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CHEMICAL CHARACTERIZATION OF BISCUITS (COOKIES) AS FUNCTIONAL FOOD PRODUCT SUPPLEMENTED WITH QUINOA FLOUR

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ABSTRACT

In recent years, quinoa has gained renewed relevance as an alternative crop to cereals due to its excellent nutritional value. The aim of this work was to utilize quinoa seed flour as a substitute supplementation for wheat biscuits. The physicochemical properties of quinoa seed flour were studied. Wheat flour was substituted with 25, 50 and 75% of quinoa seed flour. The obtained results declared that the rheological characteristics of the mixtures dough were altered by increasing the ratio of quinoa seed flour. Substitution with 25 and 50% quinoa seed flour had the best results which were relatively close to that of the control sample. The physicochemical properties of biscuits enriched by quinoa seed flour that characterized by increasing density, texture, water-holding capacity and oil-holding capacity. The chemical composition of enriched biscuits, for moisture, ash, dietary fiber, protein and minerals content were increased while fat and available carbohydrate content lowered. Sensory evaluation showed that substitution with 25% and 50% quinoa seed flour had the best sensory characteristics, and increased its content of protein, fat, minerals and vitamins.

1.Introduction

Concerns about food are developing, mostly about supplying the people with safe and sustainable food, as well as important nutritional characteristics that contribute to relieving hunger and malnutrition problems. Malnutrition, primarily protein energy, is expected to impact 10% of the global population (Torres-Tiji et al., 2020). As a result, the use of functional foods presents itself as an intriguing option in population nutrition and helps to the reduction of the risk of certain diseases (Nystrand & Olsen, 2020). In this context, and in response to the growing consumer demand for health-related products, technologies in vegetable matrices such as quinoa have been widely used to enhance nutritional effects as well as the extraction of compounds that can be incorporated into the formulation of novel foods (Foucault et al., 2014; Obaroakpo et al., 2020; Vera et al., 2020).

Quinoa *(Chenopodium quinoa Willd.)* belongs to Chenopodiaceae family, which also includes spinach and beet is an endemic to South America. However, it was domesticated by people living in the Andes, it is highly resistant to weather, climate, and soil conditions. Quinoa has traditionally been used by a variety of native populations in South America Citation (Jancurová et al., 2009). It draws attention with its high nutritional value, but more importantly, the seeds are the most economical and scientifically significant parts. It has a balance of proteins rich in sulphur amino acids and lysine as well as lipids, and has been consumed by people as a holy plant due to its rich protein content and incredible balance of essential amino acids (Repo-Carrasco-Valencia et al., 2010; Vega-Gálvez et al., 2011)**.**

Quinoa has gained popularity as a functional food due to its high levels of proteins, lipids, fibers, vitamins, minerals, amino acids, and phytochemicals such as saponins, phytosterols, phytoecdysteroids, phenolic compounds, and bioactive peptides (Chen et al., 2020; Pereira et al., 2019). The FAO proclaimed 2013 the "International Year of Quinoa" because of its nutritious content and it has been described as one of the cultures meant to offer food security in the twenty-first century (Nowak et al., 2016). According to the FoodEx 2 food categorization and description system, the European Food Safety Authority (EFSA) has also put quinoa in the list of functional foods/products with health claims (A000R).

Similar to rice, its seeds are used to make soups, morning cereal by puffing them, or baked goods including cookies, bread, pasta, crisps, tortillas, and pancakes by flouring them (Bhargava et al., 2006)**.** In addition, quinoa seeds can be fermented to make beer or a kind of traditional alcoholic drink used for a religious ceremony called chicha in South America (Miranda et al., 2011). It is additionally utilized as a nutrient-rich source for feeding farm animals like cattle, pigs, and chickens (Bhargava et al., 2006)**.** This study's objectives were to assess the physio-chemical characteristics of quinoa seeds, use them to fortify biscuits at three different levels (at 25%, 50%, and 75%), and assess the impact of the fortification on the characteristics of the finished products.

2.1. Materials

- Quinoa seeds (grown in Egypt in the 2022 season) obtained from agriculture research center from season 2021–2022crop and kept at 5°C until used in technological studies
- Wheat flour 72% extraction, margarine, vanilla, sugar, skim milk powder, ammonium bicarbonate and baking powder were obtained from local market, Zagazig, Sharkia Governorate, Egypt.
- All chemicals used in this study were analytical grade and purchased from El-Gomhoria Co., Zagazig, Sharkia Governorate, Egypt.

2.2. Technological process and preparation of biscuit samples

2.2.1. Preparation of the Quinoa flour

Quinoa flour was prepared according to Al Shehry (Al Shehry, 2016) with some modifications. To remove saponins, the seeds were washed repeatedly with tap water until there was no longer any froth in the washing water. The seeds were then dried in an air ventilation oven (SHEL LAB 1370 FX, Germany) at 50°C until dried. Quinoa seeds were ground to fine powder in an electric grinder (Quadrumat Junior flour mill, Model Type No: 279002, ©Brabender ® OHG, Duisburg 1979, Germany) and sifted through a 60 mesh, stored at 4 ±1°C until used.

2.2.2. Preparation of the treated biscuits samples

The recipes listed in Table (1) were followed in the preparation of the biscuit treatments. 25%, 50%, and 75% of quinoa flour were used to replace some of the 72% extraction rate of wheat flour. Ammonium bicarbonate and water were added and blended for 2 minutes after sugar, fat, and vanilla were creamed in a mixing bowl for 15 minutes. The mixture of skim milk powder, baking powder, and wheat flour was then supplemented with quinoa flour in varying quantities. The mixture was then thoroughly combined to create uniform dough. The latter was taken out of the mixing bowl and used by a cutting machine to be laminated, sheeted, and formed. Baking took place for 10 minutes at 250°C. After baking biscuits were cooled at room temperature and then warped tightly by aluminum foil and kept for sensory evaluation as reported by Mesías et al. (Mesías et al., 2019).

2.3. Assessments methods for biscuit samples

2.3.1. Proximate chemical composition

According to the procedures outlined by AOAC (A. O.A.C, 2005), the chemical composition of various biscuit samples, including their moisture, ash, crude protein, fiber, mineral, and crude lipid contents (%), was determined at the Central Laboratory of the Faculty of Agriculture at Zagazig University in Zagazig, Sharkia Governorate, Egypt.

2.3.2. Determination of vitamin

B1 (thiamine), B2 (riboflavin), B3 (niacin), B6 (pyridoxine) and total Folate determined according to the method according to Li (Li, 2018) .

2.3.3. Saponin analysis:

Quantification of saponins by spectrophotometric analysis by the method described by (Lozano, et al. (Lozano et al., 2012). Quantification was performed with a standard Saponin curve (50–350 lg/mL) and the results were expressed as % dry sample.

2.3.4. Physical properties of biscuit

- Hardness Determination

The hardness (N) of different biscuit samples was determined at Food Technology Research Institute, Giza, Egypt, according to Mesías et al. (Mesías et al., 2016) using a Texture Analyzer (Texture Technologies Corporation, USA) outfitted with a 50 kg load cell, a probe (Warner Bratzcer, HDP/BSK knife model) with a compression speed of 1 mm. s-1, and a distance prolongation of 10 mm to measure the hardness (N) of various biscuit samples.

Table 1. The recipe used for biscuits making

Ingredient	**Amount (g)**			
		Treatments		
	Control	**25%**	**50%**	**75%**
Wheat flour 72%	100	75	50	25
Quinoa flour	0	25	50	75
Margarine	24	24	24	24
Sugar	30	30	30	30
Vanilla	0.1	0.1	0.1	0.1
Ammonium bicarbonate	1.5	1.5	1.5	1.5
Skim milk powder	1.0	1.0	1.0	1.0
Baking powder	0.8	0.8	0.8	0.8
Water	12.0	12.0	12.0	12.0

- **Density measurement**

The density of different biscuit samples was determined using Archimedes (buoyancy) method according to Amiri *et al.* (Amiri et al., 2017). Was determined according to the following: Density = mass/volume (g/cm^{-3})

- **Color measurement**

The color of biscuit crust was measured according to Zenoozian *et al.* (Zenoozian et al., 2007) using a Minolta colorimeter (Model CR-400, Konica Minolta Sensing, Inc., Osaka, Japan) based on three color coordinates; L* (Lightness), a* (redness/ greenness), b* (yellowness/blueness). The measurement for each sample was replicated and the average value was recorded for each color parameter.

- **Water Holding Capacity**

According to Chau and Huang (Chau & Huang, 2003), the water holding capacity (WHC) of one gram of wheat flour (72%), which was substituted with quinoa seed flour, was tested after standing the mixture for one hour at room temperature. The hydrated sample underwent a 10-minute centrifugation at 1500 rpm. The extra supernatant was properly decanted after centrifugation. WHC was calculated as ml of retained water divided by 1g of the sample's dry weight (ml/g).

- **Oil Holding Capacity**

Oil Holding Capacity (OHC) was measured according to Garau *et al*. (Garau et al., 2007), with slight modification. 20 ml of maize oil and one gram of wheat flour (72% quinoa seed flour) were combined, and the mixture was left to stand for one hour at room temperature. After that, the sample was centrifuged for ten minutes at 1500 rpm. Decanting the extra oil was done with caution. WHC was calculated as ml of retained oil divided by 1 g of dry sample weight (ml. g).

2.3.5. Rheological Behavior

Farinograph and extensograph of dough rheological properties were measured according to AACC (AACC, 2000).

- **Dough properties by Farinograph**

Water absorption (%), dough development (min), stability time (min) and dough weakening were determined by Brabender Farinograph (model 810114, Brabender, Duisburg, Germany) at Food Technology Research Institute Giza, Egypt.

- **Dough properties by extensograph**

Dough extensibility E (mm), resistance to extension R (BU), Energy (cm^2) and proportional number R/E were determined by Brabender Extensograph (model 860702, Brabender, Duisburg, Germany), Food Technology Research Institute Giza, Egypt.

2.3.6. Sensory Evaluation

The sensory evaluation was done in accordance with Hooda and Jood's (Hooda & Jood, 2005) instructions. To assess the sensory qualities of the biscuits in terms of their look, color, flavor, and general acceptability, ten members of the food science department staff at the Faculty of Agriculture, Zagazig University, were given coded samples of the biscuits. The rating was based on a hedonic scale from 1 to 9, where (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 =like very much, 9 = like extremely).

2.3.7. Statistical Analysis

The obtained data were statistically analyzed by a statistical for social science package "SPSS" version 20 for Microsoft windows, SPSS Inc. according to Dominick and Derrick (Dominick & Derrick, 2001).

3.Results and discussions

3.1. Proximate Chemical composition of quinoa and wheat flour:

The proximate chemical composition of quinoa and wheat flour under are shown in Table (2). The obtained results declared that, wheat flour had higher values of moisture content and Carbohydrate, while the highest values of ash, protein, fat and fiber contents were recorded by quinoa flour (3.78, 15.45, 5.87 and 3.88%) respectively in compared to wheat flour which recorded the lowest value of ash, protein, fat and fiber content (0.59, 11.53, 2.15 and 0.74%) respectively. The obtained results nearly agreed with those of Sharoba *et al.* (Sharoba et al., 2009) and Atef et al. (Atef et al., 2014).

Concerning the mineral content of Calcium, iron and zinc , the obtained results referred to the highest value of calcium, iron and zinc was found in quinoa flour (165.71, 9.30 and 4.17 mg/100g) respectively in compared to 34.72, 4.27 and 1.58 mg/100g of calcium, iron and zinc, respectively in wheat flour. On the other hand, wheat flour had a higher content of phosphor (329.32mg/100g) compared to quinoa flour (220.73 mg/100g), The obtained results were in general agree with those of Beniwal *et al*. (Beniwal et al., 2019) and Konishi *et al.* (Konishi et al., 2004).

Table 2. Proximate Chemical composition of raw materials:

Parameter	Quinoa	Wheat
Ash (%)	3.78±0.21[a]	0.59±0.04[b]
Moisture (%)	9.67±0.43[b]	12.27±0.29[a]
Protein (%)	15.45±0.43[a]	11.53±0.48[b]
Fat (%)	5.87±0.04[a]	2.15±0.18[b]
Fiber (%)	3.88±0.32[a]	0.74±0.05[b]
Carbohydrate (%)	61.34±0.93[b]	72.72±0.03[a]
Iron mg/100g	9.30±0.57[a]	4.27±0.33[b]
Calcium mg/100g	165.71±2.89[a]	34.72±0.79[b]
Zinc mg/100g	4.17±0.31[a]	1.58±0.21[b]
Phosphor mg/100g	220.73±0.51[b]	329.32±0.55[a]

* Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).

3.2. Effect of soaking on quinoa of saponin content:

Generally, saponin caused the bitter test in cooking quinoa, The results of saponin indicate that the raw quinoa seeds had saponin of 3.46% figure 1, these results agreed with **Nickel *et al.*** (Nickel et al., 2016) who found that the saponin content spectrophotometric analysis was 3.33% in natural quinoa grains, soaking quinoa seed for after the substitution; they increased gradually by increasing the level of quinoa addition. WHC increased by 6.3%, 17.4% and 30.7% while OHC increased by 4.1%, 7.5% and 12.2% with 25, 50 and 75% in wheat flour substituted by quinoa flour, respectively compared with wheat flour 72% (control) sample may be due to the high content of fiber in quinoa (3.88%) compared whit those of wheat flour (0.74%). Oil and water holding capacity is the flour's ability to retain oil and water under a centrifugal gravity force, in addition, this property affects the flavor and mouth feels of the product, these results are in near agreement with those reported by **Pellegrini *et al.*** (Pellegrini et al., 2018)**.**

48h revealed an 85.26% decrease in saponin content, leading to enhanced sensory properties.

3.3.Water and oil holding capacity:

Table (3) shows the water and oil holding capacity (WHC and OHC) of wheat flour (72 %) and blends of wheat-quinoa flour. The obtained results showed that both WHC and OHC values increased as a general tendency

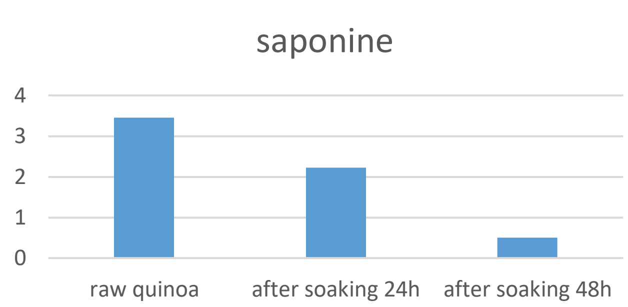


Figure 1. Effect of soaking on quinoa of saponin contint.

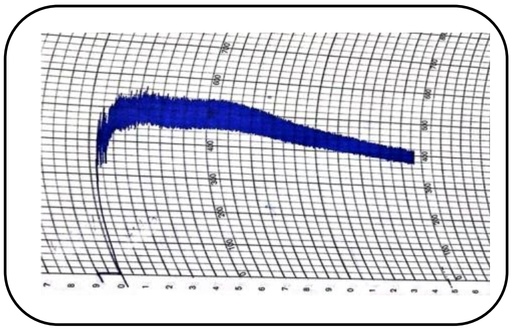
Table 3. Water and oil holding capacity of substituted wheat flour by different levels of Quinoa seed flour:

Property/sample	wheat flour 72%	Quinoa seed flour 25%	50%	75%
WHC (mg/100g)	180.9±1.9[d]	192.2±.95[c]	218.1±2.1[b]	260.5±2.1[a]
OHC (mg/100g)	172.2±1.86[d]	179.4±1.18[c]	186.7±1.5[b]	193.8±0.8[a]
WHC**:** Water holding capacity			OHC: oil holding capacity	

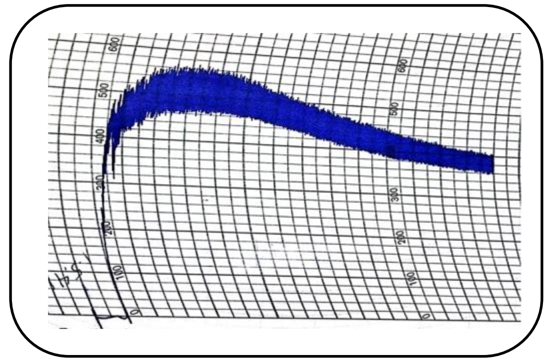
3.4.Farinograph results

Farinograph measurements are summarized in Figure 2. Results showed that the water absorption of dough increased gradually from 57.4% of control to 63.1%, 64.1% and 66.2% by adding 25, 50 and 75% of quinoa flour, respectively.

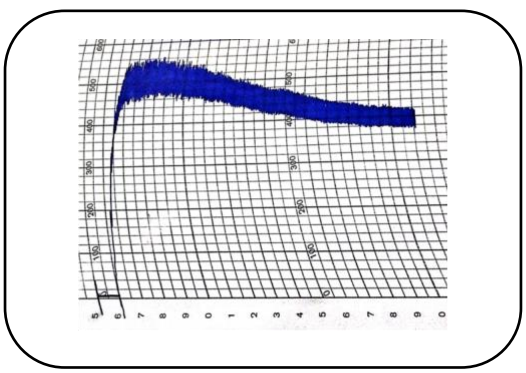
The obtained results showed that increasing the addition of quinoa flour by more than 25% led to a weakling effect on dough characteristics. Farinograph indices like arrival time, development time and dough stability were lowered in 50 and 75% quinoa flour mixtures, so the degree of weakening effect (a degree of softening, the vertical space in BU between the end of Farinograph after 12 min. of its peak and the 500 BU line) increased from 100 to reach 260 BU, at 75% quinoa seed flour These results are in agreement with **Moawad *et al.*** (Moawad et al., 2018)**.**



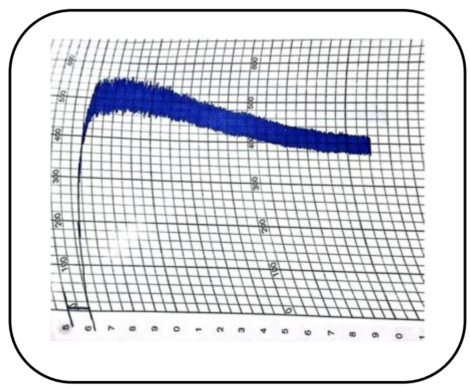
100%Wheat flour (72%)



75%Wheat flour+25% quinoa flour



50%Wheat flour+50% quinoa flour



25%Wheat flour+75% quinoa flour

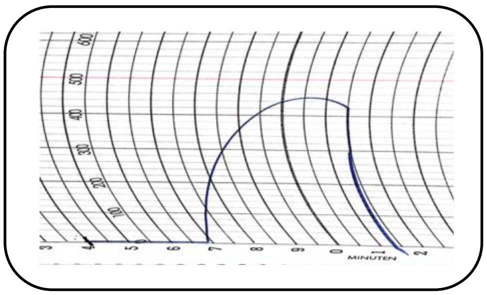
Figure 2. Effect of wheat flour substituting by different levels of Quinoa seed flour on Farinograph characteristics.

3.5.Extensograph results

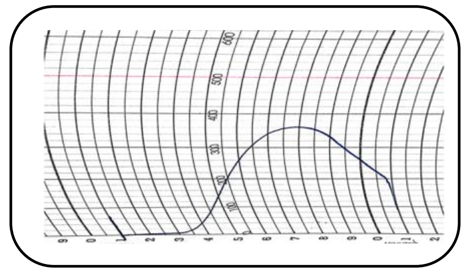
Results of Extensograph parameters of wheat flour blended with 25, 50 and 75% quinoa seed flour were given in Figure 3. Results showed that elasticity and resistance to extension (R), of dough containing up to 25%, 50% and 75% quinoa flour decreased from 420 BU for control to 390, 360 and 240 BU, respectively. Increasing the addition of quinoa flour lowered the elasticity to about half of control. On the other hand, the addition of quinoa flour caused a gradual decrement in dough extensibility (E) with increasing the adding level of quinoa.

The proportional number (R/E) is an overall index that indicates the effects of the treatments on the quality of dough. The results in Table 5 show that quinoa flour affects the quality of the dough. The addition of quinoa flour up to 25% in dough had an enhancer effect on dough quality while the higher concentrations of quinoa flour showed defects in quality. Energy values of the dough decreased by adding either quinoa flour than the control sample.

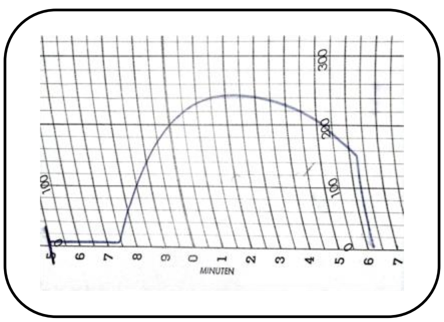
The rheological results showed that the addition of quinoa flour up to 25 and 50% have potentialities to be used in supplementing flour for manufacturing biscuits. On the other hand, increasing the supplementation will have deleterious effects on dough quality. However, it is well known that weak flours are suitable for manufacturing biscuits. These results are in agreement with **Moawad *et al.*** (Moawad et al., 2018)**.**



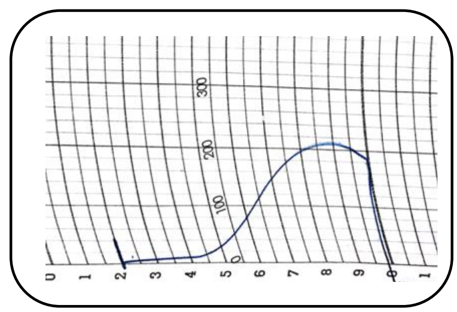
100%Wheat flour (72%)



75%Wheat flour+25% quinoa flour



50%Wheat flour+50% quinoa flour



75% quinoa flour +25% Wheat flour

Figure 3. Effect of wheat flour substitution by quinoa flour with different levels on extensograph dough characteristics**.**

3.6. Quality attributes of biscuit treatments

3.6.1. Physical characteristics

Physical characteristics of biscuits substituted with quinoa flour including density, hardness (texture) and color are shown in Table (4). Density was slightly increased by increasing the amount of quinoa compared to control sample. It was increased from 0.45(g/cm3) of control biscuits compared to 0.59, 0.63 and 0.68 (g/cm3) for biscuits samples substituted with 25, 50 and 75% of quinoa flour biscuits respectively. Concerning to hardness, it was increased gradually by increasing quinoa flour in treated biscuits. The hardness rose from 16.87N of untreated biscuits to 18.28, 20.18 and 22.23N for biscuits samples with 25, 50 and 75% of quinoa flour, respectively. The highest density and textures values of treated biscuits may be attributed to dietary fiber. The results are in accordance with those obtained by Bilgiçli and Ibanoglu (Bilgiçli & İbanoğlu, 2015) and

Nisar et al. (Nisar et al., 2017), they reported that the hardness of bread and cookies increased as increasing quinoa proportion.

Treated biscuits color evaluated by Hunter parameters L*, a*, and b* and the obtained results are shown in Table (4). The results declared that biscuits enriched by quinoa had lower values of lightness (L*) and yellowness (b*). Lightness (L*) was slightly decreased by increasing the amount of quinoa compared to the control sample. It decreased from 28.55 of control biscuits to 28.36, 27.24 and 26.34 of enriched biscuits by 25, 50 and 75% quinoa, respectively. Yellowness (b*) was slightly decreased by increasing the amount of quinoa compared to the control sample. It decreased from 66.32 for control biscuits compared to 65.43, 64.62 and 63.23 for biscuits samples substituted with 25, 50 and 75% quinoa flour biscuits respectively. a* values (redness), it was increased gradually by increasing of the level of quinoa flour in biscuits samples. Concerning to a* values (redness), it raised from 3.47 of untreated biscuits to 3.82, 4.83 and 5.25 for enriched biscuits by 25, 50 and 75% of quinoa r respectively. These results in agreement with those of Atef et al. (Atef et al., 2014) who reported that increasing the percentage of adding quinoa meal to wheat flours, led to a decrease in the values of lightness (L*) and yellowness (b*) slightly in all fortified samples. Also, Thejasri et al. (Thejasri et al., 2017) reported that the addition of quinoa flour to wheat flour led to a decrease in the lightness of gluten-free biscuit samples and they approved that to the higher value of protein in quinoa flour compared to wheat flour.

Table 4. Physical characteristics of biscuits substituted with quinoa flour

Physical property	1	2	3	4
Density (g. cm^{-3})	0.45±0.01^{c}	0.59±0.01^{b}	0.63±0.01^{b}	0.68±0.01^{a}
Hardness (N)	16.87±0.69^{d}	18.28±0.42^{c}	20.18±0.75^{b}	22.23±0.87^{a}
L*	28.55±0.14^{a}	28.36±0.05^{a}	27.24±0.09^{b}	26.34±0.34^{b}
a*	3.47±0.04^{c}	3.82±0.34^{b,c}	4.83±0.11^{b}	5.25±0.11^{a}
b*	66.32±0.04^{a}	65.43±0.24^{b}	64.62±0.62^{b,c}	63.23±0.18^{c}

1=100% wheat flour, 2=75% wheat flour+25% quinoa flour, 3=50% wheat flour+50% quinoa flour and 4=25% wheat flour+75% quinoa flour.

3.6.2. Chemical composition of supplemented biscuits

The influence of adding quinoa flour on the chemical constituents of biscuits showed in (Table 5). The obtained results declared that biscuits with quinoa flour treatments were higher in moisture, protein, fiber, ash, fat and minerals (Ca, Fe and Zn) contents but lower in Available carbohydrate content than the untreated biscuits. Moisture content increment could be explained by the high fiber content found in quinoa flour compared to wheat flour 72% allowing more absorption and retention of water. The addition of quinoa flour increased the contents of protein by 8-20%, fat by 2- 9%, fiber increased 2 to 4 times, iron by 4-20%, zinc by 28-43%, calcium by 14-21%, phosphor by 8-20%, while the decrease in energy is not significant. On the other hand, carbohydrate content was reduced by 6-15%. Such effects are due to the inherent content of quinoa flour used which contributes to the component’s content of the resultant biscuits. The chemical composition of the control biscuit was in agreement with those reported by Youssef (Youssef, 2015) he reported that the wheat biscuit contained 3.75% moisture, 9.11% protein, 1.00% fiber, and 77.19% total carbohydrates. Also, Brito et al. (Brito et al., 2015) reported that quinoa flour let to increase ash and Fiber content and decreases the total carbohydrate content compared to the biscuit produced from wheat flour as a control.

Table 5. Chemical composition of supplemented biscuits

Parameter	1	2	3	4
Ash (%)	0.53±0.03[d]	0.73±0.02[c]	0.85±0.04[b]	1.04±0.06[a]
Moisture (%)	4.6±0.27[c]	5.9±0.07[b]	6.17±0.05[b]	7.18±0.09[a]
Protein (%)	8.6±0.38[c]	10.03±0.16[b,c]	10.97±0.1[b]	12.09±0.16[a]
Fat (%)	17.61±0.09[c]	17.92±0.11[c]	18.28±0.09[b]	19.39±0.34[a]
Fiber (%)	0.87±0.05[c]	2.08±0.1[b]	2.83±0.17[b]	3.39±0.29[a]
Carbohydrate (%)	67.7±0.55[a]	63.29±0.4[b]	60.88±0.34[c]	56.9±0.56[d]
Iron mg/100g	7.81±0.34[b]	8.16±0.06[b]	8.75±0.05[a,b]	9.18±0.03[a]
Calcium mg/100g	126.36±1.8[d]	148.38±1.5[c]	159.69±0.39[b]	161.56±0.43[a]
Zinc mg/100g	6.14±0.13[c]	7.02±0.34[b]	7.41±0.07[a]	7.79±0.17[a]
Phosphor mg/100g	292.98±1.9[a]	267.24±0.54[b]	245.12±1.1[c]	236.00±0.93[d]
Energy (K.cal)	464.2±1.5[a]	456.3±0.5[b]	453.82±1.1[c]	452.43±0.41[c]

1=100% wheat flour, 2=75% wheat flour+25% quinoa flour, 3=50% wheat flour+50% quinoa flour and 4=25% wheat flour+75% quinoa flour.

Table 6. Sensory evaluation of supplemented biscuits

Sample	**Appearance (9)**	**Texture (9)**	**Color (9)**	**Taste (9)**	**odor (9)**	**Over all acceptability**
1	8.33±1.04[a]	8.33±1.11[a,b]	8.46±1.06[a]	8.33±1.34[b]	8.46±1.36[a]	7.86±1.35[b]
2	8.68±0.6[a]	8.68±0.6[a]	8.62±0.61[a]	8.75±0.57[a]	8.81±0.54[a]	8.5±0.81[a]
3	8.62±0.6[a]	8.56±0.62[a]	8.31±0.94[a,b]	8.5±0.63[a]	8.62±0.5[a]	8.56±0.51[a]
4	7.75±0.68[b]	8.01±0.63[b]	7.93±0.92[b]	7.87±0.71[c]	8.12±0.8[a]	8.00±0.73[b]

1=100% wheat flour, 2=75% wheat flour+25% quinoa flour, 3=50% wheat flour+50% quinoa flour, and 4=25% wheat flour+75% quinoa flour.

3.6.3. Sensory evaluation of biscuits:

The influences of quinoa flour substitution on sensory characteristics (appearance, color, taste, flavor and overall acceptability) of control and treated biscuits are illustrated in Table (6). It can be observed that all evaluated sensory attributes were positively affected by adding quinoa flour. The obtained results indicated that, no significant differences in color, taste, odor, texture and appearance between the control sample and the biscuit samples containing 25-50% quinoa flour. While that the sample contained on 75% quinoa flour to the lowest value from color, taste, odor, texture and appearance. Also, no significant differences in color between the samples containing 25-50% quinoa flour (8.62 and 8.56 respectively) and the control sample biscuit (8.46). While the sample contained 75% quinoa flour to the lowest value (7.93). Concerning odor and texture, the obtained results indicated that no significant difference between the control sample and sample (2) contained 25% quinoa flour plus 75% wheat flour and sample (3) contained 50% quinoa flour plus 75% wheat flour in the same characteristics.

Moreover, no significant difference between the biscuit sample (2) produced from 25% quinoa flour plus 75% wheat flour and the biscuit sample (3) contained 50% quinoa flour plus 50% wheat flour in appearance character, whereas the biscuit sample (3) produced from 50% quinoa flour plus 50% wheat flour recorded the highest value of overall acceptability (8.56) followed by the biscuit sample (2) contained 25% quinoa flour plus 75%wheat flour (8.5) and according to the results of Thejasri et al. (Thejasri et al., 2017), they studied the effect of quinoa flour on the quality of biscuits with different substitution levels to wheat flour and they reported that the produced biscuit recorded a high score concerning the taste and overall acceptability and the biscuit was almost same to the control sample.

3.7. Some nutrient facts the biscuits enriched by 50% quinoa seed flour:

Some of the nutrient facts of 100-gram biscuits enriched by 50% quinoa were shown in Table (7). Compared to the daily recommendation for adults (19+ years) as reported in recommendations from the Committee on Medical Aspects of Food Policy (COMA) and the Scientific Advisory Committee on Nutrition (SACN), 100 grams of enriched biscuits covered about 18.28% of carbohydrates, 18.84% fat, 19.44% of proteins and 17.8% energy. With regard to minerals and vitamins, it covered the requirements of iron and vitamins B1 and Folate. While it covered about 22.81% of calcium, 42.6% of phosphorus and 44.56% of zinc, 62% Thiamin, 30.76% Riboflavin, 50% Pyridoxine, and only 14.19% of Niacin.

Table 7. Some nutrient facts of biscuits content at 50% quinoa flour+50% wheat flour.

Parameters	3	Recomidaion19-64	% recovery
Protein (%)	10.79	55.5	19.44
Fat (%)	18.28	97	18.84
Carbohydrate (%)	60.88	333	18.28
Energy (K.cal)	445.08	2500	17.8
Iron mg/100g	8.75	8.7	100.1
Calcium mg/100g	159.69	700	22.81
Zinc mg/100g	7.41	9.5	44.5
Phosphor mg/100g	245.12	550	42.6
B1 mg/100g	0.9	0.8	110
B2 mg/100g	0.4	1.3	30.76
B3 mg/100g	2.2	15.5	14.19
B6 mg/100g	0.7	1.4	50
Folate mg/100g	0.3	0.2	150

3=50% wheat flour+50% quinoa flour, B_1.Thiamin, B_2. Riboflavin, B_6 Pyridoxine, and B_3.Niacin.

4. Conclusions

Biscuits are a favorite meal among many people all over the world. Many nations throughout the world, notably Egypt, utilize it for school feeding meals, military, and during times of crises. Quinoa has grown in popularity as a functional food due to its high protein, fat, fiber, vitamin, mineral, amino acid, and phytochemical content. As a result of its high level of protein, fat, minerals, dietary fiber, and healthful components, quinoa flour has various useful components that make it excellent for enhancing cereal products. The study's findings obviously demonstrated that adding quinoa seed flour to biscuits in amounts between 25 and 50 percent can increase their nutritional content without significantly changing their physical characteristics or other organoleptic characteristics. Quinoa is touted as a functional and nutritive alternative to wheat that may be incorporated into daily meal plans to support leading a healthy lifestyle.

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The current manuscript includes all of the data produced and examined for the study, and the associated authors have no objections regarding the data's and materials' accessibility.

Competing interests (Conflict of interest)

The authors assert that they have no competing interests.

Authors' contributions

M. R. E.: analyzed and interpreted the data of the work; performed lab experiments, analyzed and interpreted the data of the work, and prepared the original manuscript; **S. M. A:** supervised and reviewed the manuscript; **I. E. E.:** performed lab experiments, analyzed and interpreted the data of the work, and prepared the original manuscript; **A. A. E.:** supervised and reviewed the manuscript; performed lab experiments, analyzed and interpreted the data of the work, and prepared the original manuscript.

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