2003). The intestinal damage often causes steatorrhea, weight loss or gain, anaemia, severe diarrhea, fatigue, abdominal discomfort, bloating tiredness and can lead to serious complications such as lactose intolerance. In children, malabsorption can affect growth and development, in addition to the symptoms seen in adults (Gallagher *et al.*, 2004 and Osella *et al.*, 2014). Celiac disease is difficult to diagnose since it affects people differently. There are more than 200 known celiac disease symptoms which may occur in the digestive system or other parts of the body. Some people develop celiac disease as a child, others as an adult. The reason for this is still unknown. The only way to treat this disease is a gluten free diet, which celiac patients cannot consume bread, pasta, biscuit, pizza, cakes and salty cookies made of wheat etc. (Sdepanian *et al*., 1999 and Morishita *et al.*, 2003). As there is no other cereal provides proteins capable of forming dough with special characteristics like wheat does, making gluten free products become a tough challenge (Tedrus *et al*., 2001).

Thompson, (2009) reported that, the majority of whole grains including rice, corn, quinoa, sorghum, amaranth and buckwheat are excellent fiber, iron and vitamin B sources, so the gluten-free food producers are investing in the use of the aforementioned grains.

Rice (*Oryza sativa L.*) is the most worldwide consuming cereal serving as a constant food for approximately half of the population all over the world. Chaudhari *et al.*, (2018) reported that the chemical composition of milled rice includes approximately 77-89% available carbohydrates, 6.3-7.1% protein, 0.3-0.5% fat, and 0.3-0.8% ash. It considered the most principle food in the human diet and has the second largest worldwide production, after maize, providing 27% of the total energy intake in the developing countries, versus only 4% in the developed countries, it is also rich in complex carbohydrates. Moreover it has been found to be one of the most convenient cereal grain flours for making several products for celiac disease patients (Arendt and Bello, 2008). Rice flour (*Oryza Sativa*) proteins consist of orizin and orizein, which are safe for celiac patients (Tedrus *et al.*, (2001). They postulated that, the chemical composition of rice flour has a good digestibility when compared to other kinds of cereals, besides presenting 55/100 g of its protein fraction as glutenin and 25/100 g as prolamin making them with starch content, have a great retention capacity of water, mass elasticity and viscosity. Gallagher *et al.*, (2004) developed optimal rice bread formulations for celiac disease patients, which symmetry wheat bread reference standards for moisture, firmness, specific volume, and crumb and crust color. They also reported that, as the rice flour biscuit contains low fat, low calories, low cholesterol, low sodium, high fiber and free gluten, it is considered beneficial and useful especially in cases of celiac patients. The pseudocereals are gluten free grains thus considered as potential substitutes for gluten, moreover, they are nutritive and good sources of fiber (Alvarez-Jubete, *et al*., 2010).

Quinoa (*Chenopodium quinoa Willd.*) has been cultivated as pseudocereal crop in South America since centuries. The biggest exporters are Bolivia and Per!u with 88% of the worldwide production, followed by the United States of America with 6% (Brenes *et al.*, 2001). It is resistant to both frost and soil dryness and considerably is

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cultivated on poor soils, moreover it can acclimate to produce high crop under adverse conditions (Carmen, 1984 and Wilson, 1985). Quinoa flour has low content of both prolamines and glutamines thus considered gluten free. Frequently it is used to promote baking flours used in making biscuits, noodles and for the preparation of baked foods to give an acceptable flavor and to retain the moisture. It is high in protein, lysine amino acid, fiber and fat (Herencia *et al*., (1999). Moreover it is a good source of vitamin E when compared to other cereals and has a high protein quality. Coulter and Lorenz, (1990) reported the proximate composition of quinoa as follows: protein ranges from (10 to 18%), crude fat ranges from (4. 5 to 8.75%), carbohydrates ranges from (54.1 to 64.2%), ash ranges from (2.4 to 3.65%) and crude fiber ranges from (2.1 to 4.9%).

Chickpeas (*Cicer Arietinum*) are one of the most important pulses in the world, they characterized by their highest nutritional compositions compared to other edible pulses. Costa, *et al*., (2006), Sanjeewa, (2008) and Wang, *et al*., (2010) reported that, chickpeas are excellent sources of protein, complex carbohydrates, dietary fiber, vitamins and minerals such as iron and manganese. Mobarak and Soliman (2007) postulated that the chemical composition of chickpea seeds was 26.3% protein, 7.4% crude fat, 4.8%ash, 6.8% crude fiber, 54.7% total carbohydrate and total calories/100g were 385.2, respectively.

Maize (*Zea mays L.*) is the third most important cereal crop in the world after wheat and rice.

It plays an important role in feeding humans and animals. Žilić *et al*, (2010) reported the chemical compostion of white maize flour as follows: 8.55% proteins, 6.55% oil, 3.05 ash 2.19 cellulose and 67.91% starch. Moreover, Enyisi *et al*., (2014b) and Ullah *et al*., (2010) reported that maize seeds have moisture (11.6-20.0%), protein (4.50-9.87%), fat (2.17-4.43%), fiber (2.10-26.70%), ash (1.10-2.95%) and carbohydrates contents (44.60-69.60%). The storage proteins of maize kernel consist of zeins and glutelins. The zein fraction accounts for about 50 % of the total endosperm protein. Maize protein characterized as nutritionally inadequate because of the lack of the essential amino acid lysine. However, zeins rich in other essential amino acids, like methionine and cystein the sulfur amino acids (Chok-Fun Chui and Falco, 1995). Maize also provides many nutrients B vitamins along with fiber, and minerals, in addition to number of elements such as Cu, Fe, Ni, Mn and Zn Qamar *et al*.,(2017).

Sweet potato (*Ipomoea batatas (L.) Lam*) known as a patata, are cultivated in the tropics in a warm and hot climate zone. Its tubers characterized by moist and soft with desirable aromatic smell and a sweetish taste (Marczak *et al*., 2014). Ludvik et. al., (2004) and Allen et. al., (2012) reported that sweet potato has a low glycemic index so it is very beneficial in the diet of diabetics and consumers with an insulin resistance. Sweet potato is nutritious, an excellent source of complex carbohydrates, pro-vitamin A, dietary fiber and minerals like iron, calcium, potassium, and phosphorous (Singh *et al*., 2008 and Seelam *et al*., 2017).

Biscuit or cookie is one of the most popular bakery products which are consumed by all age groups. Mostly both of them are formed by using flour or blended flour replacements, fat, shortening, sugar and salt. This study was aimed to preparation of biscuit for celiac patients from gluten free cereals (rice and maize), legume (Chickpeas), roots (sweet potato) and pseudo-cereal (quinoa), and to increase the nutrition value and sensory acceptability of baked products. Thus, using several mixtures of cereals, psedocereals, legumes and root crops which are gluten-free can raise the nutritional value of biscuits in order to serve certain people, especially those suffering from gluten sensitivity. Along with the advantages of these composite flours the challenge is to achieve acceptable physical and sensory properties of the formulated products (McWatters *et al*., 2003 and Arshad *et al*., 2007).

This study aimed to formulate nutritious tasty gluten free biscuits for celiac patients by using partial replacement of rice flour with quinoa flour in order to raise the nutritional value of the product.

MATERIALS AND METHODS

Materials:

All ingredients required in biscuits preparation were obtained from local market in Cairo city, Cairo governorate, Egypt. Both peeled roasted chickpea and quinoa were milled using a laboratory mill (Mikro-Felnmuhle-Culatti Typ MFC, model polymix micro hammer mill Switzerland). Sweet potato tubers were purchased from local market and washed carefully with tap water then roasted in an oven at 160˚C for 30 min until reaching a soft texture, then allowed to cool then packaged in poly ethylene bags and refrigerated at 4˚C tell use. Before using immediately the tubers were peeled.

Methods:

Five gluten free blends were formulated using rice flour white maize flour, quinoa flour, roasted chickpea and roasted sweet potato as shown in Table 1.

The proportions of white maize flour, roasted chickpeas and sweet potato were constant in all formulas, while rice flour was replacement by different ratios of quinoa flour as shown in Table 1.

Table 1. Blends composition used for the preparation of gluten free biscuit.

Ingredients Samples	Rice flour	Quinoa flour	Maize flour	Roasted chickpea	Roasted sweet potato
Control	80	-	5	10	5
F1	75	5	5	10	5
F2	70	10	5	10	5
F3	65	15	5	10	5
F4	60	20	5	10	5

Biscuit making: For every 100 g blend the following Ingredients were added: 50 g butter, 50 g sugar, 0.25 g vanilla, 1g baking powder and half an egg. All ingredients were mixed manually until homogeneous smooth dough was obtained. Dough were sheeted to a thickness of about 5 mm approximately, cut into different shapes, then were baked at 180 °C for 30 min, cooled to room temperature and subjected to physical and sensory characteristics and to laboratory analyses. The gluten free baked biscuit from different blends are in Fig.1.

Fig. 1. Gluten free baked biscuit from different blends.

Analytical Methods: The moisture, protein, crude fat and ash were determined using standard methods of (AOAC, 2005). Carbohydrates were calculated by difference (Turhan *et al*., 2005). Iron, zinc, potassium and calcium were determined by (ICP) Inductively Coupled Plasma Emission Spectrometer (ICAP 6200); the determination was carried out in Central Laboratory for Chemical Analysis, Faculty of Agriculture, Assiut University, as described in (AOAC .1995). Amino acids were determined according to the method described by Pellett and Young (1980). With some modifications, which could be summarized as follows: A known weight of the dry, fat free samples, were hydrolyzed with 5 ml of 6 N HCl, in closed test tube at 110°C for 24h. The hydrolysate was filtered. The residue was washed with distilled water and the volume of the filtrate was completed to 50ml with distilled water. Then 5 ml of the filtrate were evaporated on water bath at 50°C. The residue was dissolved in 5 ml loading buffer (0.2 N sodium citrate buffer of pH 2.2). Amino acids were determined chromatography using Beckman Amino Acid Analyzer Model119CL, at Agriculture Research Center Giza- Cairo.

Sensory evaluation:

Samples were evaluated by 10 staff members in the Food Science and Technology Department, Faculty of Agriculture, Assuit University and who are familiar with these products. A 9 point hedonic scale (where 1 corresponding to dislike extremely to 9 represents highly liked) were used to evaluate the sensory attributes of color, taste, flavor, texture and overall acceptability of the prepared biscuits according to (Gelman and Benjamin, 1989).

Statistical analysis: The data obtained from three replicates were analyzed by ANOVA using the SPSS statistical package program, and differences among the means were compared using the Duncan's Multiple Range test (SPSS, 2011). A significance level of 0.05 was chosen.

RESULTS AND DISCUSSION

Sensory evaluation:

According to the means given by the panelists of prepared biscuits, sensory scores for studied parameters such as taste, texture, odor, color, chewing and general acceptability were given in Table 2**.** Results revealed that there were no significant differences detected among control sample and all studied formulae. All formulae were acceptable according to sensory scores for studied parameters. This indicates that replacing rice flour with quinoa flour up to 20% is acceptable and did not appear any significant differences when compared to control for the evaluated sensory properties.

Table 2. Effect of substituting rice flour with different levels of quinoa flour on organoleptic properties of gluten free biscuits:

Parameters Sample	Color	Taste	Odor	Texture	Chewing	Overall acceptability
Control	8.80[a]	8.85[a]	8.85[a]	8.75[a]	8.40[a]	8.65[a]
F1	8.90[a]	8.50[a]	8.65[a]	8.50[a]	8.20[a]	8.35[a]
F2	8.85[a]	8.35[a]	8.30[a]	8.10[a]	8.15[a]	8.40[a]
F3	8.95[a]	8.35[a]	8.50[a]	7.90[a]	8.00[a]	8.15[a]
F4	8.95[a]	8.30[a]	8.55[a]	7.90[a]	7.90[a]	7.83[a]

Although quinoa has a bitter taste that limits its use as food due to the presence of saponins which are located in the outer layers of the quinoa seeds (Ruales and Nair 1992), all prepared biscuits were acceptable and didn’t show any significant difference with control sample, because of milling and sieving quinoa seeds, therefore decrease the bitterness of quinoa thus enhance biscuits palatability. This are agreement with that observed by Farfan *et al*., (1978) who reported that, the milling process could remove the bitter compounds as an alternative to the traditionally extensive washing done before consumption. Also Suarez, Diego *et al* (2018) postulated that, approximately 34% of quinoa saponins are present in the bran, indicating that dehulling could remove almost one half of the saponins.

Proximate composition of flour samples and roasted sweet potato:

The proximate chemical composition of flour samples and roasted sweet potato used in formulating biscuits are presented in Table (3).

Table 3. Chemical composition of Ingredients (g/100g) on dry weight basis.*

Sample	Moisture	Protein**	Crude fat**	Ash**	Carbohydrate**
Rice	11.92[b]	8.40[c]	0.44 [d]	0.71[d]	90.45
Quinoa	11.62[b]	13.03[b]	3.81[b]	2.86[b]	80.30
Maize	10.73[c]	8.35[c]	1.78[c]	1.72[c]	88.15
Roasted chickpea	4.15[d]	22.09[a]	6.31[a]	3.12[a]	68.48
Roasted sweet potato	79.12[a]	5.93[d]	0.15[d]	1.48[c]	92.44

*** Data are average of three replicates.**

**** Data calculated on dry weight basis.**

Different letters in the same column Means significantly difference at p<0.05.

The moisture, ash, fat, protein and carbohydrate contents of rice, quinoa, white maize, roasted chickpea flours and roasted sweet potato are shown in Table 3. Roasted sweet potato showed the highest moisture content (79.12%) followed by rice flour (11.92%), quinoa flour (11.62%) and maize flour (10.73%). Roasted chickpea recorded the lowest moisture level (4.15%). The highest protein content was found in roasted chickpea flour (22.09%) followed by quinoa flour (13.03%) while roasted sweet potato scored the lowest protein content (5.93%). Coulter and Lorenz, (1990) found the protein content in quinoa varied from (10 to 18%). Quinoa has high protein content with a unique distribution of essential amino acids (Lopez-Rubio *et al*., 2008). The highest fat content was in the roasted chickpea flour (6.21%) followed by quinoa flour (3.82) %. Varli and Sanlier (2016) reported that, the fat content of quinoa ranged from 2.0% to 9.5% and most of the fat consists of healthy alpha-linoleic and linoleic fatty acids. None of them, can be synthesized by humans, therefore it is recommended that humans consume their needs from food sources rich of them. Roasted sweet potato and rice scored the lowest fat values (0.15 and 0.44; respectively). These results are good in agreement with that reported by Chaudhari *et al*., (2018). Roasted chickpea scored the highest ash content (3.12%) followed by quinoa flour (2.86%), while rice flour had the lowest ash content (0.71%).

Proximate composition of biscuits

Data in Table 4 observed that, moisture, protein, fat and ash contents in the formulated biscuits are increment with increasing the quinoa flour, which replacement the rice flour, in the composite blend. This may be due to the richest nutritional value of quinoa as compared to rice flour. Moisture content of biscuits increased by the replacement of rice flour with increasingly quinoa flour percent , this could be explain due to high protein content (13.03 %) of quinoa flour. This agreed with results of Dhillon *et al*., (2018). On the other hand, Mustafa *et al*., (1986) reported that the moisture content of baked products increased proportionally with the increment of their protein content. Foegeding (1989) stated that water absorption was associated with the protein content of the product, thus as the protein content increased, the viscosity increased double fold. Moreover, he declared that, the amount of binding water by proteins depends upon the amino acid composition, especially the number of polar groups. The mature quinoa seed consists of 11S-type globulin, comprising about 37% of the total protein, and also 2S albumin accounting for 35% of the seed protein both stabilized through disulfide bridges. Moreover, contains low concentration of prolamins (0.5-7% of total protein) (Koziol, 1992 and Dakhili *et al*., 2019). The protein contents of biscuit were increased with the increment of replacement level of rice flour with quinoa flour, due to higher protein content of quinoa flour (13.03%) than the rice flour (8.40%). This agreed with the results reported by Dhillon *et al*., (2018).

Table 4. Chemical composition of formulated biscuits (g/100g) on dry weight basis*.

Sample	Moisture	Protein**	Crude fat**	Ash**	Carbohydrate**
Control	4.14^{c}	8.14^{e}	20.23^{b}	1.12^{a}	70.51
F1	5.16^{b}	8.70^{d}	20.41^{b}	1.16^{a}	69.73
F2	7.08^{a}	9.24^{c}	21.25^{ab}	1.35^{a}	68.16
F3	7.17^{a}	9.62^{b}	21.76^{a}	1.45^{a}	67.17
F4	7.24^{a}	10.38^{a}	22.43^{a}	1.51^{a}	65.68

*** Data are average of three replicates.**
**** Data calculated on dry weight basis.**
Different letters in the same column Means significantly difference at p<0.05.

The analyses for fat contents of the formulated biscuits demonstrated increasing values as the percentage of rice was replaced with quinoa. The increasing in biscuits fat content may have resulted from the high oil absorption and retention capacity of quinoa flour (Dhillon *et al*., 2018 and Rufeng *et al*., 1995). The ash content of biscuits showed that control sample (C) had the lowest ash content (1.12%), while, the sample (F4) showed the highest ash content (1.51%). The ash content raised with increasing the values of quinoa flour due to the high ash content of quinoa flour (2.86%) compared to rice flour (0.71%). Similar observation was reported by Bhargava *et al*, (2006), who stated that, the ash content of quinoa (3.4%) is higher than that of rice (0.5%).

Minerals content:

Since all formulae were acceptable and there were no significant differences between the prepared biscuits according to sensory evaluation, it was better to choose the highest formula in quinoa flour content to compare with control sample in terms of their minerals content.

Data observed that substituting rice flour with 20 percent quinoa flour lead to increasing Calcium (Ca), Iron (Fe), Potassium (K) and Zink (Zn) contents as shown in Table 5.

Table 5. Minerals content in control C and F4 biscuit samples (mg/Kg)

Samples	Minerals			
	Ca	Fe	K	Zn
C	201.55	90.94	1542.91	9.35
F4	315.79	239.27	2096.34	14.55

The results in Table 5 showed that the all minerals studied were increased with replacement rice flour with 20% quinoa flour, which indicated that the quinoa flour is rich minerals. The results are compatible with that mentioned previously by Esther *et al*., (2015) who found that, Ca, Fe, and Zn contents of bread were increased by addition of quinoa flour. Nowak *et al*., (2016) reported that the Ca, Fe, K and Zn contents (mg/100g) were Ca (87, 22), Fe (9.74, 1.36), K (907, 80) and Zn (2.15, 0.57) in raw quinoa and rice; respectively. Moreover, Kozioł (1992) observed that quinoa has higher mineral contents compared to other cereals (wheat, corn and rice), especially for calcium (87 mg/100 g DM), iron (9.47 mg/100 g DM), potassium (907 mg/100 g DM), and magnesium (362 mg/100 g DM). Additionally, iron in quinoa was suggested to have a good bioavailability. Thus, substituting rice flour by 20% quinoa flour increased the biscuits mineral contents, which maximizes the benefit for celiac patients.

Amino acid composition:

Amino acids are important for growth, building muscles, healthy skin and hair, improving eyesight and nourish the brain, heart and lung, nervous system and glandular network and tendons and ligaments (Chaudhari, 2018). The amino acid profile in formulated biscuits: Control (C) and F4 (with 20% quinoa flour) mg amino acid/100 g dry weight biscuit sample are shown in Table 6.

The determination of amino acids in control C and F4 biscuit samples indicated that, the replacement of rice flour with 20% quinoa flour increased most of the amino acids values. Both of tyrosine and methionine values didn't affect by the replacement process, while the values of proline and valine were decreased from 290 to 280 and from 370 to 360 mg/100g; respectively. Lysine value increased by 12.09 % which raised from 310 mg/100 g in control sample to 350 mg /100 g in F4. Moreover, leucine, isolucine, phenylalanine and histidine values were increased by 5.88%, 7.41%, 6.06% and 12.50%; respectively.

Table 6. Amino acid composition of Control and F4 biscuit samples (mg amino acid/100 g sample on dry weight basis)

Sample	Control	F4
Amino acids	**Essential amino acids**	
Leucine	510	540
Isoleucine	270	290
Phenylalanine	330	350
Histidine	160	180
Lysine	310	350
Arginine	530	550
Therionine	260	280
Valine	370	360
Methionine	190	190
Total essential amino acids	2930	3090
	Non-essential amino acids	
Aspartic	680	730
Proline	290	280
Serine	330	340
Glutamic	1200	1130
Glycine	240	280
Alanine	370	390
Cystine	240	260
Tyrosine	300	300
Total non essential amino acids	3650	3710
Total amino acids	6580	6800

The observation of Elsohaimy *et al*., (2015); USDA, (2015) and Kozioł, (1992) indicated that, methionine + cysteine content in both quinoa and rice flours scored the same value 3.6 g/100g protein, whereas, valine values were higher in rice (6.1 g/100g protein) than quinoa (4.2 g/100g protein). Ruales and Nair (1992) found that, the first limiting amino acids in quinoa were the two aromatic amino acids, tyrosine and phenylalanine. The content of lysine, methionine and cystine is high in quinoa protein compared to most food proteins of plant origin which are usually deficient in lysine which considered being important for the digestibility of food and for its nutritional quality (Huebner *et al*., 1990). Moreover, Bhargava *et al*, (2006) reported that, lysine is present in relatively higher amounts in quinoa seeds. (Escuredo *et al*., 2014) reported that lysine content in quinoa verities ranged from 1.55 to 2.83 g/100g protein, while Santos *et al*., (2013) found the lysine content of rice (oryza sativa) was 0.34 g/100g protein and they reported also that rice (*Oryza Sativa*) contains 0.48 proline, 0.53 tyrosine, 0.24 methionine and 0.57 valine (g/100g protein). Escuredo *et al*., (2014) observed that quinoa flour contain (0.05- 0.61), (0.77- 1.77) and (0.22- 1.83) g/100g protein methionine, tyrosine and valine respectively, depending on genotype.

The replacement of rice flour with 20% quinoa flour led to an increase of 5.46 and 1.64 % in the values of the total essential amino acids and total non-essential amino acids; respectively. While the ratio of essential amino acids of sample C was 1 to 1.05 of sample F4.

CONCLUSION

It could be concluded from this study that quinoa flour can be replaced the rice flour in the blend, consists of rice, maize, chickpea flours and sweet potato, up to the level of 20% to make gluten free biscuit, which was acceptable to the consumers with good sensory properties as color, texture, odor, taste, chewing and overall acceptability. Using roasted chickpea didn't affect either taste or odor, where the bean flavor was not sensed, therefore, it is useful to use a higher percentage of its flour to enhance the nutritional quality of the product. The use of 5% roasted sweet potato was appropriate in order to break hardness, and using a higher percentage led to undesirable soft texture. This study will help to improve the nutritional aspects and health status of people suffering from gluten intolerance.

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الخصائص الفيزيائية والتغذوية للبسكويت الخال من الجلوتين , المجهز باستخدام عدة حبوب مع البطاطا الحلوة المشوية

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تم إجراء الدراسة الحالية بغرض تحضير البسكويت الخالي من الجلوتين من مخلوط دقيق متعدد الحبوب يتكون من الأرز (80٪) والذرة (5٪) والحمص المحمص (10٪) وكذلك البطاطا الحلوة المحمصة (5٪) . إن نسب الخليط هذه ثابتة وتُعتبر كنترول ، في حين تم استبدال دقيق الأرز في المعالجات الأخرى بنسبة مختلفة من دقيق الكينوا (5 ، 10 ، 15 و 20٪). تم تقييم البسكويت المخبوز من حيث التركيب الكيميائى ، ونمط الأحماض الأمينية ، والصفات الحسية والكالسيوم (Ca) ، والحديد (Fe) ، والبوتاسيوم (K) ، ومحتوى الزنك (Zn). أظهرت النتائج أن استبدال دقيق الأرز بدقيق الكينوا قد حسن من القيمة الغذائية للبسكويت حيث تمت زيادة محتويات البروتين والرماد وال Fe و Zn و Ca و K. ازدادت قيم الأحماض الأمينية باستثناء التيروزين والميثيونين ، واللذان لم يتأثرا بعملية الإحلال ، في حين انخفضت قيم البرولين والفالين. كانت جميع عينات البسكويت المخبوزة مقبولة ولم تكن هناك أي اختلافات في الخصائص الحسية من حيث اللون والملمس والرائحة والذوق والمضغ والقبول العام.