

***Quinoa Grain to Improve the Nutritive Value and Functional Ingredient for Breadsticks***

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***Abstract***

This investigation aimed to substitute wheat flour (72%) extraction with milled quinoa flour to breadsticks improve quality. The chemical composition of quinoa flour and wheat flour (72%) were determined, then added quinoa to wheat flour(72%) at levels of 5, 10, 15, or 20%. The results revealed that ether extract of quinoa flour had high amount of unsaturated fatty acids including the essential fatty acids such as oleic, linoleic or erucic acids . The obtained results showed that as the level of substitution increase, all components increased except total carbohydrates. The nutritive value of breadsticks enhanced due to the content of unsaturated fatty acids (oleic acid  $\omega$ 9 and linoleic acid  $\omega$ 6) in quinoa flour.Sensory evaluation of the produced of breadsticks,and the chemical ingredients of product and energy value (Cal/100g) were determined

## ***Introduction***

Quinoa flour is showing appropriate nutritional and functional properties due to its high quality protein with a wide amino acid spectrum, particularly rich in lysine. Quinoa is oldest cultivated grain in the world. Quinoa is high in protein, calcium and iron. You can substitute this flour for ½ of the all-purpose flour in many recipes. Consequently, considering appropriate nutritional and functional properties of quinoa protein, it can be considered as a good candidate to supply human food products (***Food Chem.2019***). Quinoa flour used from desserts to muffins to breads. The protein in quinoa flour helps to give your bread same structure, and will improve the overall texture. It's too high in carbs for keto diet and also has a high glycemic index- (***Haros et al .,2017 and Ballester-sanchez et al .,2019***).

Quinoa flour in formulations increase the protein content but it could also improve the biological value of the proteins in these formulations, since quinoa proteins contribute essential amino acids that are limiting in wheat flours (such as lysine and threonine), and they are more digestible (***Vega –Galvez et al.,2010***). It could also lead to an increase in the unsaturated fatty acid content and an improvement in the omega 3/omega 6 fatty acid relationship. The main unsaturated fatty acids in quinoa are linoleic and α-linolenic acids, , which are essential fatty acids (***Repo-Carrasco and Sevna.,2013***). Moreover, its high fiber and mineral contents could help to attain the daily requirements of these substances and of calcium, iron and zinc in the diet (***Haros et al .,2017 and Ballester-Sanchez et al .,2019***). Quinoa is significantly known as a high protein source (more than 15%), and balanced amino acid composition compared to the major cereals (***Oshodi et al 2013***)with

higher content of lysine (5.1-6.4%) and methionine (0.4-1.0%) (*Bhrgava et al 2013*). It contains a considerable amount of fiber and minerals *Ando et al (2013)*. Quinoa contains large amount of Flavonoids,including quercetin and kaempferol.These are potent antioxidants numerous health benefit.Quinoa is also rich in antioxidants such as polyphenols (*Repo-Carroso et al 2011*). It has the highest content of its bioactive compounds compared to other cereal and pseudocereal crops (*Hirosey-Fujta et al 2010*) .

Quinoa flour has perfect-balanced ingredients such as minerals (potassium, sodium, magnesium and calcium as well as even 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, phytic acid ,but its can partly prevent them from being absorbed .Soaking or Sprouting degrades most of the phytic acid. Its natural antioxidants such as phenolic compounds and flavonoids are helpful in treatment of degenerative diseases ,water and oil absorptions of quinoa flour were favorably sound, which enhances its potentiality in human food and drinks formulations. Foaming as well as emulsion capacities and stabilities prove the importance of quinoa seeds flour to be used as a food additive/ingredient in food processing for its manufacturing quality. The high digestibility of quinoa flour protein was (86.85 ± 0.83%) which is supporting its high availability and digestibility in the human stomach and consequently its benefits for human health. (*EI Sohaimy et al.,2018*).

The nutrient composition of quinoa is very good compared with common cereals (*Demir, 2014*). Quinoa seeds contains about from 1.8% to 9.5% oil (*Vega-Gálvez et al., 2010*).). Thus, it is a good supplement for legumes, which are ordinarily low in cysteine and

## **Lamia. M .Lotfy and Mona. E.M.Naga**

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methionine. Some types of wheat come close to matching quinoa's protein content, but grain such as barley, corn and rice generally have less than half the protein content of quinoa have vitamins (B complex and C, E), important minerals (potassium, magnesium, calcium, iron, phosphorus, manganese) and high quality lipids (**Vega-Gálvez et al., 2010 and Miranda et al., 2012**).

Quinoa is much higher in fiber than most grains. One study found 17.27gm of fiber per cup (185 gms). Most of the fiber is insoluble, but one cup of quinoa still contains 2.5 gms of insoluble fiber.

Polyphenols are bioactive secondary plant metabolites that are widely present in particularly eaten foods of plant origin. The three major types of polyphenols are phenolic acids, flavonoids and tannins, which act as powerful antioxidants *in vitro*. These components are reported to have many potential serviceable health effects, containing antioxidant, apoptotic, anti-aging, anti-carcinogenic and anti-inflammatory activities, cardiovascular protection and improvement of endothelial function. Polyphenols also inhibit angiogenesis and cell proliferation (**Han et al.2007**).

The purpose of this research was to determine the quinoa chemical composition and its essential fatty acids in comparison to the flour of common cereals (wheat flour 72%).

## **Materials and Methods**

### **Chemical composition:**

Moisture, protein, ether extract and ash were determined according to the methods of the **A.O.A.C (2000)**. While total

carbohydrates were estimated by subtracting from initial weight of the sample as follow:

% carbohydrates = 100- (% crude protein + % crude fat+ % ash).

**Determination fatty acids composition:**

Fatty acids composition of quinoa oil was determined using “gas chromatography” according to the method described by **Radwan(1978)**.

**Breadsticks making:**

Preparation of sticks using quinoa flour by ingredients shown Table (1). Quinoa flour milled to obtain quinoa flour was substituted the base flour at different level (5, 10, 15 and 20 %). The control dough was prepared form 100% wheat flour (72% extraction).

The straight dough procedure was used for breadsticks making as follow: sugar, fat, salt and dry yeast, were added to each types of flour with warm water and oil, the ingredients were thoroughly mixed together manually. Dough was left to ferment for 30 min at room temperature ( $30 \pm 2$  °C). Dough was divided into pieces and left 10 min to rest. The fermented pieces were shaped to the final form and fermented for 1/2 hour at 30 °C and 90% relative humidity. Fermented snacks dough's were baked at 170 °C for 30 min (**Ballester-Sánchez.,2019**).

**Sensory evaluation:**

Organoleptic evaluation of the studied breadsticks with and without quinoa flour (quinoa flour) carried out by ten panelists to evaluate flavor, texture, color, taste and overall acceptability. The evaluations were made using scores from 1 to 10, where excellent (10-9), very good (8-6), fair (5-4) and not acceptable (3-2) according to the **Renzo (1975)** .

## ***Results and Discussion***

### **The chemical composition of quinoa flour and wheat flour 72% (g/100g on dry weight basis).**

Results presented in table (2) show the chemical composition of quinoa seed and wheat flour (72% extraction) on dry weight basis.

From these data it could be noticed that quinoa seeds had the highest values in crude protein (13.13%), ether extract (6.52%), and ash (4.65%). On the other hand total carbohydrate of wheat flour (72% extraction) was 85.73% comparing with quinoa flour (75.70%).

These results for quinoa flour are in agreement with ***Demir and Kilinc(2017)*** they found that quinoa flour contain 14.45% crude protein,5.82% crude fat and 2.82 ash. Also. ***Demir and Kilinc (2017)*** showed that chemical composition of wheat flour 72% extraction that contained 9.52% crude protein 0.51% crude fat and 0.63% ash.We are found that our results on quinoa seeds and flour is not significant with ***Demir and Kilinc (2017)*** these results may be due to different percentage of essential amino acids and may be different of crud fiber.Quinoa is much higher in fiber than most grains.Most of the fiber is in soluble.

### **Saturated fatty acids content of quinoa flour (%g total fatty acids)**

Saturated fatty acids composition of quinoa seed (%g total fatty acids) was given in table ( 3 ) . The dietary quinoa oil consisted mainly of stearic acid (34.432%), palmitic acid (8.751%), arachidic acid (0.857%) with small concentrations of tridecylic acid ,myristic acid and pentadecylic acid. These results for are in partial agreement with ***Masson and Mella(1985)*** who reported that

unsaturated fatty acids composition of crude fat of quinoa seed contained myristic, palmitic, stearic acid which were 0.1-2.4 , 9.2-11.2 and 0.6-1.1 % respectively. Also, **Calderelli et al.,(2010)** stated that saturated fatty acids of quinoa seeds were myristic (0.17%), palmitic (9.82%) and stearic (1.47%).

**Unsaturated fatty acids content of quinoa seed (%g total fatty acids).**

Unsaturated fatty acids content of quinoa seed (%g total fatty acids) are shown in table (4 ) the dietary quinoa oil consisted mainly of linoleic acid (34.429%), oleic acid (18.0%), erucic acid (1.0579%) with small concentrations of eicosenoic acid and docosadienoic acid. These results are in partial agreement with **Masson and Mella(1985)** who reported that unsaturated fatty acids composition of crude fat of quinoa seed contain oleic acid (22.8-29.5), myristoleic acid (1%), palmitoleic acid (0.2-1.2%), linoleic acid (48.1-52.3%) and linolenic acid (4.6-8%). Also, **Calderelli et al (2010)** found that unsaturated fatty acids of quinoa seeds were oleic acid (29.90%), linoleic acid (48.80%) ,linolenic acid (7.34%) and eicosenoic acid (1.53%).

No risk form erucic acid given in table (4) which amounted of 1.06% of total unsaturated fatty acids ;being 1.0579% of fatty acids in quinoa seed used at no more 20% in bread sticks. Health hazard is for children only (not adults), up to 10 years age .This occurs only if level of C22:1 exceeds 2% of total fatty acid in food (FSAN,2003) .Quinoa contains large amounts of flavonoids,and large amounts minerals, but its phytic acid can partly prevent them from being absorbed.But when Soaking degrades most of the phytic acid.They found that using quinoa instead of Typical gluten free bread,and pasts significantly reduce blood sugar,insulin and triglyceride levels.

**Chemical composition of produced breadsticks**

From the obtained results in Table( 5 ), it could be noticed that chemical composition of breadsticks produced from 100 %wheat flour (72%) extraction were as following: ether extract (1.25%), crude protein (11.75%), ash(0.55%), total carbohydrate (85.45%) and energy value were (404.05Cal/100g). Regarding the chemical composition of produced breadsticks with 5, 10, 15, 20% substitution of quinoa flour ,it was found that all components increased, except total carbohydrate which were decreased. These results are in agreement with **Abdullah et al.,(2016)** reported that all components (ash, protein and ether extract) increased in molded bread made from wheat flour with quinoa flour at levels 5, 10 or 20% except total carbohydrate which decreased. Quinoa contains relatively high concentration of tannins, Oxalates, and phytates. These natural substances many bind-proteins,enzymes,minerals and trace elements,reducing nutrient uptake.

**Organoleptic properties of bread sticks produced from wheat flour (72%) and different levels of quinoa flour.**

Table (6 ) showed organoleptic properties of bread sticks produced from wheat flour (72%) and different levels of quinoa flour . It could be observed that sample of bread sticks 100% wheat flour (72%) were excellent of acceptability against all parameters, and sticks recorded very good grade against all samples produced from different levels of quinoa flour.These results me be due to protein in quinoa flour helps to give your breadsticks some structure and well improve the overall texture and also a healthier alternative to carbohydrates like rice or other grains.Still,it is too high in carbohydrates for the Keto diet and also a high glycemic index. From Table (6) addition 20% Quinoa flour lead to low- glycemic-index carbohydrates since its very rich in fiber and protein.

This means you will feel fuller longer after consuming it which may help you eat less over time. Why we do not add more than 20% because. The only likely side effect is just some stomach irritation as a result of the saponin but easily prevented before eating rinse and soaking.

**The sensory properties of bread sticks added to its surface are quinoa seeds produced from wheat flour (72%) and different levels of quinoa flour.**

The results concerning organoleptic properties of bread sticks produced from wheat flour (72%) and different levels of milled quinoa seeds flour were illustrated in table (7) . It could be observed that sample of bread sticks which made from 100% wheat flour (72%) showed the highest in acceptability for all parameters while had very good grade against all samples produced from different levels of quinoa flour. These results are in agreement with **Abdullah et al.,(2016)** who showed that samples prepared from wheat flour or those with 5 ,10 or 20% quinoa flour blends had good properties to make molded bread and had satisfactory and acceptable organoleptic evaluation .

From these results refers that. Quinoa is high in protein, calcium and iron. It can use this delicate flour when baking, and also contains all the essential amino acids that you need.

**Organoleptic properties of bread sticks produced from wheat flour (72%) and different levels of quinoa flour.**

It is clear (Tables 6 and 7) that bread stick of milled quinoa seeds recorded nearly the same scores as for quinoa flour sticks ,indicating that it is unnecessary to get rid of bran .Sticks of both types exceptionally nutritious food source, owing to their high level of

## Lamia. M .Lotfy and Mona. E.M.Naga

protein, fatty acid, fiber, vitamin, mineral and micro constituents, phytosteroids carbohydrates possibly of low glycemic index. We are found that, The United National (UN) declared 2013 “ the internationally of Quinoa ” may due to its high nutrient value and potential to contribute to food security worldwide.

**Table(1):** The basic( control )formula used in the preparation of breadsticks

Ingredients(g)	Amount (g)
Wheat flour 72%	100
Sugar	8.00
Fat (oil)	10
Salt	0.5
Dry yeast	0.6

**Table (2):** The chemical composition of milled quinoa flour and wheat flour 72% (g /100g on dry weight basis)

Component	Quinoa seed	Wheat flour 72%
Ether extract	6.52	1.27
Crude protein	13.13	11.85
Ash	4.65	0.55
Total carbohydrate	75.70	85.73

**Table (3): Saturated fatty acids content of quinoa flour (%g total fatty acids) .**

Acids	Symbol	% of total fatty acids	Concentrate of saturated fatty acids g of lipid
Tridecylic acid	C13:0	0.129	0.0084
Myristic acid	C14:0	0.309	0.02016
Pentadecanoic acid	C15:0	0.109	0.0071
Palmitic acid	C16:0	8.751	0.5702
Stearic acid	C18:0	34.432	2.2436
Arachidic acid	C20:0	0.857	0.0558
Total saturated	%	44.587%	2.9071

**Table (4): Unsaturated fatty acids content of quinoa flour (%g total fatty acids)**

Acids	Symbol	% of total fatty acids	Concentrate of saturated fatty acids g of lipid
Oleic acid	C18:1	18.010	1.1735
Linoleic acid	C18:2	34.429	2.2434
Eicosenoic acid	C20:1	0.997	0.0649
Erucic acid	C22:1	1.058	0.0689
Docosadienoic acid	C22:2	0.919	0.0599
Total Unsaturated fatty acids	%	55.413%	3.6129

**Table (5): The chemical composition of breadsticks produced from wheat flour(72% extraction) and different levels of milled quinoa flour.**

Nutrients	Crude protein	Ether extract	Ash	Total carbohydrate	Energy value(Cal/100g)
	Quinoa and wheat flour				
100 wheat	11.75	1.25	0.55	86.45	404.05
5% +95%	11.92	1.51	0.75	85.82	404.55
10% +90%	11.98	1.79	0.97	85.26	405.07
15% +85%	12.04	2.06	1.17	84.73	405.62
20% +80%	12.11	2.32	1.37	84.20	406.12

**Lamia. M .Lotfy and Mona. E.M.Naga**

**Table (6):** The sensory properties of bread sticks added to its surface are quinoa seeds produced from wheat flour (72%) and different levels of quinoa flour.

Samples	Organoleptic characteristics				
	Color 10	Taste 10	Flavor 10	Texture 10	Overall Acceptability 10
Control	9.4	9.2	9.3	9.5	9.1
Quinoa flour 5%	8.7	8.3	8.5	8.2	8.4
Quinoa flour 10%	8.8	7.7	8.0	8.0	8.2
Quinoa flour 15%	8.4	8.1	7.7	8.0	8.3
Quinoa flour 20%	8.3	8.0	8.2	8.0	8.4

**Table (7):** Organoleptic properties of bread sticks produced from wheat flour (72%) and different levels of quinoa flour.

Samples	Organoleptic characteristics				
	Color 10	Taste 10	Flavor 10	Texture 10	Overall Acceptability 10
Control	9.3	9.4	8.9	8.9	9.0
Quinoa flour 5%	8.4	8.5	8.4	8.6	8.5
Quinoa flour 10%	8.3	8.6	8.4	7.9	8.3
Quinoa flour 15%	7.5	8.5	8.3	8.2	7.8
Quinoa flour 20%	7.7	7.8	8.4	8.0	7.8

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## حبوب الكينوا لتحسين القيمة الغذائية والمكونات الوظيفية للبقسماط

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### الملخص العربي

تم اجراء هذه الدراسة بهدف الحصول على عجائن محسنة ذات جودة عالية حيث تم استبدال جزئى لدقيق القمح استخلاص (٧٢%) بنسب معلومة من مطحون بذور الكينوا ( دقيق الكينوا ) لتحسين جودة العجين واعداد البقسماط , وتم اضافة دقيق الكينوا بنسب ٥-١٠-١٥-٢٠% لدقيق القمح استخلاص (٧٢%) . كما تم تقدير التركيب الكيماوى لدقيق الكينوا ودقيق القمح استخلاص (٧٢%) ومعرفة نسب الرطوبة والرماد والكربوهيدرات الكلية. وأيضا تم تحليل الاحماض الدهنية المشبعة والاحماض الدهنية غير المشبعة لدقيق الكينوا . كما تم تحليل التركيب الكيماوى للبقسماط المصنع من مخلوط دقيق القمح ودقيق الكينوا مقارنة بالمنتج الكونترول (١٠٠% دقيق قمح) وتم معرفة التركيب الكيماوى من كربوهيدرات كلية , رماد , البروتين الخام ونسبة استخراج الاثير وتم حساب الطاقة . وأخيرا تم عمل تقييم حسى لمنتجات من البقسماط باستخدام مخلوط الدقيق , أحدهما مضاف على سطحه الخارجى بذور الكينوا , والآخر لا يوجد على سطحه بذور. وقد أوضحت الدراسة أن دقيق الكينوا يعد مصدر عال وجيد للأحماض الدهنية الغير مشبعة ومنها أحماض الأوليك, اللينوليك , والأيسيك . وأيضا اتضح أنه كلما زادت نسبة اضافة دقيق الكينوا الى البقسماط كلما زادت نسب محتوى عناصر التركيب الكيماوى فيما عدا الكربوهيدرات الكلية , وأيضا تحسنت القيمة التغذوية للبقسماط بسبب محتوى دقيق الكينوا من الأحماض الدهنية الغير مشبعة . وتوصى الدراسة باستخدام دقيق الكينوا فى العجائن لتحسين جودتها ورفع قيمتها الغذائية .