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EFFECT OF SOME TECHNOLOGICAL PROCESSES ON CHEMICAL COMPOSITION AND FUNCTIONAL PROPERTIES OF QUINOA (*CHENOPODIUM QUINOA*)

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ABSTRACT

In this study quinoa seeds, were soaked in water for 4 hrs or were germinated at 25 C^0 for 24 hrs then dried and ground to 60 mesh flours. Chemical composition for control and treated quinoa seed flours were studied and the effect of incorporation of quinoa flour to wheat flour on the chemical composition and the quality attributes of the prepared biscuits were studied. The results showed that control flour contained 16.39 % protein, 69.31% carbohydrates, 3.89% ash, 5.72 % crude fat, 4.69 % fibers and 59.57 % starch (on dry basis). The incorporation of quinoa flours into wheat flour increased the moisture, protein, ash and fiber contents of biscuit samples. The germinated quinoa seeds flour could be incorporated to wheat flour up to 20 % level to make biscuits with acceptable quality attributes. However, from the obtained data, it could be concluded that germinated quinoa seed flours could find an application in various biscuit types to ensure providing the opportunity to upgrade the nutritional aspects for many people.

Keywords: quinoa seeds, quinoa flour, Chemical Composition, Functional properties.

INTRODUCTION

Quinoa seeds considered as pseudo cereals; it is a broadleaf plant that has been used like the cereals. Quinoa seeds are used to make various food products including bread, biscuits, cookies, crepes, muffins, pancakes, and tortillas. More recently, attention has been given to quinoa for people suffering celiac disease (allergy

to gluten), as an alternative to wheat, rye and barley, which all contain gluten (Fleming and Galwey, 1995 and Jacobsen, 2003 and 2011). Quinoa leaves have also been eaten similarly to spinach (Schlick and Bubenheim, 1996), and the germinated quinoa seedlings (quinoa sprouts) have been incorporated in salads (Schlick and Bubenheim, 1996). Furthermore, quinoa seeds can be fermented to make beer, or a traditional ceremonial alcoholic beverage from South America called "chicha" (FAO, 2011b). The seeds also have been consumed similarly to rice, prepared in soup, puffed to make breakfast cereal, or ground to flour to produce toasted and baked goods such as cookies, breads, biscuits, noodles, flakes, tortillas, pancakes (Valencia, 2003; Jacobsen, 2003 ; Bhargava *et al.*, 2006 and ; Repo-Carrasco-Valencia *et al.*, 2010). Quinoa flour contains higher amounts of protein, ether extract, crude fiber, ash (as 13.97, 3.93, 10.31, and 3.67 %, respectively) compared to wheat flour (W F). (DeBruin, 1964; Koziol, 1992 and Bhargava *et al.*, 2006). This plant has been investigated extensively because of its high protein content, 12–23% (Koziol, 1992; Ruales and Nair, 1992; Ando *et al.*, 2002), and in particular its amino acid composition, which is close to the ideal protein balance recommended by FAO (FAO/WHO, 1973; Oshodi *et al.*, 1999). Quinoa seed proteins are rich in amino acids like lysine, threonine and methionine that are deficient in cereals (Fleming and Galwey, 1995; Jacobsen, 2011). Furthermore, (FAO/WHO, 1973) states that the quality of quinoa is equal to the quality of protein of whole dried milk. Quinoa flour can be mixed with maize or wheat flour and several levels of quinoa flour substitution have been reported, for instance, in bread (10–13% quinoa flour), noodles and pasta (30–40% quinoa flour), and sweet biscuits (60% quinoa flour) (Valencia and Chamorro, 2003).

The main objective of this study was:

1. o prepare quinoa flours.
2. o study the chemical composition of prepared flours
3. o prepare biscuits by substituting wheat flour by quinoa flours at different levels ranging between 0 (control) to 50 %.
4. o study the quality of produced biscuits as compared to control biscuits.

MATERIALS AND METHODS

Quinoa seeds (, variety *Titicaca*) were obtained from agronomy Dept. Fac. Of Agric., Minia Univ., Minia, Egypt (season 2015). Wheat flour (72% extraction) was obtained from local market. Shortening, Baking powder, Ammonium bicarbonate, Sodium bicarbonate, Sodium chloride and powdered sugar were obtained from market.

1-Preparation of (Quinoa seed flours): Quinoa seeds were divided into three groups**:**

The 1st group (control). The 2nd group was soaked in tap water at room temperature 28 ± 3 °C (1:5 W.V) for 4 hrs then dried at 55°C for 24 hrs. The 3rd group was germinated at wetted cloth pieces covered with another one followed by spraying water every 6 hrs for 24 hrs then dried at 55°C for 24 hrs. These three groups were ground into flour that could pass through a 60 mesh screen .The obtained flours were kept in polyethylene packages at 4°C until analysis.

2- Chemical analysis:

Proximate chemical composition (Moisture, crude protein, crude fiber, crude fat, and ash) contents were determined according to official methods of the Association of Official Analytical Chemists AOAC, 1995. Soluble sugars were extracted according to Macrae and Zand-Moghddam, 1978 and determined by the phenol-sulphuric acid method described by Dubois *et al.,* 1956. Total reducing sugars were determined by modified neocuproine method described by Dygert *et al.,* 1965. Starch content of samples was determined according to the method of Faithful, 1990.

3- Preparation of biscuits:

The method described by Manohar and Rao, 1997 was used for preparation of biscuits. The dough was sheeted to a thickness of about 3 mm by using (Atlas brand) rolling machine. The sheeted dough was cut into round shape using a 45mm diameter cutter and baked on an aluminum tray in an electric oven at 180°C for 6 minutes. The biscuit was cooled for 30 minutes, packed in Polyethylene bags and stored under dissection Vatsala and Rao, 1991; and Manohar and Rao, 1997

4- Sensory evaluation of biscuits: Color, taste, odor and texture were evaluated as described by using 10 panelists Steel and Torrie, 1980.

5- Statistical analysis:

Data were statistically evaluated using analysis of variance (ANOVA) with the program SPSS 16.00 to asses the significance of the main factors and interactions. Means were also compared using Duncan's test at $P \leq 0.05$ in order to find significant differences between treatments.

RESULTS AND DISCUSSION

Effect of soaking and germination of quinoa seed on the chemical composition of Quinoa flour:

The data in Table (1) showed that both soaking and germination of quinoa seeds caused some decrease in total protein , crude either extract and starch. This might be due to the occurrence of some loss of these ingredients in water during soaking and also during germination since it should be available to the germ during germination. There was some increase in ash, and crude fibers due to these two treatments and this might be due to the loss of other constituents. However, the crude fibers increased to 4.76 % as compared to control (4.69%) or soaked seed flour (4.61%) . This might be due to consumption of other constituents during germination.

Table (1): Effect of soaking and germination of quinoa seed on the chemical composition of quinoa flour (dry weight bases).

Sample	Control	Soaking for 4 hrs	Ger. for 24 hrs at 25 c^0
Protein T.N ×6.25%	16.39	16.32	15.92
Total carbohydrates %	69.31	69.31	69.82
Ash %	3.89	3.92	4.18
Crude either extract %	5.72	5.64	5.32
Crude fibers %	4.69	4.61	4.76
Starch %	59.57	59.53	56.60

* each value is an average of three determinations .

Effect of incorporation of quinoa flour on the chemical composition of biscuits:

The proximate composition of biscuits made by using wheat flour supplemented with quinoa flour is given in Tables (2 and 3). The results showed that, the incorporation of quinoa flour into wheat flour increased the moisture, protein, fat, ash and fiber contents of biscuit samples. The higher moisture content of biscuit containing quinoa flour than the control biscuit might be due to the great water binding properties of quinoa flour Vilche et al.,(2003). Biscuits supplemented with quinoa flower had the highest protein content (7.48%) and this could be due to the high initial protein content (16.39%) of the quinoa flour. The addition of quinoa flour showed a slight increase in fat content which was (13.52 %) for control biscuit, increased to (14.45%) for the biscuit supplemented with quinoa flour at (20%) level, the crude fiber contents of quinoa flour biscuits was slightly higher (49%) than that of control biscuit (41%) . The energy value of the supplemented biscuits was (465.45) higher than (460.32%) that of control biscuits and was calculated as k cal /100g. However both tables 12 and 13 gave the same impression regarding either data and could be summarized that supplementation of biscuits with quinoa flour at 20% level caused some increase in protein, crude fat, ash, crude fiber and energy value. It should be also mentioned that beyond 20% level of supplementation gave unacceptable biscuits.

Effect of incorporation of quinoa flour on the sensory quality of biscuit samples:

The sensory quality of the studied biscuit samples as influenced by the incorporation of quinoa flour is shown in Table (4) and Fig. (1). the use of quinoa flour 20 % level did not affect the color significantly. However, when the quinoa flour was used at higher levels of incorporation (30 - 50 %) the color was adversely affected (Fig. 2). There was no significant difference in the texture and odor of biscuit when the quinoa flour was added up to 20% level. However, significant difference in the texture, taste, odor and overall acceptability, was found only when

quinoa flour was used at 50 % level. These data showed that quinoa flour could be incorporated with wheat flour up to 20 % level to make biscuits with acceptable quality attributes.

Table (2): chemical composition of control and supplemented biscuits (wet weight basis).

Constituents %	Type of biscuit	
	Control (100% wheat flour)	Biscuit supplemented with 20% quinoa flour
Moisture	2.12	2.68
Protein *	6.78	7.28
Crude fat	13.23	14.06
Ash	1.12	1.18
Crude fiber	0.40	0.48
Carbohydrates **	76.35	74.32
Energy value K cal /100 g	451.59	452.94

* T.N. × 6.25
** Calculated by difference

Table (3): chemical composition of control and supplemented biscuits (dry weight basis).

Constituents %	Type of biscuit	
	Control (100% wheat flour)	Biscuit supplemented with 20% quinoa flour
Protein *	6.93	7.48
Crude fat	13.52	14.45
Ash	1.14	1.21
Crude fiber	0.41	0.49
Carbohydrates **	77.73	76.37
Energy value K cal /100 g	460.32	465.45

** T.N. × 6.25*
*** Calculated by difference*

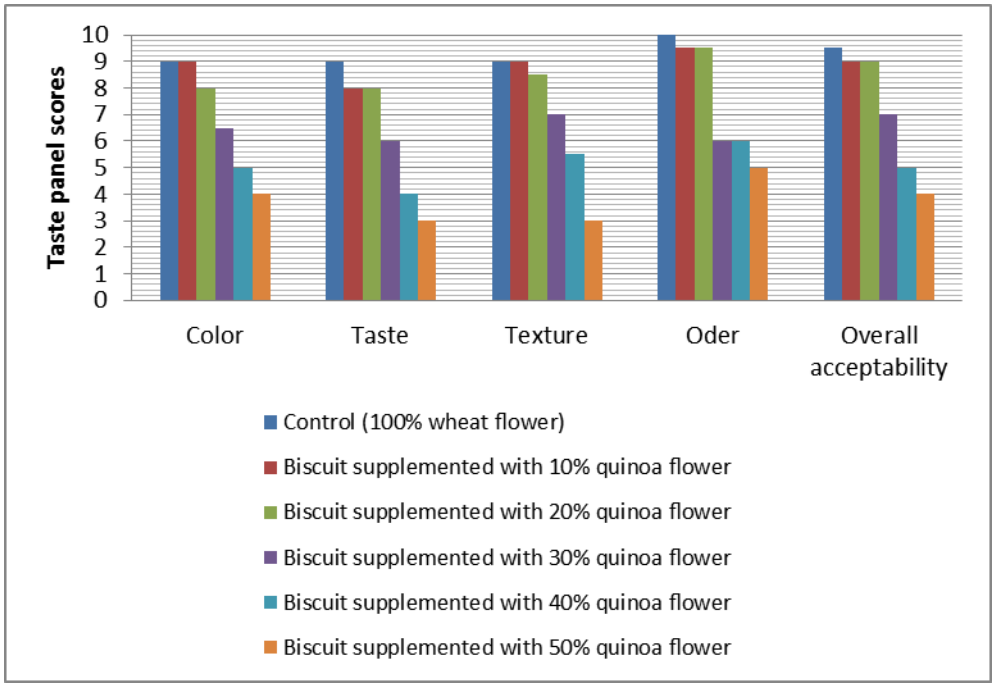
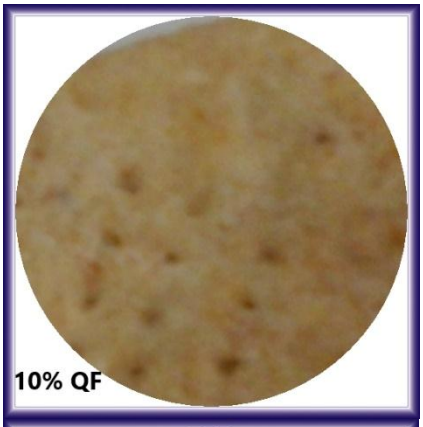


Figure (1): sensory characteristics of biscuit samples as affected by incorporation of quinoa flour at different levels.

Table (4): sensory characteristics of biscuit samples as affected by incorporation of quinoa flower at different levels:

Biscuit samples	Color	Taste	Texture	Oder	Overall acceptability
Control (100% wheat flower)	9.00^{a}	9.00^{a}	9.00^{a}	10.00^{a}	9.50^{a}
Biscuit supplemented with 10% quinoa flour	9.00^{a}	8.00^{b}	9.00^{a}	9.50^{b}	9.00^{a}
Biscuit supplemented with 20% quinoa flour	8.00^{b}	8.00^{b}	8.50^{b}	9.50^{b}	9.00^{a}
Biscuit supplemented with 30% quinoa flour	6.50^{c}	6.00^{c}	7.00^{c}	6.00^{c}	7.00^{b}
Biscuit supplemented with 40% quinoa flour	5.00^{d}	4.00^{d}	5.50^{d}	6.00^{c}	5.00^{c}
Biscuit supplemented with 50% quinoa flour	4.00^{e}	3.00^{e}	3.00^{e}	5.00^{d}	4.00^{d}

*values within the same column followed by the same letter are not the significantly different ($p \leq 0.05$).



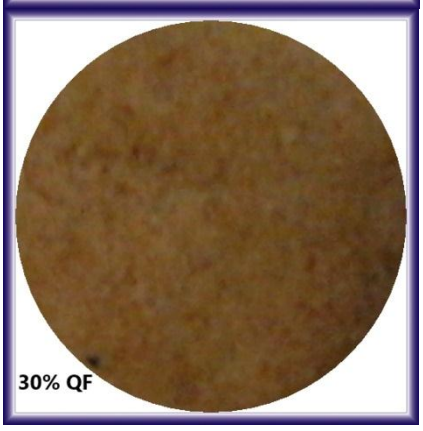


Figure (2): Control and supplemented biscuits with quinoa flower at different levels.

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الملخص العربي

تأثير بعض العمليات التكنولوجية علي التركيب الكيميائي والخواص الوظيفية لبذور الكينوا

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أجريت هذه الدراسة بغرض رفع القيمة الغذائية لبعض المخبوزات وفيها تم تحضير نوعين من دقيق الكينوا الناتج من أجراء معاملتين، الأولي هي نقع بذور الكينوا والثاني هو إنبات بذور الكينوا وقد اشتملت هذه الدراسة علي دراسة التركيب لكل من بذور الكينوا الطازجة ودقيق الكينوا الناتج من المعاملات وأيضاً دراسة تأثير خلط دقيق الكينوا مع دقيق القمح المستخدم في صناعة البسكويت علي التركيب الكيميائي وخواص الجودة للبسكويت الناتج. تبين من الدراسة أن التركيب الكيميائي لبذور الكينوا الطازجة احتوائه علي 16.39% بروتين، 69.31% كربوهيدرات، 3.89% رماد، 5.72% دهون، 4.69% ألياف، 59.57% نشا (علي أساس الوزن جاف) ويوضح ذلك أن بذور الكينوا تعتبر مصدراً جيداً لكل من الكربوهيدرات، البروتين، النشا والدهون ولكنه يعتبر مصدر فقير لكل من الرماد والألياف. من الدراسة أيضاً وجد أن مزج دقيق الكينوا مع دقيق القمح أدي الي زيادة محتوي الرطوبة ، البروتين، الرماد والألياف. أظهرت نتائج التقييم الحسي لعينات البسكويت الناتجة أنه يمكن خلط مطحون بذور الكينوا المستنبته حتي مستوي 20% لصناعة البسكويت مع الحصول علي خواص جودة مقبولة. كنتيجة عامة لهذه الدراسة ومن خلال النتائج المتحصل عليها يمكن التوصية بإضافة دقيق بذور الكينوا المستنبته الي منتجات البسكويت المختلفة وذلك لرفع القيمة الغذائية لتلك المنتجات بالإضافة لمحتوها الرطوبي المنخفض والذي يضمن خلوها من الفساد الميكروبي عموماً ويمنحه فترة صلاحية طويلة.