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# RESEARCH STUDY TO BENEFIT OF QUINOA, CHICKPEAS AND SOME VEGETABLES IN FOOD APPLICATIONS FOR PATIENTS WITH GLUTEN INTOLERANCE AND ITS IMPACT ON THE CHARACTERISTICS OF THE FINAL PRODUCT

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**ABSTRACT**

*Gluten is one of the most abundant components of food particular grains. It is a composite of the proteins gliadin and glutenin. Celiac disease patients must consume food with gluten substitutes or gluten free grains. For this reason, quinoa and chickpea are excellent gluten-free foods, with a high content of vitamins and minerals that make it a potentially essential part of any healthy, gluten-free diet. So this search aimed to a research study to benefit of quinoa, chickpeas and some vegetables in food applications for patients with gluten intolerance and its impact on the characteristics of the final product. Sensory evaluation (taste, colour, smell, texture, appearance structure and overall acceptability) of Quinoa crackers with bill, beet and potatoes showed overall acceptability (4.56±0.2, 4.72±0.1and 4.856±0.02) respectively, but the best results observed in Quinoa crackers with potatoes (4.856±0.02). Chickpea biscuit was showed the best results in sensory evaluation compared with Quinoa products (4.8±0.31, 4.9±0.4, 5±0.004, 5±0.05, 4.7±0.87 and 4.88±0.1) respectively. The results of chemical compostion of Quinoa and chickpea showed high content of protein, Ash, fiber and carbohydrate (12.87 ±1.3, 2.46 ±0.05, 5.11 ±0.44 and 63.57 ±0.61) and (21.49±0.3, 8.0±0.21, 1.51±0.01 and 60.71±0.5) respectively, also, the vitamins content of quinoa and chickpea (B1, B6, B12, C and E) are recorded high levels (0.38 ±0.3, 0.18 ±0.12, 0.63 ±0.4, 1.37 ±0.01 and 54.36 ±0.8) and (0.34 ± 0.02, 53.64±2.1, 0.00 , 1.29 ±0.1 and 0.36 ±0.03 ) respectively. The mineral content (calcium, phosphorus, potassium, magnesium and iron) of quinoa seeds and chickpea were recorded (426.59±0.1, 2728.0±0.8, 3431.98±0.3, 1149.19±0.2 and 24.98±0.08) and (129.67 ±0.11, 218.29 ±0.3, 149.68 ±1.3, 163.29 ±1.72 and 3.96 ±1.6) respectively. Conclusion: It can be formed gluten free bakery products with high nutritional value and good quality properties by using Quinoa with some vegetables and chickpea.*

*Keywords: Quinoa, chickpea, crackers, biscuits, free gluten.*

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## INTRODUCTION

There is some glutein flours that have been reported to be successful in making pasta such as amaranth flour, rice flour, millet flour, maize flour, modified cassava flour, quinoa flour, buckwheat flour, or a mixture thereof **(Yulianti et al.,2019 and Sholichah et al., 2020). (Shokry, 2016; Nisar et al., 2017; Dimitrios Bilalis et al., 2019)** studied the Quinoa as a new, alternative crop and complete food, it marketed as a" Super food" for its unique nutritional properties particularly its high content of good quality protein, lipids, carbohydrates, minerals, vitamins like B, C, E and low Saponins content, and its functional properties, which it can be used as an alternative to milk protein and it has beneficial hypoglycemic effects (**Videiros et al., 2015; Food Chem.2019; Viktória Angeli et al., 2022**). Quinoa is highly appreciated among human's nutrition and animal. It is a great importance for the industry, so it may be suggested as a new alternative crop because of its characteristics nutritional and economic value. Quinoa contains higher amounts of protein and greater balance in the distribution of essential amino acids, particularly rich in lysine of quinoa grains are higher than other cereals such as wheat, rice and maize, addition to it resembling the biological value of milk protein. It exceeds cereals in the amount of lipids, proteins, dietary fiber, and minerals, mainly calcium, phosphorus, iron and zinc **(González Martín et al., 2014; Cooper, 2015; Gajendra et al., 2019).** It contains protein (14-18%), starch (48-69%), lipid (4.4-8.8%) and unsaturated fatty acids of the dry matter in quinoa **(Gordillo Bastidas et al., 2016; Li and Zhu, 2017)**, a good source of dietary fiber (7-10%), lysine (5.1-6.4%) and methionine (0.4-1.0%) **(Abugoch, 2009),** also have amino acids balanced **(Abdellattif, 2018).** Quinoa protein is gluten free to be used for people with celiac disease **(Mota et al., 2015). (Arneja et al., 2015)** reported that lysine content of quinoa (5.6%) is double as compared to wheat (2.8%). In addition, amino acids cysteine and methionine (3.1%). It is also rich in micronutrients particularly potassium, vitamins (B6 and Folate), rich in natural

antioxidants activity and bioactive compounds like polyphenols than amaranth **(Paśko et al., 2009; Repo-Carroso et al 2011 ;Stikic et al., 2012; Tang et al., 2016)** and large amount of flavonoids, including quercetin and kaempferol. It has the highest content of its bioactive compounds compared to other cereal and pseudo cereal crops **(Hirose y-Fujta et al 2010)**. Quinoa is much higher in fiber that most grains, and Polyphenols such as phenolic acids, flavonoids and tannins, which act as powerful antioxidants components are reflect to have many potential serviceable health effects such as anti-aging, anticarcinogenic and anti-inflammatory activities, cardio vascular protection and improvement of endothelial function. Polyphenols also inhibit angiogenesis and cell proliferation **(Han et al.2007).** There are some studies used quinoa in food industrial such as **(Ali Gomaa et al., 2019)** evaluated the effect of different pre-treatment (dehulling process and treated with water) on physical, chemical and quality characteristics of flour produced from quinoa seeds, The obtained results revealed that, the Saponins content reduced significantly**,** protein content was slightly decreased , fat and ash content were low, while the total carbohydrates content was high and the highest macro and micro elements were potassium and iron, respectively. Also, results indicated that using of quinoa flour in preparation of cake at levels 25, 50, 75 and 100% did not affected on color and odor of cake. The best acceptance was up to 50% of the cake substitution level, so quinoa flour can be used as a substitute of wheat flour in cake production. Also, **(Nickel et al., 2016)** reported that the washing process under running water increasing the total phenolic compounds, antioxidant capacity and reducing the content of Saponins, thus decrease the bitter taste of quinoa seeds. Quinoa flour has ingredients such as minerals (potassium, sodium, magnesium, calcium and soluble iron). It has different kinds of vitamins such as B3, B6, B9, and C that are vital for human metabolism and prevention of several diseases. Quinoa is very high in minerals and phytic acid. Its natural antioxidants such as phenolic compounds and flavonoids are helpful in treatment of degenerative diseases **(El Sohaimy et al., 2018),** also it had high amount of unsaturated fatty acids including the essential fatty acids such as oleic, linoleic or erucic acids, except total carbohydrates **(Lamia Lotfy and Mona Naga, 2020).** Quinoa flour used in desserts, muffins and breads. The protein in quinoa flour helps to give your bread same structure and will improve the overall texture. It's too high in carbohydrates for keto diet and also has a high glycemic index (**Ballester sanchez et al., 2019).** Legumes flour is an ideal ingredient for improving the nutritional value of bread and bakery products **(Hefnawy et al., 2012 and Koubaier et al., 2015).** Chickpea has a high protein, high levels of complex carbohydrates, is rich in vitamins and minerals **(Wood and Grusak, 2007),** Chickpea also, consists of various nutrients and chickpea proteins are high in all essential amino acids, including lysine and threonine **(Meng et al., 2010).** Chickpea proteins are considered a suitable source of dietary protein due to the excellent balance of essential amino acid composition **(Zhang et al., 2007).** Chickpea has been shown to provide a variety of medicinal and therapeutic effects, including antihypertensive and antihyperglycemic activity **(Mokni et al., 2015 and Li et al., 2015).** Chickpeas can be consumed in many different ways, boiled, roasted, pressure-cooked, or used as an ingredient in many food formulations after milling (Alajaji and El-Adawy, 2006; Ma et al., 2011). There are numerous studies about using chickpea in nutritional applications such as **(Miñarro et al., 2012; Burešová et al., 2014; Aguilar et al., 2015)** used Chickpea and tiger nut flours as alternatives to emulsifier and shortening in gluten-free bread to development the bread. **(Gokcen Kahraman et al., 2022)** investigated impact of raw, roasted and dehulled Chickpea flours on technological and nutritional characteristics of gluten-free bread to develop healthy rice-based gluten-free bread, the results of this study indicated that the enrichment of rice-based gluten-free breads with chickpea flours improved the technological and nutritional quality of the breads differently. **(Galila et alk., 2021)** investigated processing Gluten- Free noodles fortified with Chickpea flour, results showed an increment in protein content (9.23 – 16.54 %), fat (2.64 – 4.14 %) and ash (1.91 – 2.71 %). Fortification with chickpea flour also, reduced cooking time (8.5 – 7.32 min). Chickpea flour can be successfully using in the noodles formula and improving the nutritional quality of noodles, the black rice-chickpea noodles are a nutritional alternative to traditional rice noodles, as well as providing variety to dietary categories for celiac disease sufferers. **(Eman Abd El-Hamid Ahmad Abd Rabou, 2017)** investigated the effect of Enriched Gluten Free Biscuits with Chickpea Flour or Kareish Cheese on Chemical, Nutritional Value, Physical and Sensory Properties, the results showed increasing the moisture, protein, ash and fat. However carbohydrates contents were decreased compared to the control samples on both types of biscuits, also, increased the nutritional value compared to the control samples. Moreover, physical properties as the diameter of both biscuits were gradually decreased, but the thickness was increased. Also, all salty biscuits had high sensory properties. So, it can be formed gluten free biscuits with high nutritional value and good quality properties by adding chickpea flour by small quantity or kareish cheese by medium quantity. In this research we used quinoa seeds and chickpea as healthy alternatives for glutein sensitive patients.

## MATERIAL AND METHODS

### Material

-Quinoa seeds, chickpeas and some vegetables (dill, beet and potatoes), salt, egg, butter, corn oil, full fat milk powder, vanilla, baking powder were obtained from the local market, Najran, Saudi Arabia.

-Sensory evaluation of quinoa and chickpea products.

-Twenty persons (female) suffering from gluten intolerance, age 18 to 40 years participated in sensory evaluation of glutein free products.

**Methods**

**Preparation of Composite Flour**

-Quinoa seeds and chickpeas washed well, cleaned, dried and crushed using electric blender to obtain a fine powder, and stored at room temperature (25 ± 2°C) till using and chemical analysis.

**Preparation of quinoa, chickpea and some vegetables to make bakery free gluten (crackers and biscuit)**

-Quinoa was washed and soaked in water for about 6 hours, then the water was filtered and a quantity of water was placed on the quinoa and placed on the fire for ten minutes, then filtered from the water.

-Preparing vegetables, the beets, sweet potatoes and dill were washed, the beets and potatoes were boiled, then removing the skin and cutting.

- Chickpeas were washed and soaked for 8 hours, then filtered and a quantity of water was put on it and boiled. After boiling, it was washed again.

**Preparation of crackers and biscuit**

-Crackers and biscuits were prepared according to the formula shown in **Table (1)**. Using Quinoa seeds with some vegetables such as dill, beet and potatoes to make crackers, they were mixed well and shaped as circles an outer diameter of 60 mm with 3 mm thickness. Then, the crackers were baked at 180 °C for 10 min. Finally, after cooling at room temperature crackers samples for sensory evaluation.

-A cup of quinoa with a quarter cup of beet and lemon juice put in an electric blender with spices such as paprika, cumin, black pepper and salt until the texture becomes smooth, then form it, and put it in the oven at 180 °C.

- Put a cup of quinoa with a quarter cup of potatoes, spices and mix until the texture becomes smooth, then form and put it in the oven.

- Put a cup of quinoa with a quarter of a cup of chopped dill and spices and mix it in a blender until the texture becomes smooth, form it and put it in the oven.

- Biscuits were prepared according to the procedure described by AACC (2000). A cup of boiling chickpea was put in the blender and mixed until the texture became smooth, then two tablespoons of butter were added, a quarter cup of sugar, eggs, vanilla and baking board, mixed by hand, then put into the oven 160 $^{o}{}_{C}$

Butter and sugar are whipped until they become creamy. Other dry ingredients were added to the cream, and then the dough was shaped as fingers or slides an outer diameter of 60 mm with 3 mm thickness. Then, the biscuits were baked at 180 to 190 C for 20 min. Finally, after cooling at room temperature biscuits samples for sensory evaluation**.**

**Table 1:** The formula of crackers and biscuit samples

| Ingredient/ gm | Crackers with quinoa | | | Biscuits with chickpea |
|---|---|---|---|---|
| | Quinoa with dill | Quinoa with beet | Quinoa with Potatoes | |
| Quinoa | 75 | 75 | 75 | _ |
| Chickpea | _ | _ | _ | 200 |
| dill | 25 | _ | _ | _ |
| Black pepper | 5 | 5 | 5 | _ |
| cumin | 5 | 5 | 5 | _ |
| paprika | 5 | 5 | 5 | _ |
| Beet | __ | 25 | _ | _ |
| Lemon juice | _ | 10 | _ | _ |
| Potatoes | _ | _ | 25 | _ |
| Butter | _ | _ | _ | 40 |
| Sugar | | | | 50 |
| Hen egg (whole) | _ | _ | _ | 20 |
| Baking powder | _ | _ | _ | 5 |
| Vanilla | _ | _ | _ | 5 |
| water | 20 ml | 20 ml | 20 ml | _ |
| salt | 5 | 5 | 5 | A pinch of salt |

*Quinoa: 75%, 25% bill, 25%beet and 25%potatoes. *Chickpea 100%

**Chemical composition of quinoa seeds and chickpea**

The contents of moisture, ash, crude protein and crude fat in quinoa seeds, chickpea was determined according to (**A.O.A.C, 2007).** Carbohydrates were determined by difference.

**Determination of Minerals**

The content of iron, calcium, phosphorus, potassium and magnesium were determined in quinoa seeds and chickpea using atomic absorption spectrum (**A.O.A.C, 2007).**

**Determination of Vitamins**
The content of vitamin B1, B6, B12, C and E were determined in quinoa seeds and chickpea using atomic absorption spectrum (**A.O.A.C, 2007).**

**Sensory Evaluation**
Twenty persons from the staff members of nutrition and Food Science Department, Faculty of education, Najran University were asked to evaluate taste, color, smell, texture, structure and overall acceptability of the processed quinoa and chickpea with some vegetables according to **(Ares et al., 2009).**

**Statistical Analysis**
ANOVA was used to test statistical differences in sensory attributes between the samples of quinoa and Chickpea (n=4), the results were expressed as means ± stander deviation (SD). Statistical significance was considered at $p<0.05$. Results and discussions.

**Table. 1:** Sensory evaluation average of quinoa crackers with some vegetables and chickpea biscuits.

| Sensory evaluation | 75% Quinoa crackers with | | | 100% Chickpea biscuit |
|---|---|---|---|---|
| | 25% Dill | 25% Beet | 25% Potatoes | |
| Taste | 4.6±0.2 | 4.7±0.5 | 4.98±0.1 | 4.8±0.31 |
| Colour | 4.5±0.5 | 4.8±0.13 | 4.7±0.01 | 4.9±0.4 |
| Smell | 5±0.00 | 4.6±0.11 | 4.8±0.21 | 5±0.004 |
| Texture | 4.2±0.3 | 4.7±0.02 | 4.9±0.33 | 5±0.05 |
| structure | 4.5±0.4 | 4.8±0.05 | 4.9±0.1 | 4.7±0.87 |
| overall acceptability | 4.56±0.2 | 4.72±0.1 | 4.856±0.02 | 4.88±0.1 |

*Values are expressed as mean ±SD. *Significant at $p<0.05$ using one way ANOVA test.

**Sensory Evaluation**
Data presented in **table 1** showed sensory evaluation average of quinoa crackers with some vegetables and chickpea biscuits, which a panel of 20 evaluators performed the sensory evaluation (taste, colour, smell, texture, appearance structure and overall acceptability) of the final seeds with some vegetable's products. The sensory evaluation of partial parameters has been chosen on a scale of 1–5, where 1 is the worst, 5 is the best. The goal is to predict consumers' acceptability of food products according to **(Aschemann-Witzel et al., 2019).** These results showed that sensory evaluation of all Quinoa products was good respectively (4.56±0.2, 4.72±0.1and 4.856±0.02), but the best results observed in Quinoa crackers with potatoes (4.856±0.02), these results confirmed with those by **(Hanan Sayed et al., 2019)** who studied the nutritional applications of Quinoa seeds and their effect on diabetic rats, sensory properties of both quinoa pudding and quinoa soup showed insignificant differences. Chickpea biscuit also, showed overall acceptability (4.88), this result is in agreement with those of **Yamsaengsung et al., (2012).** All formulas of biscuits were acceptable, but the best form of sweet biscuit which had 10% chickpea flour.

**Table (2):** Chemical composition of Quinoa seeds and Chickpea of macronutrients (g/100 g)

| Nutrients grain and legume | Protein | Fat | Moisture | Ash | Fiber | Carbohydrate |
|---|---|---|---|---|---|---|
| Quinoa | 12.87 ±1.3 | 4.13 ±0.21 | 11.69±0.3 | 2.46 ±0.05 | 5.11 ±0.44 | 63.57 ±0.61 |
| Chickpea | 21.49±0.3 | 4.88±0.1 | 8.21±0.04 | 8.0±0.21 | 1.51±0.01 | 60.71±0.5 |

*Results are presented as means ± standard deviations (SD). The difference in values at ($p>0.05$).

Data presented in **Table (2),** the chemical composition of the quinoa seeds powder and chickpea on dry weight basis were illustrated. The present results showed that quinoa had the highest content of protein, Ash, fiber and carbohydrate (12.87 ±1.3, 2.46 ±0.05, 5.11 ±0.44 and 63.57 ±0.61) respectively, these results agreement with the study of (**Vega-Galvez et al., 2010),** the quinoa has higher content of vegetable protein than found in wheat, rice, barley, rye, corn, sorghum and maize, also the study of **(Lamothe et al., 2015)** who found that quinoa is source of dietary fiber (2.6% - 10%) of the total weight of the grain. Quinoa also has a high biological value (73%), it is an excellent protein source such as beef (74%), and higher than white rice (56%), wheat (49%) and corn (36%). Quinoa also contains all ten essential amino acids, and its protein content ranges from 12.9 to 16.5% **(Meneguetti et al., 2011; Ruini et al., 2015)**. According to the daily recommended amounts of amino acids indicated by the Food and Agriculture Organization (FAO) of the United Nations and by the World Health Organization (WHO), quinoa fulfills the amino acid requirements for adults: 180% of histidine, 274% of isoleucine, 338% of lysine, 212% of methionine+cysteine, 320% of phenylalanine+tyrosine, 331% of threonine, 228% of tryptophan and 323% of valine (20). For these reasons, quinoa could represent a valuable source of nutrition, especially for infants and children, and may be used in nutritive foods and beverages **(Abugoch et al., 2008**). According to **(Saturni et al., 2010)** the content of starch in quinoa ranges from 58.1% to 64.2% of dry matter, of which 11% is amylose. Moreover, quinoa has a high content of D-xylose and maltose and a low content of glucose and fructose. 100 g of quinoa contains:

Glucose 1.70 mg, fructose 0.20 mg, saccharose 2.90 mg and maltose 1.40 mg**.** In addition, there are studies that suggest that quinoa polysaccharides have antioxidant properties **(Yao et al., 2014).** The total lipid content of quinoa is 14.5%, with approximately 70%-89.4% being unsaturated (38.9%-57% of linoleic acid, 24.0%-27.7% of oleic acid and 4% of α-linolenic acid). The total lipid content of quinoa is 14.5%, unsaturated 70%-89.4% include (38.9%-57% of linoleic acid, 24.0%-27.7% of oleic acid and 4% of α-linolenic acid). The unsaturated fatty acid content is protected by vitamin E in this plant. The content of omega-6: omega-3 in quinoa is about 6:1 **(Tang et al., 2015).** According to **(Lamothe et al., 2015)** Quinoa is an excellent source of dietary fiber, it content 2.6%-10% of the total weight; about 78% of its insoluble fiber and 22% soluble. And chickpea had the highest content of the same nutrients (21.49±0.3, 8.0±0.21, 1.51±0.01 and 60.71±0.5) respectively, these results of the chemical composition of chickpea flours was confirmed by those of **El-Shimy (2013) and Wani and Kumar (2014).**

**Table (3):** Quinoa seeds and Chickpea content of vitamins and minerals (mg/100 g)

| Nutrients grain and legume | Vitamins mg/100 g | | | | | Minerals mg/100 g | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **B1** | **B6** | **B12** | **C** | **E µ/1 g** | **Ca** | **P** | **K** | **Mg** | **Fe** |
| Quinoa | 0.38 ±0.3 | 0.18 ±0.12 | 0.63 ±0.4 | 1.37 ±0.01 | 54.36 ±0.8 | 426.59 ±0.1 | 2728.0 ±0.8 | 3431.89 ±0.6 | 1149.19 ±0.2 | 24.98 ±0.08 |
| Chickpea | 0.34 ± 0.02 | 53.64 ±2.1 | 0.00 | 1.29 ±0.1 | 0.36 ±0.03 | 129.67 ±0.11 | 218.29 ±0.3 | 149.68 ±1.3 | 163.29 ±1.72 | 3.96 ±1.6 |

*Results are presented as means ± standard deviations (SD). The difference in values at (p>0.05).

The vitamins content of quinoa and chickpea (B1, B6, B12, C and E) are presented in **Table (3)** that recorded high levels (0.38 ±0.3, 0.18 ±0.12, 0.63 ±0.4, 1.37 ±0.01 and 54.36 ±0.8) respectively, these results were agreement with **(Vega-Gálvez A, Miranda et al., 2010 & Tang et al.,2015),** and chickpea was recorded high levels of vitamins B , C and E (0.34 ± 0.02, 53.64±2.1, 0.00 , 1.29 ±0.1 and 0.36 ±0.03 ) respectively, these results were agreement with **(Jukanti et al., 2012 & Danuta Rachwa Rosiak., 2015 & Shiqi Xia et al., 2022)** reported that chickpea is a good source of important vitamins such as riboflavin, niacin, thiamin, folate and the vitamin A precursor, β-carotene. The mineral content (calcium, potassium, magnesium and iron) of quinoa seeds and chickpea were recorded (428.65±0.2, 3438.98±0.3, 1151.21±0.4 and 26.97±0.05) and (129.67 ±0.11, 218.29 ±0.3149.68 ±1.3, 163.29 ±1.72 and 3.96 ±1.6) respectively. According to **(Vega- Gálvez et al., 2010)** mentioned that Quinoa contains magnesium, calcium and potassium, these minerals are considered to make sufficient balanced diet. Calcium, magnesium and potassium in quinoa are found in sucient quantities. It contains 874 mg/kg of Calcium **(Sharma et al., 2012)**, 948.5 mg/kg iron, 2735.0-4543.3 mg/kg phosphorus, 9562.2 mg/kg potassium and 1901.5 mg/kg magnesium **(Nascimento et al.,2014).** According to **(Vega-Gálvez et al., 2010)** studied nutrition facts and functional potential of quinoa, an ancient Andean grain, vitamins are compounds essential for the health of humans, 100 gm of Quinoa containing 0.4 mg thiamine, 1.4 mg vitamin C, 0.20 mg vitamin B6, and 0.61 mg pantothenic acid , Vitamin E content ranges 37.49-59.82 µg/g **(Tang et al., 2015).** Also, quinoa seeds contained a considerable amount of B2, B6, B9, B12, E and beta carotene equal to 0.60, 5.83, 6.80, 0.27, 2.010 and 0.127 mg/100g, respectively **(Hanan Sayed et al., 2019**). P, Mg, and K are minerals that are necessary for human health. They've been recommended as having the potential to prevent people against obesity and metabolic diseases **(Cai et al.,2016).**The phosphorus (220.15), magnesium (165.23), and calcium (130.54) content of chickpea flour was higher. This results in agreement with those of **Dandachy et al. (2019).**

## CONCLUSION

Quinoa use could improve the phytochemicals that are known to be beneficial to human health. Quinoa is an attractive, gluten-free alternative available to celiac patients, and including quinoa in the diet may prove to be a good strategy for consuming high biological value proteins as well as all essential amino acids. Quinoa also contains unsaturated lipids, fiber, complex carbohydrates and other beneficial compounds such as betaine. As for culinary applications, the replacement of refined flour by whole grains such as quinoa to incidence the including changes in organoleptic properties. Chickpea flour also, can be successfully used in bakery products to improve the technological process quality. The addition of chickpea flour created a healthier alternative for patients with gluten intolerance, which Chickpea-fortified possessed more protein and other chemical components. Fortification level was satisfactory and highly rated in terms of color, taste, odor, texture and overall acceptance.

**Samples of Quinoa and Chickpea with some vegetables**

**Quinoa with dill**

**Quinoa with beet**

**Quinoa with Potatoes**

**Chickpea biscuits**

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