Nutritional Value and Sensory Properties of Fortified Wheat Flour with White and Tri-Color Quinoa Powder: Application in Toast Bread

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Abstract:

Recently, attention has increased to using natural sources rich in bioactive compounds to enhance the functional characteristics of food products. Therefore, this study aims to determine the nutrition profile of strengthening wheat flour (WF) with white quinoa powder (WQP) and tri-color quinoa powder (TCQP) by 20- 40 % using it in the production of toast bread. The results clarified that WQP recorded the highest content of fat and moisture (7.07 and 11.77%) respectively, compared to TCQP recorded (5.14 and 5.49%) respectively. TCQP showed the highest values of protein and carbohydrate (19.46 and 63.10%) respectively; while WQP content was (15.09 and 58.63%) respectively. Both of WQP and TCQP were recorded nearly results in ash (2.60%) and (2.25%) respectively; also fiber recorded (4.91%) and (4.56%) respectively. Total phenols content (TPC) was (369.3 and 373.4 mg) for WQP and TCQP respectively, total flavonoids content (TFC) was (120.8 and 148.2 mg) for WQP and TCQP respectively, and total antioxidant capacity (TAC) was (246.9 and 519.9 mg) for WQP and TCQP respectively. The sensory properties showed an increase with increased the addition level of WQP and TCQP from 20 to 40%. It can be recommended that fortified wheat flour with white and tri-color quinoa powder could positively impact the nutritional and functional properties of fortified bread.

Keyword: Pseudo cereal, tri-color quinoa, chemical composition, bioactive compounds

Introduction:

Quinoa (*Chenopodium quinoa Willd*.) is considered an annual herbaceous dicotyledonous summer crop; it has small and round seeds **(Srujana *et al*., 2019; Pathan and Siddiqui, 2022).** About 7,000 years ago the Andean people of South America began cultivating quinoa because of its ability to grow in high salt conditions, drought tolerance and its nutritional value. They called quinoa "the mother grain", although it was overlooked for thousands of years, the number of countries that grow quinoa has greatly increased and it is now being produced in more than 100 countries **(Pathan and Siddiqui, 2022).** There are about 250 species of quinoa in Worldwide and called a pseudo grain **(Vega-Galvez *et al.,* 2010).** Depending on the cultivar, quinoa seeds have varied in color from white to red or black **(Valencia-Chamorro, 2003).**

Quinoa is an excellent functional food because of the exceptional balance between fat, protein and oil and which reduces the risk of several diseases **(Arafa and Elseedy, 2016).** Its high biological value was 73%, it was similar to that of beef at 74%; while that value was higher than those of white rice, wheat and corn was (56,49 and 36%) respectively **(Bastidas *et al*., 2016; Kovalev *et al*., 2019).** Quinoa protein is a complete protein because it contains all of the essential amino acids **(Craine and Murphy, 2020).** The protein content of quinoa is higher than other cereals such as (corn, rice, rye and barley). The percentage of protein usually varies from 13.8 to 16.5% **(Vega-Gálvez *et al.,* 2010; Maradini-Filho**, **2017; Rizwan *et al*., 2020).** Quinoa content of amino acids higher than other cereals (arginine, cystine, isoleucine, lysine, serine, threonine, tryptophan, tyrosine and valine) ranged between 2.6 and 5.2, for the rest of amino acids were higher to 1.8 **(Escuredo *et al.*, 2014).** Quinoa could represent a valuable source of nutrition, especially for infants children and adults, and may be used in nutritive foods and beverages **(Abugoch *et al*., 2008).**

Carbohydrates usually constitutes a major portion in quinoa of varies from 67 to 74% and starch represents approximately 52 to 60%. Starch exists in seeds as simple units. The diameter of starch granules present in quinoa is smaller than that of other cereals **(Valencia-Chamorro, 2003; Mouminah, 2018).**

The range of quinoa grains' carbohydrate content was 48.5-69.8% **(Repo-Carrasco *et al.*, 2003).** Starch is the primary component of the quinoa seed and it in the range of 53.2–73.4% on a dry weight basis **(Mu, 2023).** Quinoa starch accounts for 58.1 to 64.2% of the dry weight of the seed and has a low glycemic index **(Vega-Galvez *et al.*, 2010).** Quinoa carbohydrates consist of 2.9-3.6% pentosans, 2.5-3.9% crude fiber, 2% mono-saccharides and 2.3% di-saccharides **(Valencia-Chamorro, 2003)**.Where100 g of quinoa is contains the following amounts of sugar: 1.70 mg glucose, 0.20 mg fructose, 2.90 mg sucrose and 1.40mg maltose **(Ahmed *et al.*, 2021).** Quinoa seeds contain 7-16% of dietary fiber and when compared to other grains, quinoa contains a lot of fiber; in 185 g quinoa detected 17.27 g of fiber **(Lamothe *et al*., 2015; Lotfy and Naga, 2020).**

Quinoa is pseudo cereal rich in lipid, compared to the common cereals the fat content of quinoa is quite high (5–10%); so it was considered an alternative to oil seeds **(Prego *et al*., 1998).** Oil content in quinoa ranges from 1.8% to 9.5%, with an average of 5.0–7.2% **(Kozioł, 1992).** Quinoa seed oil content 89.4% unsaturated fatty acids and 54.2% to 58.3% polyunsaturated fatty acids **(Tang *et al*., 2015a).**

The free phenolic compounds present in quinoa grains range from (167.2 to 308.3 mg gallic acid (GAE) equivalents per 100 g dry weight) **(Ocampo *et al*., 2023)**. The amount of bound phenols in quinoa grains is lower than that in free phenols **(Renard *et al*., 1999; Harborne and Williams 2000; Tang *et al*., 2015b)**, and the bound phenolic compounds are mostly found in the quinoa leaves rather than the seeds **(Da-Silva *et al*., 2007).** Ferulic acid, vanillic and gallic acid were prominent compounds then flavonoids or proanthocyanidins and their glycoside derivatives; whereas the fraction of bound phenolics includes phenolic acids **(Gomez-Caravaca, *et al*., 2011; Murphy and Matanguihan, 2015; Hussain *et al*., 2021).** Flavonoids found in quinoa include orientin, vitexin, rutin, morin, hesperidin and neohesperidin **(Paśko *et al*., 2008).** TFC ranged from (11.40 to 223.80 mg per 100 g of dry weight) in quinoa grains **(Paśko *et al*., 2009; Kaur *et al*., 2016).**

In quinoa seeds, there are significant amounts of riboflavin (B2), pyridoxine (B6), folic acid (B9), cobalamin (B12) and alpha-tocopherol (E) (5.83, 6.80, 0.27, 2.010, 0.127 mg / 100) respectively**. (AL-Sayed *et al*., 2019)**. Potassium, Calcium, Magnesium, iron, and zinc was (1400-5300, 275-1487, 260-5020, 14-168 and 28-48 mg/kg) respectively **(Vega-Galvez *et al*., 2010).**

Quinoa may be combined as functional food ingredients in other food products. And the bread is among the most common foods for the world's population; therefore, it can be fortified to be a carrier of other substances with a nutritional or physiological effect, bringing health benefits to its consumers. And quinoa presents a promising food for nutrition and human health, its considered an excellent source of nutrients, it's an outstanding source of protein, amino acids, minerals omega-3 fatty acids and health promoting compounds with anticancer, antioxidant, anti-obesity, antimicrobial, cardio-beneficial properties and gastroprotective potential **(Pathan and Siddiqui, 2022; Kaim and Goluch, 2023).** So, the current study was carried out to assess the effect of fortifications with varying levels of WQP and TCQP (20 and 40%) on the nutrition and sensory properties of wheat toast bread.

Materials and methods:

Materials:

Source of plant:

White quinoa seeds and tri-color quinoa (white-red-black) seeds were obtained from Organic Nation Market in Minia City, Minia Governorate, Egypt.

Ingredients:

The main ingredients used in this study (wheat flour 72%, yeast, sugar, butter, salt, and milk) were obtained from Alrayah Market in Minia City, Minia Governorate, Egypt.

Reagents and chemicals:

All solvents and chemicals were obtained from El-Gomhoria Company for chemicals, medical instruments and trading, Cairo, Egypt.

Methods:

Determination of chemical composition:

At the Food Technology Research Institute, we assessed moisture, protein, ash, fat, and crude fiber using the methods described in **A.O.A.C. (2012).** The outcomes are displayed below.

Determination of phytochemical composition:

Determination of total flavonoids, total phenols, antioxidant activity and total antioxidant capacity according to **Bakar *et al.*,(2009); Oms-Oliu *et al.*, (2009); Musa *et al.*, (2011); Kanika *et al.*,(2015).**

Blending the powder:

White quinoa powder (WQP) as well as tri-color quinoa powder (TCQP) at levels of 20 and 40% were mixed with wheat flour (WF). The flour mixture is then kept in an airtight container in the refrigerator for further analysis of the process and preparation of the product after being individually packed in sealed polyethylene bags (Table 1).

Table (1): Blend formulation:

Abbreviation of sample	Mixture (dry weight)
WF 100%	**100%Wheat Flour**
WQP 20%	**80% Wheat flour + 20% White Quinoa powder**
WQP 40%	**60% Wheat flour + 40% White Quinoa Powder**
TCQP 20%	**80% Wheat flour + 20% Tri-Color quinoa powder**
TQCP 40%	**60% Wheat flour + 40% Tri-Color quinoa Powder**

Technological Methods:

Preparation of toast bread:

According to method **Sharawy, (2023)** make toast bread with a few adjustments stated in Table (2).

Statistical Analysis:

Using the General Linear Model software as statistical analysis method we analyzed data by **SAS, (2003)** and used double range tests to compare the average with **Duncan, (1955)** method.

Table (2): Preparation of toast bread:

Samples / Ingredients(g)	WF 100%	WQP 20%	WQP 40%	TCQP 20%	TCQP 40%
WF	440	352	264	352	264
WQP	---	88	176	---	---
TCQP	---	---	---	88	176
Butter	42	42	42	42	42
Salt	6	6	6	6	6
Sugar	22	22	22	22	22
Yeast	7	7	7	7	7
Water(ml)	174	174	174	174	174
Milk (ml)	125	125	125	125	125

Ethical approval:

Experiments, especially the sensory evaluations for this study were approved by the Ethics Committee of Scientific Research, Faculty of Specific Education-Minia University.

Result and discussion

Chemical compositions

Chemical analyses of WQP and TCQP:

The proximate chemical composition of WQP and TCQP were presented in Table (3). The results clarified that the protein content of WQP and TCQP was (15.09 and 19.46%) respectively, while the moisture content of WQP and TCQP was (11.77 and 5.49%) respectively, and our findings show that the crude fat content of samples was (7.07 % for WQP and 5.14% for TCQP). The content of ash was (2.60 and 2.25%) for WQP and TCQP respectively. Fiber content was (4.91 and 4.56%) in WQP and TCQP respectively, while the content of total carbohydrate was (58.63 and 63.10%) for WQP and TCQP respectively.

White quinoa powder was recorded to have the highest content of moisture, ash, crude fat and fiber, while TCQP showed the highest values of protein and total carbohydrates. Our results showed a high content of carbohydrates for TCQP and WQP. Our results were in in agreement with **Alamri *et al*., (2023)** confirmed that quinoa has a high nutritional value and belongs to the category of complete proteins. Also, our results were in agreement with **Ranjan *et al*., (2023)** reported that quinoa carbohydrates have ability to reduce free fatty acids and lessen hypoglycemia symptoms. Results were presented in Table (3) were show the content of fiber value (4.91and 4.56%) for WQP and TCQP respectively; that agree with **Lamothe *et al*., (2015)** confirmed that quinoa grains are also an excellent source of dietary fiber with 78% insoluble and 22% soluble fiber. Our results showed a high content of crude fat value (7.07 and 5.14%) for WQP and TCQP respectively.

Results agreed with **Hussain *et al*., (2021)** confirmed that the fat content of quinoa is quite high (5–10 %) and is mainly localized in the embryo. Quinoa was considered an alternative to oil seeds due to its lipid composition compared to common cereals. **Benito-Román *et al*., (2018)** explain that quinoa oil possesses high anti-oxidant activity, high contents of polyunsaturated fatty acids (63% of total) and a significant amount of tocopherols.

Our results were consistent with results obtained by **García-Salcedo *et al*., (2018)** reported that the moisture content of white quinoa powder was (11.64 %); on the other hand, the results of ash content (0.011%) differed from our results; also, the results are near in protein, fat, carbohydrates and fiber (13.46, 5.47, 62.759 and 6.66 %) respectively. And our results were near in the chemical composition with results obtained by **Marmouzi *et al*., (2015)** found that the moisture, protein, carbohydrates, ash, fat of white quinoa powder were (9.2, 12.51, 63.58, 3.1 and 4.88 %) respectively; also near in the results were obtained by **Al-Anbari *et al*., (2020)** explained that the moisture, protein, carbohydrates, ash, fat and fiber of white quinoa powder was (12.25, 14.04, 55.63, 5.17, 5.80 and 7.10%) respectively.

On other hand, our results were different from results obtained by **Al-Okbi *et al*., (2024)** reported that carbohydrates, ash and fiber content of white quinoa powder were (65.36, 1.64 and 1.88 %) respectively while they near with our results in moisture, protein and fat content were (10.19, 16.45 and 4.48%) respectively. Also our results were consistent with results obtained by **Gaikwad *et al*., (2021)** found that the protein of white quinoa powder was (15.24%) and the results were near in moisture, fat, carbohydrates, ash and fiber content (9.8, 6.1, 61.12, 3 and 4.74 %) respectively.

Table (3): Proximate chemical content of WQP and TCQP:

Chemical Composition (g/100g)	WQP	TCQP
Moisture	11.77 ± 0.59	5.49 ± 0.59
Protein	15.09 ± 1.58	19.46 ± 0.54
Crude Fat	7.07 ± 0.35	5.14 ± 0.14
Ash	2.60 ± 0.26	2.25 ± 0.01
Total Carbohydrates	58.63 ± 1.16	63.10 ± 0.90
Fiber	4.91 ± 0.2	4.56 ± 0.40

*Data represent the mean ± S.D. of observation from three determinations

Our results of proximate chemical content TCQP were consistent with **Pereiraa *et al*., (2019)** found ash content was (2.7%), near in fat content was (6.4%) and different in carbohydrates, moisture and proteins content (76.1, 9.5 and 14.8%) respectively; while our results were consistent with **Diaz-Valencia *et al*., (2018)** reported that ash content was (2.6%) and different in proteins, fiber and fat content (13.7, 14.7 and 7.1%) respectively.

Phytochemical analyses of WQP and TCQP:

The Phytochemical analyses of WQP and TCQP were presented in Table (4). The results show that total phenol content (369.3 and 373.4 mg) for WQP and TCQP respectively. The flavonoid content was (120.8 and 148.2 mg) for WQP and TCQP respectively, and the total antioxidant capacity was (246.9 and 519.9 mg) for WQP and TCQP respectively, while the DPPH content of samples was (45.06 and 46.97 %) for WQP and TCQP respectively.

In the same Table tri-color quinoa powder recorded the highest content of TPC, TFC, TAC and DPPH than WQP. Results showed high content of TPC and high content of TFC for WQP and TCQP respectively.

Table (4): Phytochemicals composition content of WQP and TCQP:

Phytochemicals composition	WQP	TCQP
TPC (mg GAE /100g)	**369.3±2.10**	**373.4±4.72**
TFC (mg quercetin /100g)	**120.8±6.63**	**148.2±2.80**
TAC (mg ascorbic acid /100g)	**246.9±2.81**	**519.9±3.90**
DPPH (%)	**45.06±2.03**	**46.97±1.77**

*Data represent the mean ± S.D. of observation from three determinations

Tang and Tsao, (2017)confirmed that the phenolic compounds, especially phenolic acids are located primarily in the seed coat of the quinoa seeds. **Han *et al*., (2019) and Antognoni *et al*., (2021)** confirmed that detected 23 polyphenols in quinoa, mainly vanillic acid, ferulic acid and their derivatives, quercetin, kaempferol and their glycosides; also, different studies confirmed that the darker the color of quinoa seed, the higher the phenolic content; black and red quinoa seeds having higher phenolic contents than white and darker quinoa seeds have higher phenolic concentrations and antioxidant activity.

Also, our results showed a high content of DPPH for WQP and TCQP respectively. White quinoa powder has high content of DPPH **(Shen *et al*., 2022)**. **Daliri *et al*., (2021)** confirmed that quinoa peptides and polysaccharides also have obvious antioxidant activity, for example, quinoa peptides produced by trypsin digestion have DPPH free radical scavenging ability, which is mainly due to the expansion of protein molecules after hydrolysis and the greater availability of electron donor amino acids.

Phenolic compounds have been found to be efficient free-radical scavengers, partly due to their one-electron reduction potential, the ability to act as hydrogen or electron donors **(Higdon and Frei, 2003).** Results were found that TCQP was richer in value of DPPH due to the high content of phenolic compounds compared to WQP. In addition, results were in agreements with results obtained by **Ibrahem and Mohamed, (2021)** found that the TFC of white quinoa powder was (123.42 mg); while their results were different in TPC and TAC values (249.43 and 162.3 mg) respectively. On the other hand, our results were different from the results were obtained by **AL-Sayed *et al*., (2019)** reported that the TPC, TFC and DPPH of white quinoa powder were (2.63, 0.53 and 0.29 mg) respectively.

Our results were consistent with results obtained by **Mu *et al*., (2023)** reported that TFC value of white quinoa powder was (36.2–288 mg); while the results of TPC (30.3–202 mg) which was different with our results. As well as, our results disagreed with the results obtained by **Mohamed *et al*., (2022)** reported that TPC and TAC value were (212.5 and 450.44 mg) respectively.

In addition, our results were near in TPC and TFC of tri-color quinoa powder with the results were obtained by **Ibrahem and Mohamed, (2021)** found that the mean of TPC and TFC in tri-color quinoa powder was (401.46 and 139.09 mg) respectively. As well as, our results in DPPH of tri-color quinoa powder were near with the results were obtained by **Lakshmi *et al*., (2021) and Shen *et al*., (2022)** reported that the DPPH was (35.93 mg).

On the other hand, our results were disagreed with these results obtained **by Diaz-Valencia *et al*., (2018)** found that TPC and DPPH of TCQ powder were (60.16 and 31.26 mg) respectively. Our results in Table (4) were show the high content of TAC in TCQP was (519.9 mg); our results in the same line were obtain by **Abderrahim *et al*., (2015)** founded that TAC of tri-color quinoa powder was (772.8 mg).

Sensory evaluation:

Sensory evaluation of toastbread prepared by WF mixed withWQP and TCQP at levels (20 and 40 %):

The sensory evaluation of any food item is a fundamental step in the development of food products since it determines whether the product will be accepted or not. The influence of addition WQP and TCQP at level (20 and 40%) to WF was significant in terms of the sensory characteristics including (color, smell, taste, shape, texture and general acceptance) for the toast bread was summarized in Table (5). A significant decrease (P≤0.05) in all properties was observed in the presence of additional amounts of white and tri-color quinoa powder. Moreover, the increase level addition of white quinoa powder and tri-color quinoa powder to wheat flour decreased in all properties compare to control sample.

The results in photo (1) showed a significant difference (P ≤ 0.05) in the color of the toast bread replaced with 20 and 40% of WQP and TCQP. The control sample has the highest color score value (9.73); followed by color of toast bread produced by 20% WQP has score value (9.60) compare to all samples, followed by toast bread produced by 20% TCQP was (9.40) and toast bread produced by 40% WQP was (9.28) and toast bread produced by 40% TCQP has less score value was (9.18).

Our results were agreed with **Olawuni *et al.*, (2024)** reported that the mean scores for the color of the bread significantly decreased when quinoa powder was added. **Elgeti *et al*., (2014)** noticed that incorporation of quinoa powder in bread at high ratios a relatively dark color of the crust and crumb. As well as, data showed a significant difference (P ≤ 0.05) in the smell and texture of the toast bread replaced with 20 and 40% of WQP and TCQP.
The control sample has highest smell and texture score value (9.40 and 9.63) respectively; followed by toast bread produced by 40%TCQP has score value (9.28 and 9.53) respectively, compare

to all samples, followed by toast bread product by 40%WQP was (9.23 and 9.40) respectively, and toast bread produced by 20%TCQP was (9.13 and 9.23) respectively, and toast bread by 20%WQP has less score value was (9.10 and 9.18) respectively.

The results showed that increased percentage of quinoa lead to increase in homogeneity that indicates the softer texture of product our results was agree with **Ghasemizadeh *et al*., (2018)** reported that quinoa causes softness in bread due to the presence of bran and networking. Also, **Olawuni *et al*., (2024)** confirmed that the mean scores for the texture of the bread significantly decreased when added quinoa powder.

And our results are in different with **Iglesias-Puig *et al*., (2015)** reported that crumb hardness in pan bread increased when the ratio of quinoa in wheat-quinoa four mixtures increased from 25 to50%. Also, data in Table (5), present that addition WQP and TCQP at level (20 and 40%) to WF was significant in the shape of the toast bread. The control sample has highest shape score value (9.63); followed by toast bread by20%WQP and 20% TCQP has score value (9.55 and 9.53) respectively compared to all samples, followed by toast bread produced by 40%TCQP and 40%WQP was (9.33 and 9.30) respectively; and toast bread by WQP 20% has less score value was (9.30).

Table (5): Sensory evaluation of toast bread prepared by WF replaced with different levels of WQP and TCQP (20 and 40%):

Samples	WF 100%	WQP 20%	WQP 40%	TCQP 20 %	TCQP 40%
Color	9.73± 0.55[a]	9.60±0.55[ab]	9.28± 0.68[c]	9.40± 0.63[b]	9.18 ± 0.81[c]
Smell	9.40± 0.63[a]	9.10± 0.71[c]	9.23± 0.89[b]	9.13± 0.76[c]	9.28 ± 0.28[b]
Shape	9.63± 0.77[a]	9.55± 0.64[b]	9.30± 0.79[c]	9.53± 0.64[b]	9.33 ± 0.76[c]
Taste	9.75 ± 0.54[a]	9.18± 0.96[c]	9.55± 0.55[b]	9.20± 0.69[c]	9.60±0.50[ab]
Texture	9.63± 0.49[a]	9.18± 0.85[c]	9.40± 0.59[b]	9.23± 0.73[c]	9.53± .85[ab]
General Acceptance	9.68± 0.47[a]	9.20± 0.69[c]	9.52± 0.60[b]	9.25± 0.63[c]	9.58±0.84[ab]

* Each value reflects the mean value ± SD.
* Mean values of various letters in the same raw average atp≤0.05. stage are substantially different.

Photo (1): Toast Bread

Ballester-Sánchez *et al.*, (2019) reported that there were no significant changes in loaf weight between the breads that incorporated quinoa and the control bread. And our results agreed with **Wang *et al.*, (2015)** reported that their reduction in loaf height compare to the control bread cause of the dilution of gluten and the higher fiber concentration in the quinoa flours. The results showed a significant difference ($P \leq 0.05$) in the taste of the toast bread. The control sample has highest taste score value (9.75); followed by taste of toast bread produced by TCQP 40 % has score value (9.60) compare to all samples, followed by toast bread produced by WQP 40% was (9.55) and toast bread produced by TCQP 20% was (9.20); while toast bread with WQP 20% has less score value was (9.18).

In Table (5), samples showed significant differences n in the general acceptance of the toast bread. Data showed that the control sample has highest acceptance score value (9.68); followed by toast bread produced by TCQP 40 % has score value (9.58), toast bread produced by WQP 40% was (9.52) and toast bread produced by TCQP 20% was (9.25); while toast bread with WQP 20% has less score value was (9.20). Our results agreed with **El-Sohaimy *et al.*, (2019)** reported that it was clear that by increasing quinoa in the blend up to 40% the toast shape had slightly changed but it was more acceptable. Our results agreed with **Verma and Shukla, (2023)** explained that substitution of quinoa flour up to 40% in preparation bread has the best sensory attribute.

Conclusion:

These results indicate that the addition of natural sources such as white and tri-color quinoa powder to wheat flour, could positively increase of protein and dietary fiber content that improve the nutritional value of toast bread and enhanced the influenced the sensory evaluation for most consumers to accept the bread. So, this study recommends incorporating white and tri-color quinoa powder with wheat flour to enhance the nutritional quality, sensory and functional properties of toast bread.

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القيمة الغذائية والخصائص الحسية لدقيق القمح المدعم بمسحوق الكينوا الأبيض وثلاثي الألوان

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المستخلص:

في الآونة الأخيرة، زاد الاهتمام بإستخدام المصادر الطبيعية الغنية بالمركبات النشطة بيولوجيا لتعزيز الخصائص الوظيفية للمنتجات الغذائية. لذلك تهدف هذه الدراسة إلى تقدير القيمة الغذائية لدقيق القمح (WF) المدعم بمسحوق الكينوا الأبيض (WQP) ومسحوق الكينوا ثلاثي الألوان(TCQP) بنسبة 20–40% واستخدامه في إنتاج خبز التوست. أوضحت النتائج أن WQP سجل أعلى محتوى للدهون والرطوبة (7,07 و11,77%) على التوالي، مقارنة بـ TCQPحيث سجل (5,14و49, 5%) على التوالي. بينما أظهر TCQP أعلى قيم للبروتين والكربوهيدرات (19,46و63,10%) على التوالي؛ بينما بلغ محتوى (15,9WQPو58,63%) على التوالي. سجلت كل من WQPوTCQP تقديرات متقاربة في الرماد (2,60%) و(2,25%) على التوالي؛ كما سجلت نتائج قريبه أيضاً للألياف (4,91%) و(4,56%) على التوالي. أيضاً يتمتع TCQPبقيمه عالية في إجمالي محتوى الفينولات (TPC)، الفلافونويد (TFC)، وإجمالي القدرة المضادة للأكسدة (TAC) والذي سجلت (373,4 و148,2 و519,9 مليجرام)، على التوالي؛ بينما بلغت قيم WQP (369,3، 120,8و246,9 مليجرام) على التوالي. وأظهرت الخصائص الحسية تحسن مع زيادة مستوى الإضافة لـ WQP،TCP من 20 إلى 40%. يمكن التوصية بتدعيم دقيق القمح بمسحوق الكينوا الأبيض وثلاثي الألوان حيث أنه يؤثر بشكل إيجابي على الخصائص الغذائية والوظيفية للخبز المدعم.

الكلمات المفتاحيه: الحبوب الزائفة، الكينوا ثلاثية الألوان، التركيب الكيميائي، المركبات النشطة حيويا.