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(Original Article)

Physicochemical and Functional Properties, Nutritional Value and Bioactive Compounds of Some Composite Flours

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Abstract

The aim of this work was to study the properties of composite flours for cereals (oats) and legumes (chickpea and sweet lupine) in addition to 72% wheat flour. The chemical composition, physicochemical and functional properties, nutritional value and bioactive compounds for all flours were determined. The results showed that there were significant differences ($P<0.05$) between the flour samples in the majority of those parameters. Data showed that the whole sweet lupine flour had a higher value of each protein, ash, lipid and crude fiber content, while the lowest values of the same chemical composition components were obtained with the 72% wheat flour. In the same trend, whole sweet lupine flour had higher amounts of physicochemical and functional properties, including (WAC and OAC) and bulk density, but its pH value was low compared to other flours. For the mineral contents, the whole oat flour had a higher content of Mg, P and Zn; and higher amount of Fe was recorded with chickpea flour; and a higher value of K was achieved by whole flours from chickpea and sweet lupine, on the other hand the 72% wheat flour had lower contents of those minerals. Results showed that the whole sweet lupine flour had higher values with regard to the amino acid composition and (TPC and TFC). It was discovered that the whole flour from legumes, particularly sweet lupine flour, had the highest values for most these parameters.

Keywords: *Composite flour, Cereal/leguminous blend, Bulk density, Amino acids*

Introduction

Composite flour is an innovative product that has attracted a lot of interest in the discovery of the new with the development of food products (Hasmadi *et al*., 2018; Emmanuel *et al*., 2019). According to Adeyemi and Ogazi (1985) and Shittu *et al*. (2007) composite flour has been defined as a mixture of several types of flour obtained from (tubers, roots, grains, and legumes), with or without adding wheat flour. Composite flour is used on a large scale and is successful in the manufacture of baked foods. There are many studies that deal with the use of cereal-legume combinations to produce various products (Akubor and Ukwuru, 2005; Oladunmoye *et al*., 2010).

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Cereal grains are the main source of energy for most of the people in poor countries. Foods produced from cereals, such as bread, biscuits, etc., are limited in nutritional protein, therefore have low nutritional quality. Many studies have been used to enrich cereal flour with sources of legume flour and others (McWatters *et al*., 2004), because legume proteins have a high content of lysine, which is an essential amino acid that is lacking in most cereals (Alain *et al*., 2007).

Recently, a large group of grain-derived products, which are used for food purposes, appeared in the world food market. There are special breeding programs that have been launched that target the varieties that can be used for these new products of the main sources of grain e.g, wheat, rice and corn, in addition to other crops, like oats, barley, sorghum, millet and others, in order to work on finding and developing a wide assortment of health-friendly dietary products that contribute to the physical fitness of individuals (Loskutov and Khlestkina, 2021). Whole grain foods, according to McKeown *et al*. (2002), are associated with a lower risk of cardiovascular disease and some types of cancer, as well as controlling glucose and lipids in the blood, improving insulin resistance, and eating more dietary fiber and micronutrients. The use of whole grains and mixtures of wheat flour with some legumes or other cereal grain flour in the production of some food products like biscuits and others have led to an improvement in the nutritional and functional properties (Vitali *et al*., 2009).

Dhingra and Jood (2001) reported that wheat is considered nutritionally poor, and like other grain proteins, it lacks essential amino acids such as threonine and lysine,. Therefore, supplementation of wheat flour with legume flour or some other sources leads to an improvement in the nutritional value of wheat products (Sharma *et al*., 1999).

Oats (Avena *sativa* L.) are one of the cereal grains that are consumed at a lower rate than wheat in most countries of the world. Despite this, oats are high in dietary fiber and nutritional value. Oat protein has a higher percentage compared to other grain proteins; it contains many essential and non-essential amino acids, as well as highly effective antioxidant components like (tocopherols, tocotrienols, and flavonoids), in addition to a large proportion of vitamins and minerals (Biel *et al.,* 2009; Koenig *et al*., 2014; Ahmad and Zaffar, 2014). Oat products like whole oat flour (WOF), oat bran concentrate (OBC) contain b-glucan, which has beneficial health effects to prevent coronary heart disease by lowering blood cholesterol and postprandial blood glucose levels (Klopfenstein, 1988). According to Fric, *et al.* (2011), oat flour plays an important role in breakfast cereals, biscuits, cookies, infant foods and flour mixtures. The gluten-free oat protein formula makes it approved as a food ingredient for celiac patients in many countries. Since oats are mainly used as animal feed, it has recently been used in many functional foods for its health and nutritional benefits that attracted the interest of researchers in all countries of the world, and then this led to interest in the food industry based on oats as a food ingredient in many food products containing infant foods (Santillana *et al.,* 2021).

Legumes are characterized by their high nutritional value, as they are rich in protein, low in fat, high in dietary fiber and a good source of micro-nutrients and phytochemicals. One of its most important nutritional properties was associated with a reduced incidence of various cancers, low-density lipoprotein cholesterol (LDL), heart disease and type 2 diabetes according to Bassett *et al.* (2010); Roy *et al.* (2010) and Cryne *et al.* (2012). Among the legumes used as a protein-enriching agents for bakery products, which are in the form of different protein preparations such as flour and isolated protein are chickpeas, soybean, lupine and peas (Kiosseoglou and Paraskevopoulou, 2011). From a nutritional standpoint, using a cereal/leguminous blend is appropriate for producing bakery products and pasta. The process of adding legume flour to wheat flour involves incorporating a higher protein content, but has effects on the functional and viscoelastic characteristics of wheat flour dough (Giménez *et al*., 2012).

Chickpeas (*Cicer arietinum* L.) are widely popular around the world, being a major ingredient in many traditional foods such as hummus and fermented products. More recently, chickpeas have been used to enhance several cereal foods like pasta, snacks and bakery products as a partial substitution for wheat flour and gluten-free products. There are some treatments that take place on chickpeas that work to eliminate their anti-nutritional factors and improve their digestibility (Kaur and Prasad, 2021).

Boye *et al*. (2010) found that chickpeas contain 19-29 g proteins/100 g, which is twice the amount found in grains of cereals, in addition to its high content of lysine, which increases their nutritional value (Stone *et al*., 2019). Also, chickpeas are rich in dietary fiber and unsaturated fatty acids, like linoleic and oleic acids (Rincon and Iba´nez, ˜ 1998; Jukanti *et al*., 2012). Chickpea flour is a good source of protein, fiber, minerals and bioactive compounds, and accordingly, it can be used to improve the nutritional value of bakery products, e.g., bread, biscuits and so on. (Man *et al*., 2015).

Sweet lupine (*Lupinus albus*) is gaining momentum as a high protein food supplement (Gladstones 1970). Introduce lupine flour as an officially recognised food ingredient in Britain in 1996, France in 1997 and Australia in 2001. Lupine has a high content of protein, dietary fiber, but a low content of fat. Medical and food researchers are studying the many benefits of lupine because of its importance in preventing obesity and its associated health problems of heart disease and diabetes (Biadge and Bethel, 2020). According to Dervas *et al.* (1999) and Erbas *et al.* (2005) they reported that lupine flour is used in different grain-based foodstuffs (pasta, bread, cookie, cake, crisp and breakfast cereal). The objective of this work is to study some physicochemical, functional and nutritional properties of composite flour from cereals (oats) and legumes (chickpea and sweet lupine) in addition to wheat flour, for the possibility of using it alone or partial substitution for wheat flour in the production of some bakery products or other food products because of its health, nutritional and functional benefits.

Materials and Methods

Materials

Wheat flour

Wheat flour (72% extraction) was obtained by the procedures carried out with Maray and Abdel-Mageed, Safia (2022) through using a mixture of local and imported flour.

Whole flours from oats, chickpeas and sweet lupine

Oats, chickpeas and sweet lupine were obtained from the local market, in Faypum, Egypt. After that the grains of all samples were cleaned and inspected by visual examination, then milled using a Brabender mill type in a laboratory, Botany Department, Faculty of Agriculture, Fayoum University, to obtain the whole flour for each one of them (composite flour).

Methods

Chemical analysis

The chemical composition components, which included the content of each (moisture, protein, ash, fat and crude fiber) were estimated for 72% wheat flour and whole flours from oats, chickpeas and sweet lupine, according to AOAC (2012). Total carbohydrates have been calculated by difference.

Physicochemical and functional property Analysis

Water and oil absorption capacities of flour samples were estimated by the method described by (Wani and Kumar, 2014) as follows; one g of the sample was weighed into 25 ml of preweighed centrifuge tubes and then stirred into 10 ml of double distilled water or refined oil for 1 min. The samples were allowed to stand for 30 min and then centrifuged at 2200×g for 30 min. The water or oil released on centrifugation was drained. Water or oil absorption capacity was expressed as g of water or oil held per g of flour sample.

The bulk density of flour samples was determined according to (Kaur and Singh, 2005). Bulk density was calculated as the weight of the sample per unit volume of sample (g/ml).

pH values of flour samples were determined by standard procedure 981.12 of the AOAC (2012).

Mineral composition

The mineral contents of (Mg, K, Fe and Zn) for wheat flour (72% extraction) and whole flours from oats, chickpeas and sweet lupine were determined by using Perkin- Elmer atomic absorption spectrometer. Phosphorus was estimated with a spectrophotometer by molybdovandate according to AOAC (2000). These analyzes were performed at the (EFPL), Faculty of Agriculture, Fayoum University, Egypt and the Agricultural Research Center, Giza, Egypt, respectively.

Amino acid composition

Amino acid contents of all flour samples were determined according to the method described by Campanella *et al.* (2002) and Jajić *et al.* (2013) using an HPLC instruments, at the National Research Center, Dokki, Cairo, Egypt.

Determination of bioactive compounds

The total phenolic compounds (TPC) of all flour samples were determined through the Folin–Ciocalteu reagent (Singleton and Rossi, 1965), as described by (Woldegiorgis *et al*., 2014). The results of TPC were expressed as (mg Gallic acid equivalent/100g dry sample).

Total flavonoid contents (TFC) were determined according to Ordonez *et al.* (2006) as follows; a volume of 0.5 ml of 2% $AlCl_3$ ethanol solution was added to 0.5 ml of sample solution. After 1 hour at room temperature, the absorbance was measured at 420 nm. A yellow color indicated the presence of flavonoids. TFC was calculated as quercetin (mg/100g dry weight).

Statistical analysis

The collected data were statistically analyzed using analysis of variance (ANOVA) by using the least significant differences (LSD) at the 5 % level according to (McClave and Benson, 1991).

Results and Discussion

Chemical composition of flour

The chemical composition components, which included the content of moisture, protein, ash, fat, crude fiber and total carbohydrates of wheat flour (72% ext.) and whole flours from oats, chickpeas and sweet lupine are shown in Table (1). The moisture contents were 13.65, 9.25, 8.27 and 8.98% of flours from wheat, oats, chickpeas and sweet lupine, respectively. Results showed that the highest value of moisture content was observed with wheat flour (13.65%) and that there were no significant differences ($P<0.05$) between the other flours.

The obtained data showed that the protein, ash, fat and crude fiber contents of wheat flour and whole flours from oat, chickpea and sweet lupine were (12.20, 12.89, 24.61 and 37.62%), (0.79, 2.31, 2.80 and 3.40%), (1.37, 7.82, 5.10 and 8.43) and (0.19, 8.26, 4.86 and 9.15), respectively. The sweet lupine whole flour had a significantly ($P<0.05$) higher value of each protein, ash, lipid and crude fiber content, while the 72% wheat flour was significantly lower value of the same chemical composition components mentioned.

Table 1. Chemical composition of wheat flour (72% extraction) and whole flours from oats, chickpeas and sweet lupine (on a dry weight basis)

Type of flour	Components (%)					
	Moisture	protein	Ash	Fat	Crude fiber	Total carbohydrates
wheat	13.65^{a}	12.20^{C}	0.79^{c}	1.37^{c}	0.19^{c}	85.45^{a}
oat	9.25^{b}	12.89^{C}	2.31^{b}	7.82^{a}	8.26^{a}	68.72^{b}
chickpea	8.27^{b}	24.61^{b}	2.80^{b}	5.10^{b}	4.86^{b}	62.63^{b}
sweet lupine	8.98^{b}	37.62^{a}	3.40^{a}	8.43^{a}	9.15^{a}	41.40^{c}

Values in the same column with different superscript letters are significantly different (P<0.05).

The results indicated that the total carbohydrate was contents of flours from wheat, oats, chickpeas and sweet lupine were 85.45, 68.72, 62.63 and 41.40, respectively. The highest value of total carbohydrates observed with wheat flour 72% ext. (85.45%), whereas sweet lupin flour has a lower value (41.40%).

These results agreed with the studies conducted by El-Qatey, Wallaa *et al.*, (2018) and Mousa, Marwa *et al.* (2022) who studied the chemical composition of wheat and oat flours. On the other hand, El-Said *et al.* (2021) found that the chickpea flour content of moisture, ash, protein, fat, crude fiber and total carbohydrates was 7.6, 1.96, 24.73, 5.6, 3.91 and 63.81%, respectively. Othman, Sara *et al.* (2020) mentioned that the protein, ash, crude fiber and total carbohydrate contents of sweet lupine flour were 34.76, 2.86, 6.11 and 37.92%, respectively.

Physicochemical and functional properties of flours

As shown in Table (2) results showed the physicochemical and functional properties of all flour from wheat, oats, chickpeas and sweet lupine, which contains the following items; water absorption capacity (WAC), oil absorption capacity (OAC), bulk density and pH value. For the water absorption capacity and the oil absorption capacity of flours from wheat, oats, chickpeas and sweet lupine the values were (1.13, 1.45, 1.38 and 2.06 g water/g sample) and (0.86, 1.07, 1.16 and 1.64 g oil/g sample), respectively. The whole flour sweet lupine showed a significantly (P<0.05) higher amount (2.06 g water/g sample and 1.64 g oil/g sample), respectively, while the 72% wheat flour has a significantly lower amount (1.13 g water/g sample and 0.86 g oil/g sample), respectively. Butt and Batool (2010) demonstrated that the diversity in the water absorption capacity of different types of flour is due to the different concentrations of protein, the degree of their interaction with water and their conformational properties.The lower (WAC) in some types of flour may lead to a decrease in the availability of polar amino acids in flour.The (WAC and OAC) of food proteins depend on inherent factors including; protein confirmation, amino acid contents and hydrophobicity or surface polarity (Kuntz, 1971).

Table 2. Physicochemical and functional properties of wheat flour (72% ext.) and whole flours from oats, chickpeas and sweet lupine

Type of flour	Water absorption capacity (g/g)	Oil absorption capacity (g/g)	Bulk density (g/ml)	pH value
wheat	1.13^{c}	0.86^{c}	0.71^{b}	6.03^{a}
oat	1.45^{b}	1.07^{b}	0.74^{b}	6.31^{a}
chickpea	1.38^{b}	1.16^{b}	1.06^{a}	6.39^{a}
sweet lupine	2.06^{a}	1.64^{a}	1.10^{a}	5.90^{b}

Values in the same column with different superscript letters are significantly different ($P<0.05$).

In this regard, Kefale and Yetenayet (2020) demonstrated that the WAC and OAC of sweet lupine flour were 2.5 g water/g sample and 2.0 g oil/g sample, respectively. In the same trend, Sreerama *et al.* (2012) found that the WAC and OAC of chickpea flour were 1.32 g water/g sample and 1.09 g oil/g sample, respectively. But Abdel-Gawad *et al.* (2016) reported that the water hydration capacity of wheat flour was 1.05 g water/g sample, while Mostafa *et al.* (2021) found that the fat hydration capacity of wheat flour (72% ext.) was 0.60 g fat/g sample.

For bulk density values were 0.71, 0.74, 1.06 and 1.10 g/ml of flours from wheat, oats, chickpeas and sweet lupine, respectively. The whole flour from sweet lupine and chickpea showed a significantly ($P<0.05$) higher value (1.10 and 1.06 g/ml), respectively, whereas there were no a significant differences between other flours from cereals. These results agree with those of Emire and Tizazu (2010) who found that the bulk density value of sweet lupine flour was from 1.10 to 1.13 g/ml, Ladjal Ettoumi and Chibane (2015) found that the bulk density value of chickpea flour was 1.09 g/ml. Sandhu *et al.* (2017) observed that the bulk density value of oat flour was between 0.73 to 0.77 g/ml.

The results of the pH values of wheat flour and whole flours from oats, chickpeas and sweet lupine were 6.03, 6.31, 6.39 and 5.90, respectively. The whole flour from sweet lupine showed a significantly ($P<0.05$) lower value (5.90), whereas no a significant differences between other flour samples. These results paralleled with Emire and Tizazu (2010) who found that the pH value of sweet lupine flour was 5.37. On the same trend, Ladjal Ettoumi and Chibane (2015) observed that the pH value of chickpea flour was 6.41, Mostafa *et al.* (2021) mentioned that the pH value of 72% wheat flour was (6.53).

Mineral contents

The results obtained in Table (3) illustrate the mineral composition of all flour samples. Data showed that the content of Mg in 72% wheat flour, whole flours from oats, chickpeas and sweet lupine was 61.51, 205.00, 150.50 and 140.00 mg/100g, respectively. The whole oat flour appeared a significantly ($P<0.05$) higher value (205.00 mg/100g), but the 72% ext. wheat flour had a significantly lower value (61.51 mg/100g).

Table 3. Mineral Composition of wheat flour (72% ext.) and whole flours from oats, chickpeas and sweet lupine

Type of flour	Mineral contents (mg/100g)				
	Mg	Fe	K	P	Zn
wheat	61.51^{c}	2.33^{d}	176.14^{c}	124.35^{c}	1.59^{c}
oats	205.00^{a}	7.15^{b}	492.00^{b}	470.00^{a}	5.62^{a}
chickpea	150.50^{b}	9.67^{a}	996.00^{a}	392.63^{b}	3.50^{b}
sweet lupine	140.00^{b}	4.63^{c}	950.00^{a}	410.50^{b}	3.73^{b}

Values in the same column with different superscript letters are significantly different (P<0.05).

As for the Fe content, it was 2.33, 7.15, 9.67 and 4.63 mg/100g of flours from wheat, oats, chickpeas and sweet lupine, respectively. Clearly there are significant differences (P<0.05) between all flour samples, the highest value of Fe content was observed with the whole chickpea flour (9.67 mg/100g), whereas the lowest value was achieved by the wheat flour (2.33 mg/100g).

The results indicated that the content of K for 72% wheat flour, whole flours from oats, chickpeas and sweet lupine was 176.14, 492.00, 996.00 and 950.00 mg/100g, respectively. The whole flour from chickpea and sweet lupine has significantly (P<0.05) higher amounts of K, while the wheat flour shows a significantly lower amount of K.

The obtained data showed that the P content of wheat, oats, chickpeas, and sweet lupine flours was 124.35, 470.00, 392.63, and 410.50 mg/100 g, respectively.

The highest value was obtained with whole oat flour (470.00 mg/100g), while the 72% wheat flour has a lower value (124.35 mg/100g).

As for the Zn content of flours from wheat, oats, chickpeas and sweet lupine, it was 1.59, 5.62, 3.50 and 3.73 mg/100g, respectively. The whole oat flour has a significantly (P<0.05) higher amount (5.62 mg/100g) of Zn content, while the wheat flour showed a significantly lower amount (1.59 mg/100g) of Zn.

In this regard, Rosell and Garzon (2015) reported that the process of milling and sifting wheat affects some nutritional components in the resulting flour, especially dietary fiber, minerals and vitamins.

These results are in agreement with (Levent and Bilgiçli, 2012; Mousa, Marwa, *et al*., 2022) found that oat flour was relatively higher in the content of minerals; iron, magnesium, phosphorous, potassium and zinc, whereas wheat flour was relatively lower of those minerals. Similar findings were observed by (Abou Arab *et al*., 2010; Emire and Tizazu, 2010) through their estimation of the mineral contents in the whole flour from chickpea and sweet lupine, respectively.

Amino acid composition of flours

Table (4) shows the composition of amino acids for 72% wheat flour and the whole flours from oats, chickpeas and sweet lupine expressed as mg amino acid/100 mg (%). The results showed that there were significant differences (P

<0.05) in the amino acid contents of all flour samples, with the exception of cystine, where no significant differences were found. The total amino acid amounts of flours from wheat, oat, chickpea and sweet lupine were 9.43, 10.62, 16.59 and 23.76 mg amino acid/100 mg (%). The highest value of most amino acid composition and total amino acid contents of flour samples was obtained with whole sweet lupin flour, followed by chickpea flour, while the lowest value of most amino acid composition and total amino acid contents was achieved by 72% wheat flour. The obtained results are in agreement with those reported by Abd El-Hady, Sahar and Abd El-Galeel (2012), Youssef *et al.* (2016), Rachwa-Rosiak *et al.* (2015) and Othman, Sara *et al.* (2020), regarding the amino acid composition of 72% wheat flour and flours from oat, chickpea and sweet lupine, respectively.

Table 4. Amino acid composition of wheat flour (72% ext.) and whole flours from oats, chickpeas, and sweet lupine

Amino acids (A.A)	**(mg/100 mg) (%)**			
	Wheat flour	**Oat flour**	**Chickpea flour**	**Sweet lupine flour**
Aspartic acid*	0.39^{d}	0.84^{c}	1.99^{b}	2.57^{a}
Threonine	0.25^{c}	0.27^{c}	0.62^{b}	0.99^{a}
Serine*	0.50^{c}	0.66^{c}	0.95^{b}	1.39^{a}
Glutamic acid*	3.11^{bc}	2.32^{c}	3.16^{b}	5.56^{a}
Proline*	1.49^{a}	1.50^{a}	0.99^{b}	1.44^{a}
Glycine*	0.29^{d}	0.47^{c}	0.65^{b}	0.99^{a}
Alanine*	0.28^{c}	0.50^{b}	0.66^{b}	0.84^{a}
Valine	0.34^{c}	0.47^{c}	0.64^{b}	0.91^{a}
Methionine	0.13^{b}	0.09^{c}	0.16^{ab}	0.20^{a}
Isoleucine	0.31^{c}	0.37^{c}	0.65^{b}	0.83^{a}
Leucine	0.62^{b}	0.77^{b}	1.24^{a}	1.80^{a}
Tyrosine	0.25^{c}	0.37^{bc}	0.45^{b}	1.03^{a}
Phenylalanine	0.49^{b}	0.52^{b}	0.96^{a}	0.95^{a}
Histidine	0.19^{b}	0.20^{b}	0.41^{a}	0.55^{a}
Lysine	0.15^{b}	0.28^{b}	1.00^{a}	0.95^{a}
Arginine*	0.37^{d}	0.72^{c}	1.69^{b}	2.39^{a}
Cystine	0.27^{a}	0.27^{a}	0.37^{a}	0.37^{a}
Total (A.A)	**9.43**	**10.62**	**16.59**	**23.76**
Essential A.A.	**3.00**	**3.61**	**6.50**	**8.58**
Non E. A.A.*	**6.43**	**7.01**	**10.09**	**15.18**

Values in the same rows with different superscript letters are significantly different (P<0.05).

Phenolic and flavonoid contents of flour

The obtained results as shown in Figures (1,2) refer to the total phenolic compounds (TPC) and total flavonoid contents (TFC) of all flour samples. The data refer to significant difference (P<0.05) between all flour samples from wheat, oats, chickpeas and sweet lupine for the (TPC) and (TFC) values. The (TPC) and (TFC) contents were (7.0, 13.0, 27.0 and 36.0 mg /100g) and (11.86, 7.36, 15.21 and 18.50 mg/100g), respectively. The whole sweet lupine flour recorded higher amounts of (TPC) and (TFC) (36.0 mg /100g) and (18.50

mg/100g), respectively, whereas the lowest amounts of (TPC) and (TFC) obtained by the 72% wheat flour (7.0 mg /100g) and whole oat flour (7.36 mg/100g), respectively. These results agreed with Vaher *et al.* (2010) who mentioned that the content of polyphenols (TPC) is low in the patent flour because these compounds are found in high concentration in the bran and germ, which are removed when milling and sieving were done. Li *et al.* (2015) who found that the (TPC) and (TFC) contents of refined wheat flour were (7.44 mg /100 g sample) and (10.88 mg/100 g sample), respectively. But Abd El-Maasoud and Ghaly (2018) observed that the (TPC) and (TFC) contents of sweet lupine flour were (51.84 mg /100 g sample) and (19.08 mg/100 g sample), respectively.

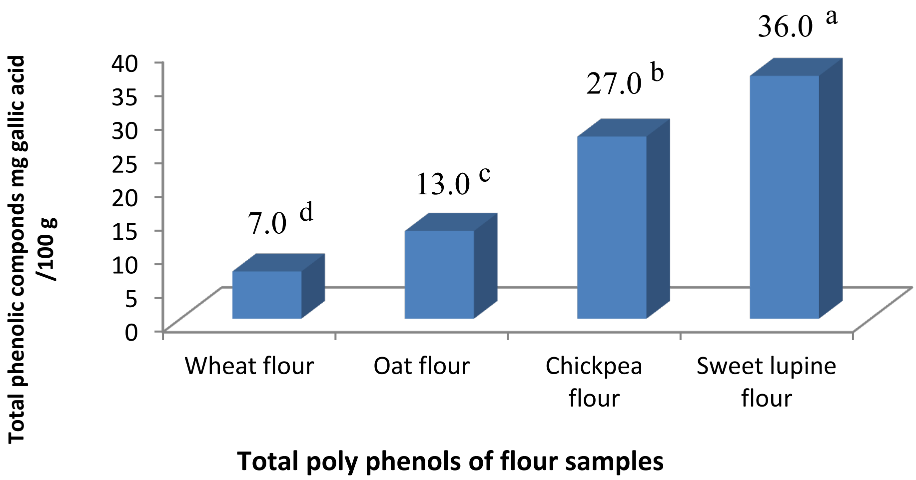

Figure 1. Total phenolic compounds (TPC) of flours

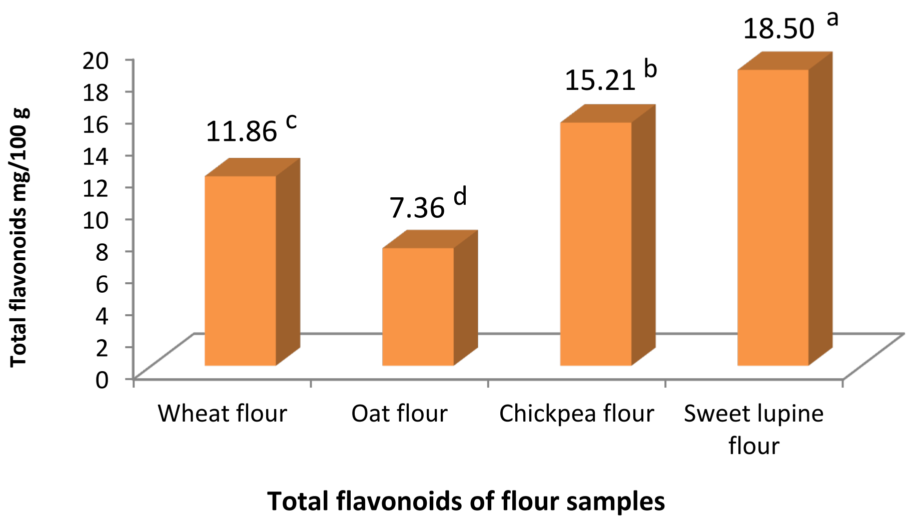

Figure 2. Total flavonoid contents (TFC) of flour samples

Conclusion

Some points can be summarized through this study as follows; by estimating the physicochemical, functional and nutritional characteristics and bioactive of composite flour from grains (oats) and legumes (chickpea and sweet lupine) in addition to wheat flour. It was discovered that the whole flour from legumes, particularly sweet lupine flour, had the highest values for these properties, while the patent wheat flour (72% extraction) had the lowest values. Because of the health, nutritional and functional benefits that can be obtained by using composite flour (chickpea or sweet lupine), it can be recommended for use in fortifying grain-based foodstuffs and some other products.

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الخصائص الفيزوكيميائية والوظيفية والقيمة التغذوية والمركبات النشطة بيولوجياً لبعض أنواع الدقيق المركب

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الملخص

الهدف من هذا العمل هو دراسة الخصائص الفيزوكيميائية والوظيفية والتغذوية والمركبات النشطة بيولوجياً لبعض الأنواع من الدقيق المركب من بعض المصادر مثل الحبوب (الشوفان) والبقوليات (الحمص والترمس الحلو) بالإضافة إلى دقيق القمح نسبة إستخلاصه 72%. أشارت النتائج إلى وجود فروق معنوية ($P < 0.05$) بين عينات الدقيق لمعظم تلك المعايير التى تم دراستها. أوضحت النتائج أن دقيق الترمس الحلو الكامل كان له القيمة الأعلى لكل من محتوى البروتين والرماد والدهون والألياف الخام ، بينما القيم الأقل لمكونات التركيب الكيميائي المذكورة سجلها دقيق القمح 72%. فى نفس الإتجاه ، حقق دقيق الترمس الحلو الكامل أعلى القيم للخصائص الفيزوكيميائية والوظيفية فيما يتعلق بسعة أمتصاص الماء والزيت (WAC ، OAC) والكثافة الظاهرية ، لكن قيمة الأس الهيدروجينى pH له كانت منخفضة مقارنةً بأنواع الدقيق الآخرى. وبالنسبة للعناصر المعدنية ، فإن دقيق الشوفان الكامل حقق المحتوى الأعلى لكل من الماغنيسيوم والفوسفور والزنك , بينما المحتوى الأعلى من الحديد سجلها دقيق الحمص الكامل , وحقق الدقيق الكامل من الحمص والترمس الحلو المحتوى الأعلى من البوتاسيوم .، من ناحية أخرى كان لدقيق القمح ذات نسبة الإستخلاص 72% المحتوى الأقل من تلك المعادن . وأظهرت النتائج أن دقيق الترمس الحلو الكامل سجل القيم الأعلى لكل من محتوى الأحماض الأمينية والمركبات النشطة بيولوجياً (الفينولات الكلية TPC والفلافونويدات الكلية TFC) .