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The Impact of Substituting Wheat Flour with Several Gluten-Free Flours (Coconut, Peas, Almond and Quinoa Flours) on Rheological Dough

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EATING gluten-free is recognized to be good for a variety of different health issuesand has been popular recently. This study's goal was to investigate the impact of wheat flour partial replacement (40%) with 5 gluten-free flours (60%) that considerably high nutritive value. The percentage of these flours is added as follows: first Sample:Wheat flour 100 % as control Sample ,samples:(2th, 3th, 4th and 5th): 40% of wheat flour (WF) + 60% of (peas flour(PF), coconut flour (CF), almond flour (AF) and quinoa flour (QF). The chemical composition, mineral content and amino acids of all flour were determined. The rheological characteristics using farinograph, extensograph instruments, and sensory evaluation for all flours were also investigated. The results showed that the highest calcium, magnesium, and phosphorus amounts were found in almond flour (268.00±8.04, 280.00±7.40 and 487.00±7.02, respectively). The highest amount of iron was found in quinoa flour (5.33±1.10).There were high values of all amino acids found in almond flour, followed by quinoa flour. Farino and extensograph evaluation revealed that sample WF40 % + AF 60% has the greatest levels of water absorption, dough development, stability, and extensibility (63.5%, 5.5min, 15.5 min and70 mm respectively). On other hand, evaluation of the organoleptic properties of toast breadrevealed that bread produced from coconut and almond flour had acceptable values of taste (9.72±1.25 and 9.56±0.88) compared with wheat control breadThis study's findings give important insights into GF flours and may aid in the creation of innovative gluten-free items such as bread, biscuits, and other baked products.

Keywords: Almond, Quinoa, Farinograph, Extensograph, Sensory evaluation.

Introduction

Wheat flour is exceptional among edible grains because it includes the protein complex known as "gluten", which may be molded into dough with the physical qualities necessary for the manufacture of baked bread (Jing et al., 2022). Gluten is the rubbery substance left over after washing wheat dough to remove particles and proteins ingredients which are soluble in water. In wheat dough, the concentration of wet gluten was 17.35 to 29.65% (žilić et al., 2011c).Through study, methods for converting wheat protein into more valuable items have been discovered. Enzymatic hydrolysis is one method for effectively applying wheat gluten, and it is commonly used in the food industry to enhance quality. Qualities like fluidity, gelatinization, and film formation, or to produce completely hydrolyzed proteins for allergenic newborn meals and nutritional treatment, the interactions between wheat starch WS and gluten are mainly concerned with the effect of gluten on the pasting properties and nutritional functions of WS (Xu et al., 2021).

Monomeric gliadins and polymeric glutenins make up gluten proteins. Glutenins and gliadins are proteins found in wheat, accounting 60-75% of total grain proteins. They include a lot of asparagine, glutamine, arginine, and proline but not much lysine, tryptophan, and methionine, which are nutritionally important amino acids (Shewry, 2007). Adherence to the gluten-free diet, the gold standard in celiac disease therapy,

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is significant in alleviating clinical symptoms, preventing long-term celiac disease-related problems, enhancing dietary habits and life quality (Bascunán et al., 2017). Gluten-free diets are also popular among those who do not suffer from gluten-related illnesses, the rate of persons avoiding gluten increased more than thrice in the United States recently (Choung et al., 2017). These gluten-free grains are abundant in protein, fiber, and minerals .These grains also include a number of bioactive chemicals that are beneficial to one's health (Alvarez-Jubete et al., 2010).

The negative impacts of a gluten-free diet on diet quality include insufficient vitamins as well as increased consumption of high-fat foods (Niland & Cash, 2018). Gluten-free meal consumption reduces carbohydrates and minerals, and increases fat intake, especially among ketogenic diet adherents and athletes (Rosell & Matos, 2015). According to a study of packaged food labeling, gluten-free goods had more fat and carbohydrate content and less protein than gluten-containing items (Kulai & Rashid, 2014). Bread is utilized in both developed and developing countries. Wheat flour, both soft and hard wheat classes, has long been an important component in leavened bread due to its functional proteins. Many attempts have been taken to boost consumption of fortified flour, in which a proportion of wheat flour is replaced for use in bread by locally cultivated crops, cutting the cost of crucialwheat(El Tanahy et al., 2021). Cookies-type biscuits and toast have a prolonged shelf life and are well-accepted by customers of all ages (Mareti et al., 2010), making them desirable for the creation of new items like gluten-free meals. Volume, colour, and texture, which have a direct impact on consumer acceptability, should be addressed while designing new items (Bassinello et al., 2011).

Nuts are high in nutritive value, and they have an excellent essential amino acid balance, but with a slight lysine deficiency. Because consuming nuts and edible seeds has been linked to a lower incidence of chronic illness, these foods provide protein and bioactive chemical sources for vegetarian diets (Freitas & Naves, 2010). Coconut (*Cocos nutrifera Linn*.) is a member of the Arecaceae family (palm family), it is a commercial plant that is grown in the majority of tropical countries. Coconut is a great energy source just because it contains 37.29% fat, 11.29% carbohydrate, and 4.08% protein (Navneet & Akhilesh, 2020). CF may supply the industry with not just value added revenue, but also a nutritious and healthful source of dietary fiber (Onsaard et al., 2006). Coconut flour helps in regulating cholesterol and blood sugar levels, as well as prevents colon cancer. According to research, eating coconut flour improves fecal mass .Coconut flour is a wonderful source of distinct flavor and aroma, as well as being high in vitamins, minerals, and dietary fibers, and it has use in bakery and human nutrition (Shakhawat et al., 2016).

Almond seed is high in proteins (30%), lipids (40%), and fiber (12%). Furthermore, almonds are a good supply of minerals, including Ca, Fe^{++} and Z (Sousa et al., 2011; Czeder et al., 2012). Along with its nutritional value, the almond is gluten free and has become a popular native fruit in Brazil owing to its health benefits, as documented in a clinical study (Bento et al., 2014), while research on its therapeutic potential is scarce. QF is a gluten-free which contain a high fiber content, great biomass significance proteins, and necessary fatty acids (□-3 and □ -6), vitamins, and minerals .Moreover , quinoa flour has shown to improve the sensory properties of bakery goods such as bread and cookies (Stikic et al., 2012). Because the starchy seeds of quinoa have properties comparable to wheat, it may also be utilized in baking (Gómez-Caravaca et al., 2011). Due to its nutritional and wellbeing features, Pea (*Pisum sativum L.*), a leguminous crop, is majorly processed into canned, dehydrated, and frozen forms , Pea pods not only yield an adequate quality of dietary fiber but provide a substantial amount of proteins, sugars, and minerals. The pea pods consist of appreciable amount of polyphenols including phenolic acids (Nasir et al., 2022). Although attempts have been developed to increase the nutritional value of bread by using legumes (Dalgetty & Baik, 2006), few articles have focused on enhancing the nutritive value of wheat-based flour (Serna et al., 2004).

Brabender Farinograph and Extensograph are two of the main analytical instruments that are commonly used for evaluation of rheological characteristics of dough and prediction of baking quality of flour in Chemistry of Cereals and Technology Laboratories. Farinograph is mostly used for evaluation of dough strength and dough stability whereas Extensograph is for determination of dough energy and dough extensibility. The indicator line for evaluating rheological properties according to Farinogram and Extensograph is Brabender 500 unit line. As standard methods for farinograph and extensograph studies are developed for volume and loaf breads, study of correlations of Farinograph and Extensograph parameters with bread quality factors seemed (Bin et al., 2017). As a consequence, this research was done to investigate the effect of 40% wheat flour partial substitution (72% extraction) with 60% of free gluten flours of quinoa flour (QF), almond flour (AF), coconut flour (CF) peas flour (PF) using farinograph and extensograph instruments for dough rheological measurements, whilethe sensory evaluations were carried out to assess the toast quality to enhance and introduce a product with high protein value and high energy value suitable for people with stomach obese and who suffered from stomach disturbances and individuals on ketogenic-diet. Furthermore, in this study we focused on overall changes in product quality to provide new ideas for an overall innovation in the gluten-free food market.

Materials and Methods

Materals

Flour of wheat (72% extraction rate), peas, coconut, almond, and quinoa were purchased from a local market in Cairo, Egypt. All chemicals and reagents were analytical grade and came from various sources.

Methods

Preparation of samples

The peas and sampleswere cleaned and free of broken grains and foreign matter. Peas were immersed in water for three hours. The water was thrown away at the end of the immersion time. The peas were left to dry in a drying oven set to 45°C. The dried soaked peas were powdered to make fine flour (315 micron) and stored for making toast bread.

Coconut flour: Coconut flour was made from local coconuts .Water was drained from the coconut after it had been dehusked and split. The kernel was then collected by smashing with a hand crusher and drying for 6 hours at 60°Cin a mechanical dryer. The dehydrated coconut was ground into flour and then stored in cold (Shakhawat et al., 2016).

The almonds were cleaned to drown dust and other foreign materials, washed many times with cold water and then they were heated for drying at 50°C in an electric oven. The nut was milled to fine powder using a Commercial electric mill stainless steel.

The quinoa seeds were cleaned to drown dust and other foreign materials, and then heated to dry at 50°C in an electric oven. The quinoa seeds were milled to fine powder using a Commercial electric mill stainless steel (More Blender mill, Model Type No: MB355, China) and passed through a sieve to obtain quinoa flour (Rosell et al., 2009).

Chemical composition

The moisture, protein, lipids, ash, and fiber contents were determined using the methods and carbohydrates calculated by differences (AACC, 2012).

Amino acids determination

Amino acids liberated by hydrolysis of 0.2 gm of dried defatted samples in evacuated sealed tubes for 24 hours at 100 C .Amino acids were determined by using an amino acids analyzer. They were expressed as a fraction of unity according to (Pellet & Young, 1980).

Dough Rheological Properties

The Farino and extensograph characteristics of tested flour samples were examined according to the International Standard ICC-114.1 and 115.1 using a 300-gram(Farino and extensograph mixer) (ICC. 114/1 Method 1992). The dough rheological characteristics of various wheat dough mixtures at (40%) with (60%), peas coconut, almond, and quinoa flours were examined according to Farinograph and Extensograph (YUCEBAS MAKINE, Turkey, with 300 g dish) after pre-experiments to choose the appropriate percentage according to (AACC, 2002).

Toast Organoleptic Assessment

The sensory qualities of toast samples were evaluated. On white, odorless, disposable plates, half slices of bread sample was served to ten panelists. Taste, chewing ability, texture, aroma, and color were all scored on a scale of 1 to 10. The evaluation was carried out using the (Land & Shepherd, 1988).

Preparation of toast bread

Straight-dough baking was used to bake flour mixtures; according to (Chauhan et al., 1992; Radwan & Elmaadawy, 2022). Three different amounts of EJL powder (5, 10, and 15%) were used in place of wheat flour. A 500 g mixture of flour, 9 g of compacted baker’s yeast, 5 g of NaCl, 13 g of cane sugar, and 10 g of vegetable oil made up the baking recipe. The dough was punched, scaled to 250 g pieces, proofed for 90 min at 30 °C, 85% relative humidity, and baked for 30 min at 250 °C after the initial 90 min of 281°C fermentation.

Statistical Analysis

An examination of variation in one direction was used to establish the statistical significance of standard deviation across groups (ANOVA). In order to determine if mean differences at (P<0.05) were significant, the Least Significant Difference (LSD) test was used. All data analysis was done using SPSS software (Version 16; SPSS Inc., Chicago., USA) (McCormick & Salcedo, 2017).

Results and Discussions

It can be noticed from Table 1. that, pea moisture content was 13.29±0.95 g/100g, represent the highest significant level of moisture content followed by quinoa and almond (10.53±0.55 g/100g and 5.52±0.21 g/100g, respectively), whereas, the level of protein show increasing significant differences in coconut 22.71±0.23 g/100gfollowed byquinoa,pea almond and wheat flour (18.41±0.47, 15.97±0.05, 11.19±0.55 and 10.25±0.74, respectively). These results mayberelated to water absorption in farinograph dough development, and dough consistency because coconut, quinoa and almond flour contain high levels of protein, these outcomes were consistent with Paucean et al. (2016). Also, the highest values of dietary fiber represented a high significant differences in pea flour followed by coconut, almond and quinoa flours (19.31±0.72, 7.09± 0.41, 6.87±0.09 and 4.37±0.63 respectively), by increasing fiber levels of their contents, there were an increases of water absorption and arrival time except for coconut and almond flours which could be attributed to high fats content in coconut and almond flour (Evelin et al., 2015).

Because legumes have more protein than grains, the incorporation of pea into wheat flour was predicted to boost the protein content of the final product (Tharanathan & Mahadevamma, 2003; Skendi et al., 2021). Legumes flour increases the necessary amino acid balance of baked items made with wheat flour (Anton et al., 2008). Proteins improve the nutritional value of gluten-free products. The choice of flour and possibly another source of protein affect the rheological properties of the dough and the water binding in the dough. Proteins interact with starch and lipids and together contribute to the stability of the dough and the structure of the product. They also give the impression of full product flavor (Culetu et al., 2021).

Data in Table 2, revealed, the most elevated levels of all essential amino acids EAAs were found in almond flour followed by quinoa flour and the lowest levels were found in pea flour. Amino acids of almond and quinoa are sufficient for the FAO/WHO suggested requirements for adult. Moreover, Almond and quinoa have a therapeutic effect on hyperlipidemia and oxidative stress caused by a high fat cholesterol-containing diet, and these effects are primarily mediated by their L-arginine content, quinoa is high in some EAAs, including lysine and methionine (Jancurova & Dandar, 2009; Ligen et al., 2020). Quinoa is essential for Celiac Disease nutrition in children due to its high content of histidine, which is vital for infants and children. Furthermore, pseudo-carp and cereals contain essential amino acids like methionine and cysteine (Letizia et al., 2010). This finding is consistent with Millward's (2012) observation that leucine and lysine are the most percentage of amino acids in optimum growth.

TABLE 1. Chemical composition of Wheat, coconut, almond, quinoa and peas flours dry weight basis (Mean± S.D).

	Wheat flour	Coconut flour	Almond flour	Quinoa flour	Pea flour
Moisture g/ 100g	2.88±0.13^{b}	3.9 ±0.15^{b}	5.52±0.21^{b}	10.53±0.55^{a}	13.29±0.95^{a}
Protein g/100g	10.25±0.74^{c}	22.71±0.23^{a}	11.19±0.55^{c}	18.41±0.47^{b}	15.97±0.05^{b}
Fat g/ 100g	1.63±0.26^{d}	15.79±0.21^{b}	25.83±0.84^{a}	10.70 ±0.61^{b}	6.28±0.64^{c}
Starch g/100g	83.82±0.99^{a}	46.48±0.58^{c}	48.77±0.64^{bc}	51.51 ±0.78^{b}	41.61±0.64^{c}
Fiber g/100g	0.53±0.08^{d}	7.09±0.41^{b}	6.87±0.09^{b}	4.37±0.63b^{c}	19.31±0.72^{a}
Ash g/100g	0.89 ±0.03^{c}	4.03 ±0.56^{a}	1.82±0.14^{b}	4.49 ±0.05^{a}	3.52 ±0.70^{a}

The values in each column with different superscripts are significant at (P<0.05).

TABLE 2. Composition of essential amino acids (EAAs) of wheat, coconut, almond, quinoa and peas flours (in grams per 100 g protein).

Essential Amino Acid (EAA g/100g)	Wheat Flour	Coconut Flour	Almond Flour	Quinoa Flour	Peas Flour
Leucine	7.6	4.77	8.5	5.43	2.16
Valine	2.6	3.33	4.7	3.9	2.98
Lysine	2.6	3.76	5.9	6.3	1.64
Phenylalanine + Tyrosine	4.7	4.45	8.9	6.5	1.88
Isoleucine	3.1	2.06	4.1	2.9	2.74
Methionine L Cysteine	2.33	1.6	3.7	4.3	3.65
Threonine	2.3	2.76	3.6	2.9	1.37
Histidine (Semi EAA)	3.3	2.65	3.9	3.1	1.03

The amino acid profile was examined, and the AAs content did not change significantly with backing energy (Freitas et al.,2012). However, studies have revealed that the amino acid profile of the almond may be affected by the native area of the fruit, which provides high quality and excellent amino acid arrangement (Czeder et al., 2012). Lysine is well known to be a nutritionally limiting amino acid in cereals. In terms of content, our findings agreed with those of Sathaporn et al. (2017), who discovered that the pseudo-carp amaranth and quinoa contained more lysine than cereals. High amounts of globulins and albumins were found to be responsible for the high lysine content (Shela et al., 2002).

Data in Table 3. showed that the highest calcium, magnesium and phosphorus (268.00±8.04, 280.00±7.40 and 487.00±7.02 mg/100g respectively) amount found in almond flour ,and had the lowest amount of sodium (3.40± 0.50 mg/100g) ,The low sodium content of almond is beneficial to health because high sodium intake is an important dietary factor that increases the risk of developing chronic diseases (Freitas & Naves, 2010), while quinoa flour have highest level in iron (5.33±1.10 mg/100g) when compared with wheat flour. Moreover, pea flour has the highest amount of potassium, zinc and sodium (1276.90±9.30,4.11±0.56 and 10.54±1.00) when compared with wheat flour. Regarding the high level of macro-nutrient (calcium, magnesium) and low level of sodium in both almond and quinoa flours, it might be considered valuable as raw-material for healthy processed foods such as bread, biscuits and cookies.

Table 4 and Fig. 1a, b, c, d, e show farinograph data for wheat flour and flour mixtures containing various types of free gluten flours (1 a, b, c, d, e,). The results showed that when pea, quinoa, and almond flours were added to wheat flour, water absorption increased from 59.5 to 63.5%. Gluten is widely recognized as the primary ingredient in wheat flour dough that is responsible for water absorption. Quinoa, peas, almond, and flours are gluten-free, but have higher protein content than wheat flour (18.4 ±0.47, 15.97±0.05, and 11.19±0.55 g/100 g, respectively).The presence of more protein in all of the studied flour combinations may be the cause of the improved absorption capacity as presented in Table 1. The interaction of grain proteins such globulins and wheat gluten may possibly be the cause of high absorption capacity (Maforimbo et al., 2008).

A high content of fibers in the GF samples, in addition to the higher protein content, may be responsible for the higher absorption properties, results showed that the content of dietary fibers in the gluten free flours were higher as presented in Table 1, (PF 19.31±0.72, CF 7.09±0.41, AF 6.87±0.09 and QF 4.37±0.63 g/100 g) than in the wheat flour (0.53± 0.08 g/ 100 g). Generally, Fibers have better water absorption properties, owing to a higher number of hydroxyl groups in the fiber structure, which allows for a stronger interaction of water via hydrogen bonding (Muhammad et al., 2022; Wang et al., 2002). Furthermore, Quinoa contained a good amount of total dietary fiber consisting of both insoluble fiber and soluble fiber. Quinoa consumption can be regarded as advantageous in the management of gastrointestinal issues and risk factors for celiac disease. Quinoa may be used as flour to make bakery goods including gluten-free bread. The increase in water absorption may be associated with a boost in protein and crude fiber percentage in QF (Simran et al., 2015; Enriquez et al., 2003). The arrival time showed a high increase by the substitution level of wheat flour by AF and QF, similar effects were observed by (Atef et al., 2014). As shown in the obtained data Table 4, with the AF and QF dough there were a progressive increase firmness in the dough (15.5, 14 min).Whereas, the degree of softening of the dough was increased by all flours except AF and QF (20, 30 B.U). Correlations are classified into two types: those between chemical parameters and those between chemical and rheology characteristics. In the first group, High protein level correlates with high lipid, high ash, high gluten and fiber content. High levels of gluten are associated with low levels of fiber, which suggests that flour blends containing protein-rich plants have greater levels of fiber and lower levels of gluten. In the second set of correlations, high protein concentration has a significant impact on dough development time and water absorption, but high lipid content has a significant impact on dough absorption. PF, QF, and AF proteins as well as wheat gluten were present in the flour mixture that comprised the protein-rich flour, which is consistent with the negative link between the amount of gluten and the water absorption value (Nicoleta et al., 2021).

Extensograph parameter in Table 5 revealed that, the resistance to extension of the dough showed a decrease in CF and QF, the addition of gluten free flour caused gluten protein dilution, resulting in a loss of dough strength. Extensibility of the dough was decreased from 105 mm for the control sample to 60,65,70,70 mm of CF, PF, AF and QF respectively probably due to dilution of a cohesive gluten matrix. On the other hand, the energy of the dough (area under the curve) (Cm3), decreased from 40 in Pea flour to 15 in quinoa flour when compared to wheat flour control (45 Cm^3).Gluten-free flour functions very differently than wheat flour and has poor rheological characteristics in terms of pliability and high flexibility (Alina et al.*,* 2021).

The extensibility of the dough demonstrates the consistency of the dough and the standard of the baked food (Sulieman et al., 2016). The results showed that total flours with different particle sizes had the lowest extension values compared to the control (wheat bread) at all rest durations. This can be attributed to the creation of a qualitatively robust gluten network and its subsequent resistance to stretching and fast rupture. These outcomes corroborated the conclusions that were published by Sakhare et al. (2014).

Ratio is the ratio of the gluten protein's extensibility to resistance to extension, or how far the dough can be stretched before breaking. The elastic proteins glutenins are the major source of P for gluten, whereas the viscous protein portions of gluten, or gliadins, are the source of N (Gulia & Khatkar, 2015). It should be noted that while the protein content increases due to a high extraction rate, the stability and consistency of the gluten decreases, making it more susceptible to damage from mixing and other mechanical forces and weakening gas maintenance (Mirza et al., 2022).

TABLE 3. Mineral composition of wheat, coconut, almond, quinoa and peas flours (Mean±S.D).

Minerals	Wheat flour	Coconut flour	Almond flour	Quinoa flour	Peas flour
Phosphorus (mg/100g)	415.00±10.00	215.00±10.00	487.00±7.02	399.95±17.57	423.90±10.00
Sodium (mg/ 100g)	6.00±1.50	139.00±5.00	3.40±0.50	2.44±0.61	10.54±1.00
Potassium (mg/ 100g)	486.00±6.00	597.00±26.00	786.60±6.05	698.65±9.90	1276.90±9.30
Zinc (mg/ 100g)	3.50±0.60	2.05±0.58	3.30±0.40	3.22±0.80	4.11±0.56
Iron (mg/ 100g)	4.70±0.40	1.65±0.45	3.60±0.50	5.33±1.10	4.96±1.00
Mg (mg/ 100g)	166.00±3.00	95.60±3.20	280.00±7.40	220.76±4.91	129.765±10.00
Calcium (mg/ 100g)	40.70± 1.10	00.00	268.00±8.04	30.89±1.00	69.32±5.00

TABLE 4. The effect of mixing (WF40%+ CF60%, WF 40%+ PF60%, WF 40%+ AF 60%, and WF 40%+ QF 60%) on rheological properties of the dough by farinograph analysis.

Samples	water absorption %	Arrival time (min)	Dough development (min)	stability (min)	degree of softening (B.U)
WF (control) 100%	57	1.5	2	5	40
WF40%+ CF 60%	53	0.5	3.5	12	40
WF40 %+ Pf 60%	59.5	2	5	12	40
WF40 %+ AF 60%	63.5	0.5	5.5	15.5	20
WF 40 %+ QF 60%	59.5	2	5.5	14	30

B.U: brabender unit

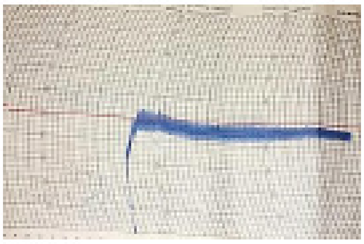
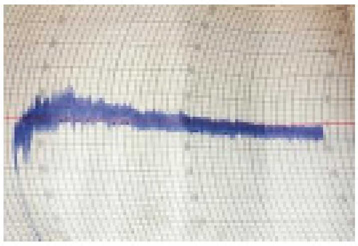


Fig 1a.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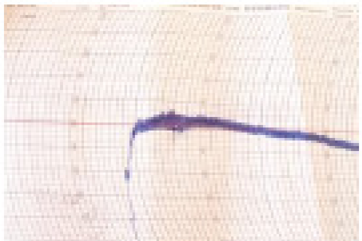
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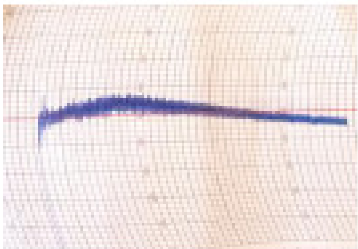
Fig 1d.

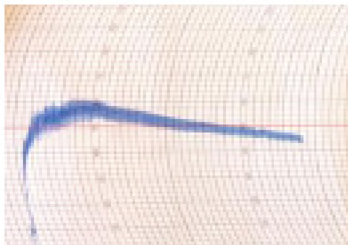
Fig 1e.

Fig. 1. a , b, c, d, e. The effect of mixing (WF 40%+ CF 60%, WF 40%+ PF60%, WF40%+ AF60% and WF 40%+ QF 60%)on rheological properties of the dough by farino-graph analysis.

TABLE 5. The effect of mixing (WF40%+CF60% , WF40%+BF60%, WF40%+AF60% and WF40%+QF60%) on rheological properties of the dough by Extensograph analysis.

samples	Elasticity(B.U)	Extensibility(mm)	P.N	Energy(cm^2)
WF (control) 100%	450	105	4.28	45
WF 40%+ CF 60%	340	60	5.66	20
WF 40 %+ PF 60%	410	65	6.31	40
WF 40 %+AF 60%	420	70	6.00	35
WF 40 %+QF 60%	240	70	3.42	15

P.N: proportional number

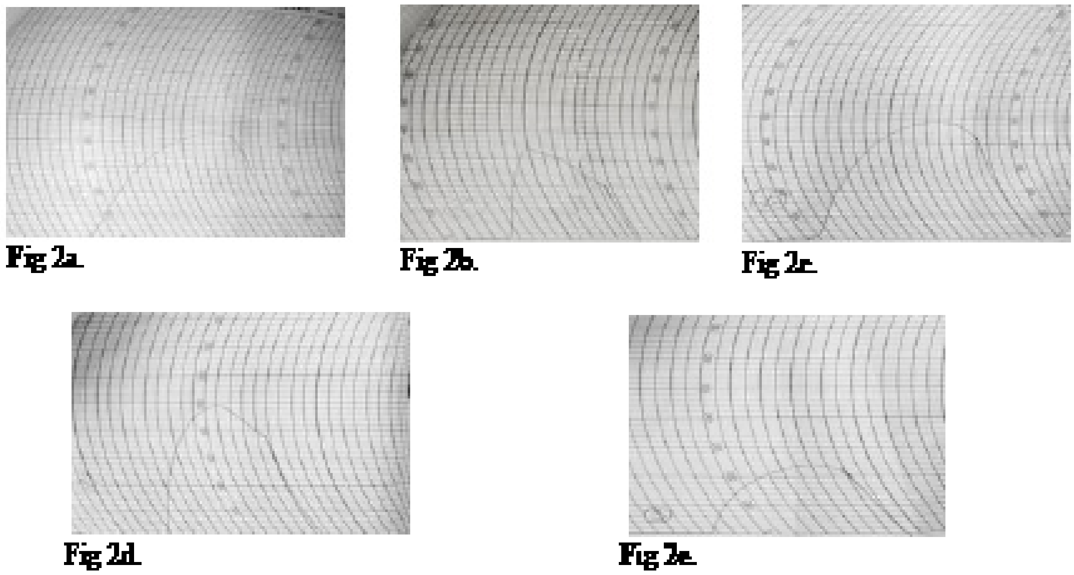

Fig. 2. (a ,b, c, d, e) The effect of mixing (WF40%+CF60% , WF40%+PF60%, WF40%+AF60% and WF40%+QF60%)on rheological properties of the dough by Extensograph analysis.

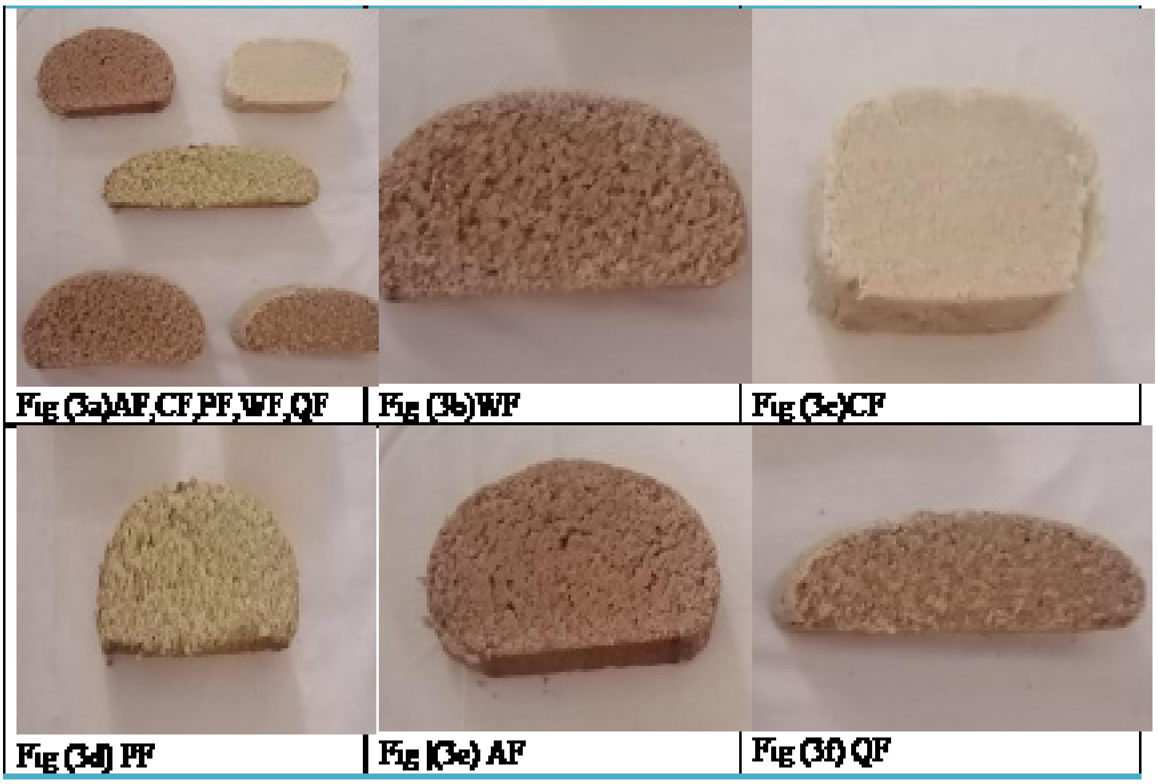

Fig. 3 (a, b, c, d, e, f) we noticed that the toast sample of wheat flour differ in color , loaf volume and pores this due to gluten network that trap air inside ,but coconut toast and almond toast seemed to have no pores due to high content of fat and gluten free that cannot trap air inside .

Taste, chewing ability, texture, aroma, and color were carried out because organoleptic properties are one of the constraints restricting consumer acceptance. Substitute 40% of wheat flour (72% ext.) was used to make toast by 60% of (CF, PF, AF, QF) respectively. Except for peas and quinoa flour, the results in Table 6, showed that toast made from coconut and almond flour had acceptable taste values when compared to wheat control bread. Except for quinoa flour, which had the lowest chewing ability score due to its viscosity, there were no significant differences in chewing ability of quinoa flour, texture, or aroma scores when compared to wheat control toast. Except for Pea toast, there is no significant difference in color between various mixes as opposed to wheat bread. Furthermore, the colors of Pea bread were significantly more affordable than wheat bread as control, which could be attributed to the green color of Pea flour, which was undesirable to panelists.

The texture of the toast enhanced with coconut flour was better-looking, which could be attributed to its high fat content. Color is frequently the first sensory quality by which foods are judged, so almond and quinoa flours receive the highest score due to caramelization. This finding might be ascribed to the appealing brown color of toast, which is widely accepted by consumers (Abdelazim, 2018).

The higher fiber and carbohydrate content of coconut was responsible for the dough's structure, and including protein (Yashi et al., 2010). When coconut flour was incorporated into the dough, the dough's toughness was lessened by the coconut flour-wheat mixture. The dough was more tough than the control, when 25% or more coconut flour was included. This result was noticed in our research and is tried to explain by the dough network of gluten, which also adds to the dough's hardness. The texture of the dough in the control sample was evaluated by the gluten network. Adding coconut flour to dough increased adhesiveness, toughness, and cohesiveness but had no effect on elastic modulus. The results also demonstrated that adding CF had a significant impact on toast texture, decreasing dispersed ratio and increasing hardness. By using these discoveries, toast may be made by substituting coconut flour for wheat flour (Lai & Vo Thi, 2017).

Conclusion

Recent studies on GF food has resulted in an improvement in the nutritional profile of these items as the major focus. The findings provided support by using functional additives in GF toast recipes. According to the findings, these useful ingredients may be utilized in different gluten-free food recipes (toast, biscuits, crackers, snacks, etc.), and with high levels of protein and dietary fiber, best product quality, and good sensory acceptability. It is necessary to do extensive, long-term studies on how a gluten-free diet affects healthy individuals.

TABLE 6. Sensory characteristics of wheat flour toast and its substituted by 60% of CF, PF, AF and QF.

Bread sample	Taste (10)	Chewing ability(10)	Texture (10)	Aroma (10)	Color (10)
Wheat flour (control)	9.60± 1.19^{a}	9.30± 0.60 ^{a}	8.99± 0.75^{a}	9.32± 0.92^{a}	9.37± 0.74^{a}
WF 40%+ CF 60%	9.72± 1.25^{a}	8.77± 1.23^{ab}	8.68± 1.37^{a}	8.50± 1.17^{a}	8.65± 1.64^{a}
WF 40 %+ PF 60%	8.42± 1.03^{b}	8.72± 0.75^{ab}	8.47± 1.00^{a}	8.82± 1.26^{a}	8.03± 1.03^{b}
WF 40 %+ AF 60%	9.56± 0.88^{a}	9.09± 0.69^{ab}	8.74± 0.52^{a}	9.08± 0.67^{a}	8.85± 0.95^{a}
WF 40 %+ QF 60%	8.70± 0.79^{ab}	7.81± 1.34^{b}	8.53± 1.14^{a}	8.97± 1.53^{a}	8.99± 1.43^{a}

The scores of the same column with the identical symbol are not statistically different at $P<0.05$; (the data are the mean of 10 replicates ± standard deviation).

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تأثير استبدال دقيق القمح بعدة أنواع من الدقيق الخالي من الجلوتين (جوز الهند والبازلاء واللوز ودقيق الكينوا) على الخصائص الريولوجية

داليا رفعت حسن

من المعروف أن تناول الطعام الخالي من الغلوتين مفيد للعديد من المشكلات الصحية المختلفة حيث أصبح شائعًا مؤخرًا. الغرض من هذا البحث هو النظر في تأثير الاستبدال الجزئي لدقيق القمح (٤٠٪) بخمسة أنواع من الدقيق الخالي من الجلوتين (٦٠٪) ذات القيمة الغذائية العالية.وتم اضافة النسبة المئوية للدقيق على النحو التالي: العينة الأولى: دقيق القمح ١٠٠٪ كعينة تحكم ، العينات: (٢ ، ٣ ، ٤ ، ٥): ٤٠٪ دقيق قمح (٦٠٪ (دقيق البازلاء (PF) ، دقيق جوز الهند (CF) ، دقيق اللوز (AF) ودقيق الكينوا (QF). تم تقدير التركيب الكيميائي الأملاح المعدنية والأحماض الأمينية لجميع انواع الدقيق. وتم تقدير الخصائص الريولوجية والتقييم الحسي لجميع أنواع الدقيق. كما تم دراسة النتائج ، حيث أظهرت النتائج أن أعلى كمية من الكالسيوم والمغنيسيوم والفوسفور وجدت في اللوز الدقيق (286 ±٨,٠٤، 280.00 ± 7.40 , ٤٨٧±7.02 على التوالي) بينما وجدت أعلى كمية من الحديد في دقيق الكينوا (٥,٣٣ ± ١,١٠) كانت هناك قيم عالية لجميع الأحماض الأمينية الموجودة في دقيق اللوز ، يليها دقيق الكينوا.كشف تقييم Farino و Extensograph أن العينة WF40٪ + AF ٦٠٪ لديها أعلى مستويات امتصاص الماء ، وتطور العجين ، والثبات ، و القابلية للتمدد (٦٣,٥٪ ، ٥,٥ دقيقة ، ١٥,٥ دقيقة و ٧٠ ملم على التوالي). من ناحية أخرى ، أظهر تقييم الخصائص الحسية لخبز التوست أن الخبز المنتج من دقيق جوز الهند واللوز له قيم طعم مقبولة (٩,٧٢ ± ١,٢٥ و ٩,٥٦ ± ٠,٨٨) مقارنة بخبز التحكم في القمح. هذه الدراسة قد يساعد في إنشاء عناصر مبتكرة خالية من الجلوتين مثل الخبز والبسكويت والمنتجات المدعومة الأخرى