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Influences of raw and germinated quinoa seeds flour on the chemical, technological and sensory properties of pan bread

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Abstract

This study aimed to incorporation of raw and germinated quinoa seed flour for wheat flour (72% extraction) by different levels (5, 10 and 15%) to take advantage of its many nutritional benefits. Incorporation of quinoa seed flour of raw and germinated obviously ($P \geq 0.05$) in composite flours blend increased in protein, fat, crude fiber and ash with increasing replacement ratio. Results of chemical analyses indicated that incorporation of raw and germinated quinoa into bread formula obviously ($P \geq 0.05$) increased each of protein, fat and crude fiber and indispensable essential amino acid (EAA) contents with increasing supplementing levels. The amino acids composition revealed that supplemented bread with flours of raw and germinated quinoa contained the most of EAA and will cover a highly percentages of reference protein pattern of FAO/WHO (1973). The mineral contents of composite flours bread from raw and germinated quinoa almost were higher than the control sample bread. Germination process of quinoa seed flour caused a decrease in the most of minerals compared with the raw quinoa bread (un-treatment). The sensory evaluation results of supplemented bread showed that a maximum of 10% germinated quinoa flour can be incorporated to make acceptable quality bread. While bread containing raw quinoa flour was less acceptable to the panelists as compared with the control bread.

Keywords: pan bread, quinoa seeds flour, raw, germination, chemical, amino acid.

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1. Introduction

One of the best plant-based sources of protein is quinoa (*Chenopodium quinoa* Willd.), a pseudocereal from the *Chenopodiaceae* family. Fact, 40 g of quinoa provides a significant portion of the required amino acid requirements for a day. Addition, quinoa is a gluten-free grain and a significant source of phenolic compounds, fiber, and minerals (Suarez-Estrella *et al.*, 2018). Due to its functional and rheological qualities, sensory traits, nutrient profile, and stability, quinoa can be used to make functional foods **(**Burgos *et al.*, 2019). Additionally, quinoa has significant levels of phytochemicals that are good for health, such as saponins, phytosterols, and phytoecdysteroids. According to Navruz-Varli and Sanlier (2016), quinoa has a significant favourable impact on metabolic, cardiovascular, and gastrointestinal health in humans. On the other hand, sensory acceptance is the most critical factor in ensuring the consumption of quinoa and its successful use in food products. In this context, the presence of bitter compounds in quinoa limits its consumption, despite its numerous nutritional benefits (Wang and Zhu, 2016). So, quinoa can have unpleasant off-flavours when processed into formulated products. One means of improving the palatability is seed germination. Also, the increased activities of hydrolytic enzymes can have a beneficial influence in food processing (Makinen, 2014). The germinated seeds possessa promising potential for essential nutrients, flavors, and textural attributes over non-germinated grain. During germination, many biochemical modifications occur, impacting product possessions such as shape, bioactivity, consistency, flavor, and digestibility. The bioavailability of nutrients is increased by germination, which activates enzymes that break down proteins, lipids, and carbohydrates into simpler substances and stimulates the protease enzyme that breaks down proteins. Hydrolytic enzymes activate and degrade starch, proteins and anti-nutrients, causing an increase in oligosaccharides and amino acids. These modifications have an effect on human health and on the nutritional content of the foodstuffs, it will increase metabolism, improve immunity, substitute for mineral and vitamin deficiency, normalize the combination of acid and base and has a strong bioactivity against cancer and diabetes (Ikram *et al.*, 2021). In this work, studied the effect of partial replacement of wheat flour (72% extraction) by different levels (5, 10 and 15%) of raw and germinated quinoa seeds flour improve the sensory, physical and chemical characteristics in addition to the mineral composition and amino acids of produced pan bread.

2. Materials and methods

2.1 Materials

Wheat flour (72% extraction rate) was obtained from Assuit Mills Co., Assuit governorate, Egypt. While a quinoa seed was obtained from Crops Institute, Agricultural Research Center, Giza Governorate, Egypt. Other ingredients (sunflower oil, sugar, salt and dry yeast) were obtained purchased from the local market, Assiut, Egypt (Table 1). All chemical and reagents used in analytical methods (analytical grade) were bought by Sigma Chemical Co. (St. Louis, MO, USA) and obtained from El-Gamhoria Trading Chemicals and Drugs Co., Assiut city, Egypt.

Table (1): Formulas of pan bread.

Ingredients	WF	WF-RQF5	WF-RQF10	WF-RQF15	WF-GQF5	WF-GQF10	WF-GQF15
Wheat flour (%)	100	95	90	85	95	90	85
Raw quinoa flour (%)	-	5	10	15	-	-	-
Germinated quinoa flour (%)	-	-	-	-	5	10	15
Sunflower oil (g)	6	6	6	6	6	6	6
Sugar (g)	5	5	5	5	5	5	5
Salt (g)	2	2	2	2	2	2	2
Yeast (g)	3	3	3	3	3	3	3
Water	Variable	Variable	Variable	Variable	Variable	Variable	Variable

WF; 100% Wheat flour, WF-RQF5: Wheat flour + Raw quinoa flour (replacement ratio 5%), WF-RQF10: Wheat flour + Raw quinoa flour (replacement ratio 10%), WF-RQF15: Wheat flour + Raw quinoa flour (replacement ratio 15%), WF-GQF5: Wheat flour + Germinated quinoa flour (replacement ratio 5%), WF-GQF10: Wheat flour + Germinated quinoa flour (replacement ratio 10%), WF-GQF15: Wheat flour + Germinated quinoa flour (replacement ratio 15%).

2.2 Methods

2.2.1 Technological processes

2.2.1.1 Preparation of quinoa seed flour

Quinoa seeds (*Chenopodium quinoa* Willd.) was cleaned and freed of broken seeds, dust and other foreign material and divided into two portions: the first portion was raw, while the second portion was germinated.

2.2.1.2 Germination process

The soaked seeds are allowed to germinate at 37°C for 48 hours with a successive change of water, then the seeds are washed with distilled water twice and then dried at 55-60°C for 4 hours (Shalaby *et al*., 2012). The raw and germinated seeds were ground in an electric mill to obtain a fine powder, the particles of which pass through a 20-hole /inch linear sieve and stored in polyethylene bags in the refrigerator until use.

2.2.1.3 Preparation of blends

Wheat flour was supplemented by 5, 10 and 15% of raw and germinated quinoa seed flour. The flour mixtures were individually blended and homogenized, packed in polyethylene bags, tightly closed and stored at room temperature until utilized.

2.2.1.4 Preparation of pan bread samples

Pan bread was prepared by straight dough method as described by Mostafa and Othman (1986). Pan bread was made from 72% extraction wheat flour and composite flours of raw or germinated quinoa described in Table (1). The basic ingredients for dough making by wheat flour or composite flours of raw or germinated quinoa flour (5, 10 and 15%), water, salt, yeast, sugar and shortening as shown in Table 1 for formulation of pan bread. The pan bread was prepared by mixing the ingredients using kneader for 10 minutes. Fermentation of dough was performed at 30°C±2 for 135 minutes and relative humidity 80-85%. The dough was punched to repartition the released carbon dioxide produced by yeast during fermentation and then followed by moulding. The moulded dough was put in pan and followed by second fermentation for 45 min. finally; the baking was carried out in an electric oven at 230-240°C for 20-25 minutes. The baking was let to cool at room temperature for 2 hours after baking and before evaluation of physical and sensorial properties of bread.

2.2.2 Analytical methods

2.2.2.1 Gross chemical composition

The chemical composition of wheat flour and composite flours of raw and germinated quinoa including moisture, protein, fat, ash, crude fiber and starch contents (on dry weight basis) were determined according to official methods as described in A.O.A.C. (2010). Carbohydrate was calculated by the difference [100- (protein + fat + ash)] on the dry weight. All determinations were performed in triplicates and the means and standard deviation were reported.

2.2.2.2 Chemical characteristics of pan bread

2.2.2.2.1 Determination of mineral contents

The total amounts of P, Ca, Zn and Fe in the digested samples were determined by atomic absorption spectrophotometry (A.O.A.C., 2010).

2.2.2.2.2 Determination of amino acids composition

Amino acids was determined using automatic amino acid analyzer according to the method of FAO/ WHO (1973). Acid hydrolysis of the samples were performed in the presence of 6 M HCL at 110oC for 24 hrs, under nitrogen atmosphere. Tryptophan was chemically determined by the method of Miller (1967).

2.2.2.3 Physical properties of pan bread

2.2.2.3.1 Loaf weight

Loaves were weighed in grams after two hours from baking as described by Mostafa and Othman (1986).

2.2.2.3.2 Loaf weight volume

The volume in (ml) of each loaf was determined using the seed displacement method using clover seeds (Mostafa and Othman, 1986).

2.2.2.3.3.1 Specific Loaf volume

The specific loaf volume was calculated from the following equation:

$$\text{Specific volume (ml/g)} = \frac{\text{Volume (ml)}}{\text{Weight (g)}}$$

2.2.2.4 Sensory characteristics of pan bread

The organoleptic characteristics of pan bread were determined by a taste panel, consisting of 10 judges. The panelists were asked to evaluate the products for crust color, crumb (graining and color), odor, taste, texture and overall acceptability. The rating was on a 10-point hedonic scale, ranging from 10 (like extremely) to 1 (dislike extremely), for each organoleptic characteristic (Mostafa and Othman, 1986).

2.2.2.5 Statistical analysis

Data were analyzed statistically by one-way analysis of variance (ANOVA) using SPSS software (IBM SPSS Statistics, version 22). When the difference between the samples was statistically significant ($P<0.05$), the Duncan test was used to determine the differences among the mean (SPSS, 2011).

3. Results and Discussion

3.1 Gross chemical composition of wheat flour and composite flours of raw and germinated quinoa

The chemical composition of wheat flour and composite flour made from wheat and raw and germinated quinoa by percentage (5, 10 and 15%) and used in preparation of pan bread are shown in Table (2). The moisture content of wheat flour used in the research was 16.32%. On the other hand, the moisture content ranged prepared composite flours of raw and germinated quinoa from 15.57% (WF-RQF15) to 16.11% (WF-RQF5). The low moisture content discovered suggested that it had the potential for increased storage stability as well as a longer shelf life (Ahmed, 2022). WF-GQF15 and WF-RQF15 had the highest protein, fat, ash and crude fiber content (10.84 and 10.58%), (1.86 and 1.97%), (0.99 and 1.23) and (0.49 and 0.37%) in comparison to wheat flour (10.23, 1.28, 0.63 and 0.14%), respectively. These results agree well with those reported by El-Sohaimy *et al.* (2021). The increase in protein, fat, ash and crude fiber content of composite flours related to high protein, fat, ash and crude fiber contents of quinoa flour than wheat flour. Furthermore, no significant differences in protein content ($P<0.05$) were found between other composite flours and wheat flour. Additionally, the ash content represents the total amount of minerals present in the composite flour, thereupon, the mineral contents of different quinoa seed flour almost higher than the control wheat flour sample. Germination process of quinoa seed had a slight effect ($P\geq0.05$) on the percentage of mineral composition. The germination process of quinoa seed caused more decrease

(P≥0.05) in most of the minerals compared raw quinoa flour. These changes in components may be due to consumption in respiration during germination (Sharma and Chauhan, 2000; Wani and Kumar, 2016). The increasing of raw and germinated quinoa flour was proportion in composite flour resulted in decreasing in carbohydrate content of flour blend with an increase in the percentage of addition which may be related to the lower content of carbohydrate in quinoa flour than in wheat flour. Results obtained in this study were in close agreement with those previously reported by Stikic *et al.* (2012).

Table (2): Gross chemical composition of wheat flour and composite flours of raw and germinated quinoa.

Sample	Moisture (%)	Protein (%)*	Fat (%)*	Ash (%)*	Crud fiber (%)*	Carbohydrate (%)**
WF	16.32±0.36^{a}	10.23±0.03^{b}	1.28±0.10^{cd}	0.63±0.16^{d}	0.14±0.01^{h}	87.86±0.21^{a}
WF-RQF5	16.11±1.13^{a}	10.33±0.20^{ab}	1.48±0.22^{bcd}	0.86±0.13^{bc}	0.18±0.01^{g}	87.32±0.16^{ab}
WF-RQF10	15.82±0.36^{a}	10.45±0.25^{ab}	1.17±0.19^{d}	1.01±0.09^{b}	0.28±0.01^{e}	87.36±0.35^{ab}
WF-RQF15	15.57±0.47^{a}	10.58±0.18^{ab}	1.97±0.17^{a}	1.23±0.16^{a}	0.37±0.01^{c}	86.22±0.38^{d}
WF-GQF5	16.10±1.00^{a}	10.39±0.27^{ab}	1.41±0.32^{bcd}	0.75±0.15^{cd}	0.21±0.01^{f}	87.44±0.24^{ab}
WF-GQF10	15.97±0.54^{a}	10.61±0.15^{ab}	1.62±0.27^{abc}	0.88±0.13^{bc}	0.35±0.01^{d}	86.88±0.23^{bc}
WF-GQF15	15.76±1.01^{a}	10.84±0.04^{ab}	1.86±0.04^{a}	0.99±0.04^{b}	0.49±0.01^{b}	86.30±0.05^{cd}

*On dry weight basis, **Carbohydrates calculated by difference. Abbreviations for symbols WF, WF-RQF5, WF-RQF10, WF-RQF15, WF-GQF5, WF-GQF10 and WF-GQF15 see footnote of Table (1). Values are the means of triplicate determinations with standard division. The different letters at the column mean significant differences at (P≤0.05), and the same letters mean no significant differences.

3.2 Gross chemical composition of pan bread baked from wheat flour and composite flours of raw and germinated quinoa

The chemical composition of pan bread baked from wheat flour and composite flours of raw and germinated quinoa are presented in Table (3). The wheat bread (control sample) contained 30.11% moisture, 11.26% protein, 1.60% fat, 2.29% ash, 0.41% crude fiber, 84.85% carbohydrate on dwb. These results are in agreement with that reported by Afzal *et al.* (2016) and Ahmed (2022) for wheat bread. On the other hand, the moisture decreased in the pan bread baked from composite flours with the increase in the addition. It ranged in raw quinoa added between 24.04 and 23.41%, while in germinated quinoa ranged between 26.41 and 20.08% for each of the addition 5 and 15%, respectively. It can be seen also from Table (2), that crude protein content of the pan bread was obviously increased (P≥0.05) by increasing raw or germinated quinoa flour replacement levels as compared with wheat bread of control. The pan bread baked from 15% germinated quinoa had the highest crude protein content (15.17%), followed by WF-GQF10, WF-GQF5 and WF-RQF15 bread samples. The lowest crude protein content for bread baked from wheat flour (11.26%). This could obviously be due to the significant quantity of protein in quinoa flour, especially the germinated (Afzal *et al.*, 2016; Demir and Bilgiçli, 2020; Kasaye and Jha, 2015). No significant differences in crude fat content of pan bread baked from wheat and composite flours of raw and germinated quinoa were also observed ($P \leq 0.05$), the mean values showed high fat content for WF-RQF15 (2.50%), followed by WF-RQF10 (2.14%) and WF-GQF10 (2.00%) bread samples. The lowest fat contents (1.60 and 1.67%) were recorded for wheat bread and WF-GQF5, respectively. Crude fiber content was higher in all pan bread baked from composite flours of raw and germinated quinoa than that of wheat flour bread. The highest crude fiber content recorded in WF-GQF15 (0.74%), while the lowest content was found in wheat flour bread (0.41%) on dwb. While wheat flour bread had the highest ash content (2.29%). Among the bread baked from composite flours of raw and germinated quinoa, WF-RQF15 and WF-RQF10 formulas bread showed high ash content (2.17%) followed by WF-RQF5 bread sample (2.78%) on dwb. Similar findings were reported previously by Minarro *et al.* (2012) and Ahmed (2022). On the other hand, the carbohydrate content of pan bread was decreased composite flours of raw and germinated quinoa. This may be due to the higher carbohydrate content of wheat flour compared to quinoa flour. Similarly, trend was supported previously by Mohammed *et al.* (2012), Kasaye and Jha (2015), and Demir and Bilgiçli (2020).

Table (3): Gross chemical composition of pan bread baked from wheat flour and composite flours of raw and germinated quinoa.

Sample	Moisture (%)	Protein (%)*	Fat (%)*	Ash (%)*	Crud fiber (%)*	Carbohydrate (%)**
WF	30.11 ± 3.29^{a}	11.26 ± 0.13^{f}	1.60 ± 0.18^{a}	2.29 ± 0.50^{a}	0.41 ± 0.01^{h}	84.85 ± 0.66^{a}
WF-RQF5	24.04 ± 3.98^{ab}	11.59 ± 0.28^{f}	1.86 ± 0.14^{a}	2.01 ± 0.14^{a}	0.55 ± 0.01^{f}	84.54 ± 0.40^{ab}
WF-RQF10	23.87 ± 4.26^{ab}	11.66 ± 0.31^{f}	2.14 ± 0.27^{a}	2.17 ± 0.18^{a}	0.62 ± 0.01^{e}	84.03 ± 0.40^{ab}
WF-RQF15	23.41 ± 9.36^{ab}	11.97 ± 1.98^{ef}	2.50 ± 0.28^{a}	2.17 ± 0.20^{a}	0.68 ± 0.01^{d}	83.36 ± 1.68^{abc}
WF-GQF5	26.41 ± 3.88^{ab}	14.34 ± 0.04^{abc}	1.67 ± 1.46^{a}	1.92 ± 0.21^{a}	0.49 ± 0.01^{g}	82.06 ± 1.21^{cde}
WF-GQF10	24.80 ± 4.47^{ab}	14.69 ± 0.24^{ab}	2.00 ± 1.47^{a}	1.95 ± 0.18^{a}	0.63 ± 0.01^{e}	81.36 ± 0.34^{de}
WF-GQF15	20.08 ± 4.27^{b}	15.17 ± 0.28^{a}	2.13 ± 0.91^{a}	1.10 ± 0.16^{a}	0.74 ± 0.01^{ab}	81.36 ± 0.34^{de}

*On dry weight basis, **Carbohydrates calculated by difference. Abbreviations for symbols WF, WF-RQF5, WF-RQF10, WF-RQF15, WF-GQF5, WF-GQF10 and WF-GQF15 see footnote of Table (1). Values are the means of triplicate determinations with standard division. The different letters at the column mean significant differences at ($P \leq 0.05$), and the same letters mean no significant differences.

3.3 Minerals of pan bread baked from wheat flour and composite flours of raw and germinated quinoa

Phosphorus, calcium, zinc and iron contents of wheat bread and bread baked from composite flours of raw and germinated quinoa are presented in Table (4). The pan bread from wheat flour had the lowest content from phosphorus (96.04), calcium (42.24) and Zinc (1.50 mg/100 g). While wheat flour pan bread had the highest iron content (1.22 mg/100 g). On the other hand, WF-RQF15 pan bread had the highest content of phosphorus (149.77), calcium (141.00) and zinc (2.75 mg/100 g) and the lowest content of iron (0.56 mg/100 g) compared to other types of pan bread. Quinoa grains are a good supply of micro-minerals like zinc, copper, and manganese, as well as macro-minerals like potassium, sodium, calcium, and magnesium (Das *et al*., 2011; Sayed *et al*., 2016). The obtained results are in good agreement with that reported by Demir and Bilgiçli (2020).

Table (4): Minerals of pan bread baked from wheat flour and composite flours of raw and germinated quinoa.

Sample	Phosphorus	Calcium	Zinc	Iron
WF	96.04	42.24	1.50	1.22
WF-RQF5	108.58	68.08	1.86	1.08
WF-RQF10	133.41	117.22	2.34	0.82
WF-RQF15	149.77	141.00	2.75	0.59
WF-GQF5	113.75	60.22	1.58	0.66
WF-GQF10	121.35	71.60	1.94	0.62
WF-GQF15	132.17	90.00	2.33	0.56

Abbreviations for symbols WF, WF-RQF5, WF-RQF10, WF-RQF15, WF-GQF5, WF-GQF10 and WF-GQF15 see footnote of Table (1).

3.4 Amino acids content of pan bread baked from wheat flour and composite flours of raw and germinated quinoa

The value of food quality is judged by its protein content, number and amounts of essential amino acids. Amino acids content of pan bread baked from wheat flour and composite flours of raw and germinated quinoa are shown in Table (5). Most pan bread samples baked from composite flours of raw and germinated quinoa was superior in its content of the essential amino acids' valine, methionine, isoleucine, lysine, threonine and tryptophan compared to wheat flour bread and was higher than the values recommended by FAO/WHO (2007). While wheat flour pan bread was higher in its content of the amino acid leucine and phenylalanine with other types of pan bread. On other hand, the content of non-essential amino acids glutamine was the highest followed by proline in wheat bread than the corresponding amino acids that observed for bread from composite flours of raw and germinated quinoa. Quinoa has the best amino acid profile when compared to the FAO/WHO (1973) reference pattern, as there is no lack of any essential amino acid. Quinoa has a lot of histidine, isoleucine, and aromatic amino acids (phenylalanine and tyrosine), as well as a lot of leucine and tryptophan. When quinoa protein is compared to the needs of schoolchildren and adults, it can meet more than 150% of school children's needs and more than 200% of adult needs (Valcarcel-Yamani and Lannes, 2012).

Table (5): Amino acids content of pan bread baked from wheat flour and composite flours of raw and germinated quinoa (g Amino acid/ 100g protein).

Amino acids		WF	WF-RQF5	WF-RQF10	WF-RQF15	WF-GQF5	WF-GQF10	WF-GQF15	FAO/WHO (2007)
		Essential amino acids (E.A.A)							
Valine	VAL	4.06	4.58	4.29	4.86	4.00	3.48	4.52	3.9
Methionine	MET	2.03	2.99	3.02	2.95	2.44	2.13	2.75	1.6
Isoleucine	ILE	3.76	3.78	3.80	3.76	3.71	3.00	4.42	3.0
Leucine	LEU	6.80	6.77	6.63	6.90	6.63	6.67	6.60	5.9
Phenylalanine	PHE	4.87	4.68	4.29	5.06	4.39	4.73	4.05	3
Lysine	LYS	2.13	2.49	2.73	2.24	2.34	2.51	2.17	4.5
Threonine	THR	2.64	2.69	2.54	2.84	2.73	3.09	2.37	2.3
Tryptophan	TRY	1.22	1.49	0.88	2.11	2.34	2.61	2.07	0.6
Total essential amino acids		27.51	29.45	28.20	30.71	28.59	28.21	28.96	-
		Non-essential amino acids (Non E.A.A)							
Aspartic	ASP	4.47	5.07	5.17	4.98	4.59	4.64	4.53	-
Serine	SER	4.06	3.78	3.51	4.05	4.10	4.83	3.36	-
Glutamic	GLU	33.71	32.14	30.44	33.84	31.80	30.82	32.79	-
Proline	PRO	11.98	10.25	10.15	10.35	10.54	10.92	10.16	-
Glycine	GLY	3.55	3.78	3.90	3.66	3.71	3.67	3.74	-
Histidine	HIS	2.23	2.29	2.44	2.14	2.24	2.42	2.07	1.5
Alanine	ALA	3.05	3.18	3.22	3.15	3.22	3.29	3.15	-
Tyrosin	TYR	2.84	2.69	1.85	3.52	2.44	0.68	4.20	-
Arginine	ARG	3.86	4.18	4.59	3.77	4.00	3.86	4.14	-
Cysteine	CYS	2.74	2.69	2.54	2.84	2.73	2.32	3.14	0.6
Total non-essential amino acids		72.49	70.05	67.80	72.29	69.37	67.44	71.29	-

Abbreviations for symbols WF, WF-RQF5, WF-RQF10, WF-RQF15, WF-GQF5, WF-GQF10 and WF-GQF15 see footnote of Table (1).

3.5 Physical properties of pan bread baked from wheat flour and composite flours of raw and germinated quinoa

Effect of using wheat flour and composite flours of raw and germinated quinoa on weight, volume, and specific volume of pan bread are presented in Table (6). The using composite flours of raw and germinated quinoa caused decreasing in weight of pan bread comparing to loaf weight of wheat bread as control with no significant difference ($P<0.05$) in weight between all bread samples. On the other hand, substitution of wheat flour with raw or germinated quinoa seed flour caused decreasing in volume of bread after baking, with increasing specific volume in composite flours bread of raw quinoa only and lower it composite flours bread of germinated quinoa comparing to wheat bread.

Table (6): Weight, volume and specific volume of pan bread baked from wheat flour and composite flours of raw and germinated quinoa.

Sample	Weight (g)	Volume (ml)	Specific volume (ml/g)
WF	148.20 ± 9.60^{a}	570.00 ± 20.00^{a}	$3.85\pm.11^{a}$
WF-RQF5	138.00 ± 18.00^{a}	506.00 ± 18.00^{b}	$3.96\pm.35^{a}$
WF-RQF10	135.07 ± 12.00^{a}	390.00 ± 15.00^{cd}	$2.89\pm.14^{bc}$
WF-RQF15	134.87 ± 10.00^{a}	388.30 ± 12.00^{cd}	$2.88\pm.13^{bcd}$
WF-GQF5	138.10 ± 15.00^{a}	357.67 ± 17.00^{f}	$2.59\pm.16^{df}$
WF-GQF10	140.70 ± 10.00^{a}	355.00 ± 15.00^{f}	$2.54\pm.07^{f}$
WF-GQF15	140.37 ± 10.10^{a}	352.33 ± 11.01^{f}	$2.51\pm.10^{f}$

Abbreviations for symbols WF, WF-RQF5, WF-RQF10, WF-RQF15, WF-GQF5, WF-GQF10 and WF-GQF15 see footnote of Table (1). Values are the mean of triplicate determinations with standard division. The different letters at the column mean significant differences at ($P\leq0.05$), and the same letters mean no significant differences.

The reason for the decreasing in volume may be due to the bread cells structure being unable to retain gas during baking (Feyzi *et al.*, 2015). Generally, these results are also in agreement with those obtained by Park *et al.* (2005).

3.6 Sensory evaluation of pan bread baked from wheat flour and composite flours of raw and germinated quinoa

Results of sensory evaluation of pan bread samples baked from wheat flour and composite flours of raw and germinated quinoa are shown in Table (7) and Figure (1). The obtained results indicated that decreased the acceptability for all sensory characteristics significantly ($P \geq 0.05$) decreased with increasing level of raw or germinated quinoa flours in the formulation compared with wheat flour bread. Outweigh composite flours bread of raw quinoa in characteristics crust color, crumb and odor compared with composite flours bread of germinated quinoa and the last outweigh in taste, texture and general admission. These results are in agreement with those obtained by Suárez-Estrella *et al.* (2019) and El-Sohaimy *et al.* (2021).

Table (7): Sensory evaluation of pan bread baked from wheat flour and composite flours of raw and germinated quinoa.

Sample	Crust color (10)	Crumb		Odor (10)	Taste (10)	Texture (10)	Overall acceptability (10)
		Graining (10)	Color (10)				
WF	8.40 ± 0.54^{a}	$8.36\pm.49^{a}$	$7.80\pm.44^{a}$	$7.80\pm.83^{a}$	$8.00\pm.70^{a}$	$8.00\pm.61^{a}$	$8.60\pm.54^{a}$
WF-RQF5	7.20 ± 0.83^{ab}	$7.60\pm.65^{ab}$	$6.20\pm.83^{bc}$	$6.20\pm.83^{b}$	$5.80\pm.44^{bc}$	$6.60\pm.54^{b}$	$6.00\pm.00^{b}$
WF-RQF10	6.70 ± 0.54^{bc}	$6.40\pm.54^{fg}$	$5.60\pm.54^{cd}$	$5.20\pm.44^{cd}$	$5.00\pm.00^{cdef}$	$6.20\pm.27^{bc}$	$5.60\pm.54^{b}$
WF-RQF15	6.00 ± 0.70^{d}	$5.20\pm.44^{g}$	$4.60\pm.54^{d}$	$4.60\pm.41^{de}$	$4.60\pm.54^{ef}$	$4.40\pm.54^{ef}$	$4.40\pm.65^{d}$
WF-GQF5	5.60 ± 0.54^{cd}	$5.00\pm.00^{c}$	$6.00\pm.00^{b}$	$5.80\pm.44^{bc}$	$6.80\pm.83^{b}$	$7.20\pm.83^{bc}$	$7.40\pm.54^{abc}$
WF-GQF10	5.60 ± 0.54^{cd}	$5.00\pm.00^{c}$	5.60 ± 1.14^{bcd}	$5.60\pm.54^{bc}$	$6.40\pm.54^{bc}$	$6.60\pm.54^{cd}$	$7.40\pm.89^{abc}$
WF-GQF15	4.20 ± 0.44^{f}	$3.60\pm.54^{e}$	$4.40\pm.54^{f}$	$4.40\pm.54^{e}$	$4.60\pm.65^{d}$	$5.60\pm.65^{ef}$	$6.60\pm.89^{bcd}$

Abbreviations for symbols WF, WF-RQF5, WF-RQF10, WF-RQF15, WF-GQF5, WF-GQF10 and WF-GQF15 see footnote of Table (1). Values are the means of triplicate determinations with standard division. The different letters at the column mean significant differences at ($P \leq 0.05$), and the same letters mean no significant differences.

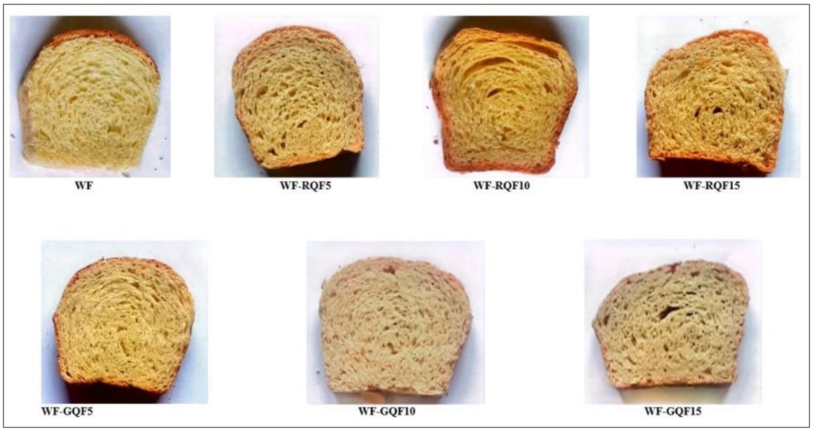

Figure (1): Pan bread from wheat flour and composite flours of raw and germinated quinoa.

Also, results indicated that there were no significant (P≤0.05) differences between control wheat bread sample and bread samples containing 5 or 10% germinated quinoa flour in overall acceptability. While the bread containing 15% of raw or germinated quinoa flour were significantly different (P≥0.05) in all sensory properties and were unacceptable to the panelists as compared to the control wheat bread sample. Therefore, it excluded from the overall acceptability rating. Finally, all samples of other composite flours bread of raw or germinated quinoa were organoleptically acceptable and gave lesser score than that of wheat flour bread as the control. These results go combined with the results obtained by Sharma and Chauhan (2000), Gamlath and Ravindran (2008), Elizabeth *et al.* (2012), and Laguna *et al.* (2013).

4. Conclusion

It may be concluded from this study that raw quinoa seeds flour could be incorporated up to a 10% replacement level and germinated quinoa seeds flour up to a 15% replacement level in the formulation of bread without affecting their overall quality. The chemical and sensory characteristics, in general, revealed that bread containing 10% germinated quinoa seeds flour were the best among all the composite quinoa seeds flour bread. Additionally, it also improved the deficiency in lysine, hence neutralized the amino acids imbalance due to its high essential amino acids contents.

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