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Website: http://www.aun.edu.eg/faculty_agriculture *E-mail: ajas@aun.edu.eg*

Composite Flours from Wheat-Legumes Flour.
1. Chemical Composition, Functional Properties and Antioxidant Activity.

Abdel-Gawad, A.S.[1] ; M.R.A. Rashwan[1]; E.A. El-Naggar[2] and M.A. Hassan[2]

[1]Department of Food Science and Technology; Faculty of Agriculture; Assiut University
[2]Department of Food Science and Technology; Fac. of Agriculture; Al-Azhar University, Assiut

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Abstract

This study was carried out to evaluate the chemical composition, functional properties and antioxidant activity of composite flours made from wheat flour and some legume flours. Legume flours were prepared from defatted soybean, soaked sweet lupine and roasted fenugreek. Composite flours were made from wheat flour (72% extraction rate) and legume flour. The ratio of wheat flour to soy or lupine flour were 90, 80, 70: 10, 20 30 while, that of wheat flour to fenugreek flour were 95, 90, 85: 5, 10, 15; respectively. Chemical composition of composite flours indicated higher protein, crude fiber and ash contents than that of wheat flour. These component were increased as the portion of legume flour was raise in composite flour. Protein, crude fiber and ash contents of the composite flours from 70% wheat and 30% soy or 30% lupine flour were increased by 61.89 and 57.56% for protein, 135.5, and 128.8% for crude fiber and 280.9 and 134.9% for ash comparing to their original contents in wheat flour; respectively. In addition, composite flour exhibited superiority functional properties, higher phenolics content and antioxidant activity than wheat flour. Slight increases were observed in phytic acid in composite flours from wheat-soy and wheat-fenugreek while the phytic acid decreased in wheat-lupine flour blend. The physical, nutritional and sensorial characterization of bread made from composite flours will be reporting in the next publication.

Keywords: *Composite flour, soybean, lupine, fenugreek, functional properties, phenolic compound, phytate, antioxidant activity.*

1.Introduction

Composite flour has been defined in numerous researches as a combination of wheat and non-wheat flours for the production of leavened breads, other baked products, and pastas; or wholly non wheat flour prepared from mixtures of flours from cereals, roots, tubers, legumes, or other raw materials, to be used for traditional or novel products (Dendy, 1992). Cereal grains provide the major energy source for the vast majority of the peoples in developing countries. The most of cereal based foods as bread, biscuit and cookies are poor sources of dietary protein and subsequently have poor nutritional quality. Several research efforts have been made in enriching the cereal flour with legume flour sources such as oil seeds and pulse (McWatters *et al*., 2004), because legume proteins are high in lysine, an essential amino acid limited in most cereals (Alain *et al*., 2007). Legumes alone contributes to about 33 % of the dietary protein nitrogen needs of humans in developing countries and are also a good source of minerals and water soluble vitamins (Rochfort and Panozz, 2007) as well as a source of other minor components that are being investigated for their health-promoting activities (Ramos, 2007**)**. Because of animal proteins being more expensive for low-income people in developing countries, the legumes and their products are alternative source for human nutrition in this case. Moreover, searching for new and valuable sources of protein to nutritionally supplement traditional food has led to an increasing interest in the use of legume seeds (Martinez-Villaluenge *et al*., 2009). Among the legumes tested as protein-enriching agents of bakery products, in the form of various protein preparations (e.g. flour and protein isolate), are soybean, chickpea, pea and lupine (Kiosseoglou and Paraskevopoulou, 2011)**.**

The use of a cereal/leguminous blend may be nutritionally convenient in pasta and bakery products manufacturing. The legume flour addition to the wheat flour involves the incorporation of a higher protein content but affects the functional and viscoelastic properties of wheat flour dough (Giménez *et al*., 2012). Supplementation of soybean, in a suitable form, to cereal foods would not only increase their protein content but also improve the availability of lysine (Riaz, 1999). Soybean proteins include all the essential amino acids that are important for health and it is about four times of wheat, six times of rice grain. It is also rich in Ca, P and Vitamins A, B, C, and D (Serrem *et al.,* 2011). Soybean flour has been used to improve protein quality and shelf life of bread (Mohamed *et al.,* 2006). Soy protein has been widely used as an important food ingredient in every food category available to the consumer, since it exhibits high nutrition and excellent functional properties (Tang and Ma, 2009). Among legumes, lupine is commonly consumed as a snack in the Middle East and is coming into use as a high-protein soy substitute in the other parts of the world (Kurzbaum *et al*., 2008). Lupine also is widely used in food production particularly as a valuable and technologically desirable additive mainly in bakery products as well as in dietary and function food products (Loza and Lampart-Szczapa, 2008). Furthermore, fenugreek flour can be also used as supplement to enhance the low nitrogen content of traditional products of cereals and tubers; emulsifying and foaming properties for the fenugreek proteins were greater than the other legumes, indicating an important role in food systems. (El Nasri and El Tinay, 2007). Due to its high content of fiber, fenugreek could be used as food stabilizer, adhesive and emulsifying agent to change food texture for some special purposes (Khorshidian *et al*., 2016).

The goal of the present work was to enhance the protein content and quality as well as improving the functional properties of composite flours by substituting wheat flour with different portions of some legume flours; soy bean, lupine and fenugreek. The gross chemical composition, functional properties, phenolics, phytic acid contents and antioxidant activity of composite flours were investigated. The composite flours will be used for bread making in next work.

2. Materials and Methods

2.1. Materials:

Wheat cv. *Misr 1* and three legume seeds, namely, soy bean *(Glycine max, cv. Giza 111)* , sweet lupine (*Lupinus albus L.,* cv. *Giza*) and fenugreek (*Trigonella foenum-graecum*, cv. *Giza 30*) were obtained from Crops Research institute, Agriculture Research center, Giza, Egypt; during 2014 season.

2.2. Methods:

2.2.1. Preparation of legume flours: Wheat grains were cleaned thoroughly, and the foreign seeds and materials were removed by hand picking followed by sieving. The wheat grains were then conditioned by wetting the grains using tap water. The tempering process was completed by mixing and storing the moist grains for 14 hours. Milling was run in a local stone mill. The straight flour thus obtained was sieved by suitable sieves to secure flour of 72% extraction rate. The flour was stored in cloth bags for 15 days at room temperature.

Lupine seeds were soaked in water for 48 h with several changes of water then the soaked seeds were air-dried for 3 days at room temperature (25 ºC ±2). The air-dried seeds were milled in laboratory to pass through a 60-mesh sieve. Soybean seeds were crushed and peels were removed then the crushed seeds were defatted by *n*-hexane (soy flour/ hexane 1:5, v/v) for 1 h at room temperature. After solvent removing, the flour was air dried at room temperature for one day then milled to pass through a 60-mesh sieve. Fenugreek seeds were roasted for 10 min at 200ºC and then milled to fine flour pass through a 60-mesh sieve (Youssef *et al*. 1987). All fine flour of lupine, soy bean and fenugreek were stored in sealed plastic bags at 5ºC±1 until used for analysis.

2.2.3. Composite flours: Flour blends were prepared by substituting wheat flour with various portions of legume flour as shown in Table 1. All prepared samples were then put in plastic bags and stored at 5ºC±1 until analysis.

Table 1: Composite flours of wheat-legume flour.

Abbreviation of sample	Mixtures (dry weight basis)
WF	100% Wheat flour
WF-SF10	90% Wheat flour + 10% soy flour
WF-SF20	80% Wheat flour + 20% soy flour
WF-SF30	70% Wheat flour + 30% soy flour
WF-LF10	90% Wheat flour + 10% lupine flour
WF-LF20	80% Wheat flour + 20% lupine flour
WF-LF30	70% Wheat flour + 30% lupine flour
WF-FF5	95% Wheat flour + 5% fenugreek flour
WF-FF10	90% Wheat flour + 10% fenugreek flour
WF-FF15	85% Wheat flour + 15% fenugreek flour

2.2.4. Proximate chemical composition: The chemical composition of composite flours including crude protein, starch, reducing and non-reducing sugar, crude fat, crude fiber and ash contents were determined according to official methods as described in A.O.A.C. (2000).

2.2.5. Functional properties of composite flours: Water Holding Capacity was determined according to the method No.51-61 of AACC (1990). Oil Holding Capacity was estimated according to the method described by Sosulski *et al*. (1976). The protein solubility was achieved according the method of Morr *et al*. (1985). Emulsion stability was determined by the method of Yasumatsu *et al.* (1972). Foaming stability was carried out according the method of Narayana and Narasinga Rao (1982).

2.2.6. DPPH Radical-Scavenging Activity: Samples were extracted using methods described by Zielijski *et al*., (2008). The DPPH assay was carried out according to the method described by Lee *et al*., (2003) with some modifications. The stock reagent solution (10−3 Mol) was prepared by dissolving 22 mg of 2,2-Diphenyl-1-picrylhydrazyl (DPPH) in 50 ml of methanol and stored at −20°C until use. The working solution (6 x 10−5 Mol) was prepared by mixing 6 mL of stock solution with 100 mL of methanol to obtain an absorbance value of 0.8±0.02 at 515 nm, as measured using a spectrophotometer. Extract solution of tested samples (0.1 ml) was vortexes for 30 s with 3.9 ml of DPPH solution and left to react for 30 min, then the absorbance was measured at 515 nm and recorded. A control without added extract was also analyzed. Scavenging activity was calculated as follows:

DPPH radical scavenging activity (%) = [(Ab control - Ab sample)/ Ab control] X 100

Where Ab is the absorbance at 515 nm.

2.2.7. Determination of phenolic compounds: The method of Abdel-Gawad (1982) was used for liberation and extraction the total phenolic compounds from the samples by alkali hydrolysis followed by the extraction the phenolics at pH 3.5 using diethyl acetate. After removing diethyl acetate, the residue was dissolved in methanol. Free phenolic compounds were extracted from the samples by methanol only without alkali hydrolysis. Phenolic compounds were determined according to the Folin-Ciocalteu spectrophotometric method (Singleton and Rossi, 1965), and as standard gallic acid was used. The results were expressed as milligrams of gallic acid equivalents (GAE) per100 gram of flour sample on dry weight basis. Bound phenolic compounds were calculated by subtract free phenolics from total phenolics.

2.2.9. Determination of Phytic acid: The phytic acid was determined in terms of its phosphorous content, using the method described by Kent-Jones and Amos (1957).

2.2.10. Statistical analysis: Data were analysed by analysis of variance (ANOVA) using a completely randomized factorial design. Basic statistics and ANOVA were performed to test the significance within replications and between treatments (MSTAT-C, 1989). The LSD tests were used to determine the differences among means at the level of 0.05%.

3. Results and Discussion

3.1 Chemical composition

The chemical composition of wheat flour and composite flours made from wheat flour and legume flours are shown in Table 2. The results of chemical composition of wheat flour are in close agreement with those obtained by Aleem *et al.* (2012) and Lopez (2014). The protein, crude fiber and ash contents of composite flours were increased significantly (P<0.05) with substituting level increasing of wheat flour by legume flours. The high protein content of flour blends recorded in WF-SF30 sample (19.05 %) followed by WF-LF30 (18.53 %). The increase in ash and crude fiber contents of blend flours may be due to the higher ash and fiber contents of legumes flours than that in wheat flour. The soybean seeds have been reported to contain an appreciable quantity of minerals (Plahar *et al*., 2003) and lupine is a good source of nutrients, not only proteins but also lipids, dietary fiber, minerals, and vitamins (Martinez-Villaluenge *et al*., 2009). The increasing of added portions of legume flour resulted a significant decreasing of starch content of blend flours which may be attributed to the lower content of starch in legume flour than wheat flour (Aniess *et al*., 2015). Small and variable variances were observed in reducing and non-reducing sugars contents of blend flours.

Table 2: Gross chemical composition of wheat flour and wheat-legume composite flours (on dry weight basis).

Samples	Protein (%)	Starch (%)	Reducing Sugar (%)	Non-reducing sugar (%)	Fat (%)	Crude fiber (%)	Ash (%)
WF	11.76 ± 0.46^{e}	82.53 ± 1.76^{a}	0.38 ± 0.021^{cd}	2.52 ± 0.07^{cde}	1.42 ± 0.021^{g}	0.59 ± 0.022^{e}	0.63 ± 0.016^{g}
WF-SF10	14.16 ± 0.95^{c}	78.86 ± 0.08^{b}	0.41 ± 0.029^{abc}	2.46 ± 0.05^{def}	1.41 ± 0.016^{g}	1.10 ± 0.012^{d}	1.29 ± 0.03^{d}
WF-SF20	17.17 ± 0.91^{b}	74.82 ± 0.49^{c}	0.43 ± 0.008^{ab}	2.43 ± 0.04^{ef}	1.38 ± 0.004^{gh}	1.27 ± 0.035^{c}	1.89 ± 0.05^{b}
WF-SF30	19.05 ± 0.23^{a}	72.14 ± 0.45^{d}	0.45 ± 0.026^{a}	2.37 ± 0.03^{f}	1.36 ± 0.008^{h}	1.39 ± 0.028^{b}	2.40 ± 0.22^{a}
WF-LF10	14.11 ± 0.04^{c}	78.09 ± 1.25^{b}	0.37 ± 0.017^{cd}	2.55 ± 0.02^{bcd}	2.32 ± 0.021^{d}	1.05 ± 0.032^{d}	0.94 ± 0.01^{ef}
WF-LF20	16.53 ± 0.25^{b}	74.48 ± 0.84^{c}	0.35 ± 0.032^{de}	2.57 ± 0.04^{bc}	3.25 ± 0.029^{b}	1.22 ± 0.044^{c}	1.26 ± 0.017^{d}
WF-LF30	18.53 ± 0.82^{a}	71.50 ± 0.77^{d}	0.32 ± 0.024^{e}	2.61 ± 0.01^{abc}	3.90 ± 0.026^{a}	1.35 ± 0.025^{b}	1.48 ± 0.1^{c}
WF-FF 5	12.29 ± 0.29^{de}	81.00 ± 0.69^{a}	0.38 ± 0.016^{cd}	2.57 ± 0.02^{bc}	1.85 ± 0.012^{f}	1.04 ± 0.037^{d}	0.84 ± 0.01^{f}
WF-FF10	13.28 ± 0.59^{cd}	79.08 ± 0.08^{b}	0.40 ± 0.017^{bc}	2.63 ± 0.02^{ab}	2.20 ± 0.016^{e}	1.32 ± 0.054^{b}	1.05 ± 0.009^{e}
WF-FF15	14.27 ± 0.18^{c}	77.35 ± 0.47^{b}	0.43 ± 0.014^{ab}	2.68 ± 0.09^{a}	2.39 ± 0.041^{c}	1.55 ± 0.086^{a}	1.28 ± 0.016^{d}

Values are the mean of triplicate determinations with standard division. The different letters at the column means significant differences at (p≤0.05) and the same letters means no significant differences.

3.2. Functional properties

The functional properties of the wheat flour and composite flour are summarized in Table 3. The most functional properties determined for composite flours exhibited higher values than that observed for wheat flour alone and showed significant variations at $p \leq 0.05$.This observation is agree with the results reported by other workers (Mahmoud *et al*., 2012 and Alu'datt *et al.,* 2012). Composite flours exhibited maximum values for the water holding capacity in WF-SF30 (148.58%) and WF-FF15 (148.12%) samples, which may be due to the high protein content (19.05%) in the WF-SF30 sample and to galactomannan presence in fenugreek flour in WF-FF15 sample. The ability of protein in flours to physically bind water is a determinant of its water absorption and binding capacity (Apotiola and Fashakinly, 2013). The high insoluble fiber 20-25% and galactomann 20-30% in fenugreek are responsible for high water absorption and binding capacity (Afzal *et al.,* 2016). Wheat-lupine flour mixtures showed lower water binding capacity in comparison to other composite flours (Table 3). Significant differences in oil holding capacity of composite flours were also observed. The mean values showed higher oil holding capacity for WF-FF15 (121.19%), followed by WF-SF30 (120.99%), WF-FF10 (119.19%) and WF-LF30 (115.90%), whereas, the lowest 106.32% was for WF-LF10. The mechanism of fat/oil holding capacity explained by Kinsella (1979) as a physical entrapment of favour retention. Chau and Cheung (1997) reported that surface area and hydrophobicity improve oil holding capacity. The composite flour samples from wheat/legume flours showed higher values and significant variations at $p \leq 0.05$ in the protein solubility, except the sample WF-FF 5, than wheat flour. The solubility of a protein is usually affected by its hydrophobicity or hydrophobic balance, depending on the amino acid composition, particularly at the protein surface (Moure *et al*., 2006). The increase in the values of emulsion stability and foam stability for wheat-legume composite flours were significant at $p \leq 0.05$ compared with that of wheat flour. The emulsion stability normally reflects the ability of the proteins to impart strength to an emulsion for resistance to stress and changes and is therefore related to the consistency of the interfacial area over a defined time period (Pearce and Kinsella, 1978). Foam formation and stability generally depend on the interfacial film formed by proteins which keeps air bubbles in suspension and slows down the rate of coalescence. Foaming properties are dependent on the proteins, as well as on other components, such as carbohydrates present in the flour (Sreerama *et al.,* 2012). The obtained results in this study indicated that the composite flours from wheat-legume had good functional properties.

Table 3: Functional properties of wheat flour and wheat-legume composite flours.

Samples	Water holding capacity (%)	Oil holding capacity (%)	Soluble protein as % of total sample protein	Emulsion stability (%)	Foam stability* (%)
WF	105.00 ± 0.25^{i}	104.10 ± 0.82^{g}	10.84 ± 0.44^{e}	39.60 ± 0.94^{g}	77.75 ± 0.34^{e}
WF-SF10	116.97 ± 0.07^{f}	113.60 ± 0.71^{d}	12.44 ± 0.15^{cd}	44.41 ± 0.72^{de}	81.94 ± 0.96^{d}
WF-SF20	130.40 ± 0.31^{c}	114.40 ± 0.45^{d}	12.94 ± 0.30^{abc}	47.66 ± 0.47^{b}	84.12 ± 1.12^{bcd}
WF-SF30	148.58 ± 0.07^{a}	120.99 ± 0.33^{a}	13.65 ± 0.26^{a}	49.51 ± 0.43^{a}	86.30 ± 0.84^{ab}
WF-LF10	110.95 ± 0.32^{h}	106.32 ± 0.48^{f}	12.14 ± 0.38^{cd}	42.75 ± 0.51^{f}	83.53 ± 1.55^{cd}
WF-LF20	115.14 ± 0.19^{g}	110.16 ± 0.59^{e}	12.70 ± 0.31^{bc}	45.79 ± 0.71^{c}	85.00 ± 1.80^{bc}
WF-LF30	121.41 ± 0.08^{e}	115.90 ± 0.53^{c}	13.36 ± 0.29^{ab}	47.31 ± 0.27^{b}	87.96 ± 0.86^{a}
WF-FF 5	125.04 ± 1.37^{d}	114.50 ± 0.39^{d}	11.56 ± 0.43^{de}	43.25 ± 0.30^{ef}	79.58 ± 1.01^{e}
WF-FF10	136.80 ± 0.29^{b}	119.19 ± 0.35^{b}	12.31 ± 0.69^{cd}	45.28 ± 0.51^{cd}	83.17 ± 0.62^{cd}
WF-FF15	148.12 ± 0.40^{a}	121.19 ± 0.82^{a}	12.81 ± 0.55^{abc}	48.20 ± 0.50^{b}	85.27 ± 1.50^{bc}

Values are the mean of triplicate determinations with standard division. The different letters at the column means significant differences at ($p \leq 0.05$) and the same letters means No significant differences.
** Foaming stability (%) after 30 min.*

3.3 Phenolic, phytate and antioxidant activity

Phenolic compound, phytate phosphorus, phytic acid content and antioxidant activity of wheat flour and wheat-legume composite flours are presented in Table 4. Results indicated that the content of free phenolics, which extracted only with methanol without alkali hydrolysis, are lower than the bound phenolics in wheat flour and composite flours. The values of free, bound and total phenolic compounds showed raise in composite flours with increasing the added portions of legume flour and the results indicated highly significant differences at $P<0.05$ between wheat flour and wheat-legume composite flours. The substitution of wheat flour with 5, 10 and 15% fenugreek flour exhibited however convergent values of total phenolic contents compared with 10, 20 and 30% soy or lupine flour due to the high phenolics content in fenugreek flour than soy and lupine. Polyphenols have been traditionally considered undesirable components in food products because they may cause darkening due to oxidation of phenols, leading to formation of dark pigments. In addition, they have been considered antinutritional components because they can react with certain essential amino acids, limiting their availability (Crépon *et al.,* 2010). Nevertheless, in more recent years, polyphenols in general, and flavonoids in particular, have been recognized as food components with health-promoting properties, including antioxidant and anti-proliferative activities in cells (Ramos, 2007; Saura-Calixto and Goni, 2009).

Phytic acid content is calculated from the values of phytate phosphorus which indicated their altitude with increasing the portions of soy bean and fenugreek flour in composite flours from 10 to 30% (Table 4). In contrast, increasing the portion of lupine flour from 10 to 30% lead to a decrease in phyatate content in all wheat-lupine flours and this may be due to decreasing the phytate content in lupine seeds by soaking for 48 h before the preparation of lupine flour. It is known that the soaking process of legume activate the enzyme phytase which degraded the phytic acid to inorganic phosphate and inositol (Frias *et al*., 2003). Phytic acid has long been known as an anti-nutritional factor since it reduces bioavailability of several minerals due to its ability to chelate them (Sandberg *et al*., 1989). At present, growing concern about phytic acid and their hydrolysis products has arisen from the finding that it might have beneficial effects such as antioxidant function, protecting against cancer risk (Vucenik and Shamsuddin, 2006).

Table 4: Phenolic compound, phytate phosphorus, phytic acid and antioxidant activity of wheat flour and wheat-legume composite flours.

Samples	Phenolic compound mg/100g d.b.			Phytate phosphorus mg/100g d.b.	phytic acid mg/100g d.b.	Antioxidant activity%
	Free	bound	Total			
WF	5.07 ± 0.76^{d}	386.22 ±0.18^{g}	391.29±0.58^{g}	119.13±0.71^{e}	422.67±1.88^{e}	3.74 ± 0.11^{f}
WF-SF10	5.50 ± 0.41^{cd}	396.12 ±0.41^{ef}	401.62±0.82^{e}	120.76±0.20^{cd}	428.45±0.70^{cd}	7.03 ± 0.79^{cd}
WF-SF20	7.42 ± 0.47^{b}	408.97 ±0.14^{d}	416.39±0.50^{c}	121.57±0.35^{bc}	431.33±1.25^{c}	8.76 ± 0.20^{b}
WF-SF30	9.41 ± 0.32^{a}	417.32 ±0.26^{a}	426.73±0.22^{a}	123.20±0.98^{a}	437.12±2.12^{a}	11.18 ± 0.86^{a}
WF-LF10	5.37± 0.51^{cd}	394.78 ±0.83^{f}	400.15±0.94^{f}	115.77±0.19^{f}	410.75±0.66^{f}	6.33 ± 0.55^{de}
WF-LF20	6.25 ± 0.61^{c}	407.19 ±0.98^{d}	413.44±1.17^{d}	113.41±0.48^{g}	402.38±1.71^{g}	8.28 ± 0.59^{bc}
WF-LF30	7.55 ± 0.37^{b}	414.75 ±0.53^{b}	422.30±0.57^{b}	110.15±0.69^{h}	390.81±2.26^{h}	10.16 ± 0.68^{a}
WF-FF 5	5.10 ± 0.59^{d}	398.00 ±1.44^{e}	403.10±1.71^{e}	119.94±0.11d^{e}	425.55±0.84^{de}	5.27 ± 0.60^{e}
WF-FF10	7.64 ± 0.29^{b}	405.80 ±0.16^{d}	413.44±0.46^{d}	120.70±0.25^{cd}	428.24±0.88^{cd}	6.11 ± 0.73^{de}
WF-FF15	8.45 ± 0.45^{ab}	412.37 ±0.30^{c}	420.82±0.45^{b}	122.39±0.50^{ab}	434.24±1.77^{b}	7.18 ± 0.67^{cd}

Values are the mean of triplicate determinations on dry weight basis (d.b.) with standard division. The different letters at the column means significant differences at ($p \leq 0.05$) and the same letters means No significant differences.

The statistical analysis of free radical scavenging activity of wheat flour and wheat-legume flours (Table 4) indicated that the WF-SF30 and WF-LF30 samples showed higher antioxidant activity than other composite flours. DPPH radicals scavenging activity for the latter samples were 11.18 and 10.16%; respectively. The results of total phenolic compound assay followed a similar pattern to that of DPPH antioxidant assay for these two samples as well. In general, it can be concluded that the results of the present study have confirmed the high antioxidant activity and phenolic content of composite flour when the portion of legume flour increased and there are a positive relation between phenolics content and DPPH antioxidant activity. The results are agree with that reported by Aniess *et al*. (2015) and Kenny *et al*.(2013).

4. Conclusion

Composite flours from wheat-legume flour showed high protein, crude fiber and ash contents. In addition, it exhibited superiority functional properties, high phenolics content and antioxidant activity.

5. References

A.A.C.C. (1990). Approved Methods, 8th ed., American Association of Cereal Chemists, St Paul, MN, U.S.A.

A.O.A.C. (2000). Official Methods of Analysis of the Association of Official Analytical Chemists International.17th ed. Maryland, USA.

Abdel-Gawad, A.S. (1982). Isolierng and charakterisierung von pentosanfraktionen aus verschiedenen weizen sorten. Ph.D.Dissertation Natural Scince TU. Berlin, D 83 No.132/FB13. (In German).

Afzal, B.; Pasha, I.; Zahoor, T. and Nawaz, H. (2016). Nutritional potential of fenugreek supplemented bread with special preference to antioxidant profiling. Pakistan Journal of Agricultural Sciences, 53(1): 217-223.

Alain, M.M.M.; Israel, M.P. and Rene, M.S. (2007). Improving the Nutritional Quality of cowpea and bambara Bean flours use in infant feeding. Pakistan Journal of Nutrition, 6: 660-664.

Aleem, Z. M. D.; Gentha, T. R. and Syed, I. H.(2012). Effects of defatted soy flour incorporation on physical, sensorial and nutritional properties of biscuits. Journal Food Processing and Technology, 3:100-149.

Alu'datt, M.H.; Rababah, T.; Ereife, J. K.; Alli, I.; Alrababah, M. A.; Almajwal, A.; Masadeh, N .and Alhamad, M. N. (2012). Effects of barley flour and barley protein isolate on chemical, functional, nutritional and biological properties of Pita bread. Food Hydrocolloids, 26:135-143.

Aniess, W. I. M.; Khalil A. F. and Mosa, Z. M. (2015). Phenolic compounds and antioxidants capacity of sweet lupine derivatives-wheat flour mixtures and the effects on diabetic rats. Journal of Environmental Science, Toxicology and Food Technology, 9(5): 61-69.

Apotiola, Z. O. and J.F. Fashakinly, J. O. (2013). Evaluation of cookies from wheat flour, soybean flour and cocoyam flour blends. Food Science and Quality Management, 14: 17-21.

Chau, C. F. and Cheung, P. C. K. (1997). Functional properties of flours prepared from three Chinese indigenous legumes seed.

Journal of Food Chemistry, 66: 429-433.

Crépon, K.; Marget, P.; Peyronnet, C.; Carrouée, B.; Arese, P. and Duc, G. (2010). Nutritional value of faba bean (*Viciafaba* L.) seeds for feed and food. Field Crops Research, 115:329-339.

Dendy, D.V. (1992). Composite flour - past, present and the future: a review with special emphasis on the place of composite flour in the semiarid zones. In M I Gomez, L R House, LW Rooney, & DV Dendy (Eds.), Utilization of Sorghum and Millets, ICRISTAT, pp 67-73.

El Nasri, N.A. and El Tinay, A. H. (2007). Functional properties of fenugreek (*Trigonella foenum-graecum*) protein concentrate. Food Chemistry, 103: 582-589.

Frias, J.; Doblado, R.; Antezana, J. R. and Vidal-Valverde, C. (2003). Inositol phosphate degradation by the action of phytase enzyme in legume seeds. Food Chemistry, 81(2):233-239.

Giménez, M.A.; Drago, S.R.; De Greef, D.; Gonzalez, R.J.; Lobo, M.O. and Samman, N.C. (2012). Rheological, functional and nutritional properties of wheat/broad bean (*Vicia faba*) flour blends for pasta formulation. Food Chemistry, 134:200-206.

Kenny, O.; Smyth, T. J.; Hewage, C. M. and Brunton, N. P. (2013). Antioxidant properties and quantitative UPLC-MS analysis of phenolic compounds from extracts of fenugreek (*Trigonella foenum-graecum*) seeds and bitter melon (*Momordicacharantia*) fruit. Food Chemistry, 141: 4295-43023.

Kent-Jones, D.W. and Amos, A.J. (1957). Modern Cereal Chemistry. Noather publishing, Liverpool.

Khorshidian, N.; Asli, M. Y.; Arab, M.; Mortazavian, A. M. and Adeli-Mirzaie, A. (2016). Fenugreek: potential applications as a functional food and nutraceutical. Nutrition and Food Sciences Research, 3:5-16.

Kinsella, J. E. (1979). Functional properties of soy protein. Journal of American Oil Chemists Society, 56: 242-249.

Kiosseoglou, V. and Paraskevopoulou, A. (2011). Functional and physicochemical properties of pulse proteins. In B. Tiwari AG, &B. McKenna (ed): Pulse Foods: Processing, Quality and Nutraceutical Application. Burlington: Elsevier Inc. Academic Press, 57-90.

Kurzbaum, A.; Safori, G.; Monir, M. and Simsolo, C. (2008). Anticholinergic syndrome in response to lupine seed toxicity. Israeli Journal of Emergency Medicine, 8: 20-22.

Lee, S.C.; Kim, J.H.; Jeong, S.M.; Kim, D.R.; Ha, J.U.; Nam, K.C. and Ahn, D.U. (2003). Effect of far-infrared radiation on the antioxidant activity of rice hulls. Journal of Agricultural and Food Chemistry, 51: 4400-4403.

Lopez, E. P., (2014). Influence of the addition of lupine protein isolate on the protein and technological characteristics of dough and fresh bread with added Brea Gum. Food Science and Technology, 34 (1): 195-203.

Łoza, A. and Lampart-Szczapa, E. (2008). Allergenicity of lupine proteins – a review. Polish Journal of Food and Nutrition Sciences, 58:283-287.

Mahmoud, E. A. M.; Nassef, S. L. and Basuny, A. M. M. (2012). Production of high protein quality noodles using wheat flour fortified with different protein products from lupine. Annals of Agricultural Science, 57(2):105-112.

Martinez-Villaluenga, C.; Zielinski, H.; Frias, J.; Piskuła, M. K., Kozłowska, H. and Vidal-Valverde, C. (2009). Antioxidant capacity and polyphenolic content of high protein lupine products. Food Chemistry, 112: 84-88.

McWatters, K.H.; Phillips, R.D.; Walker, S.L.; McCullough, S.E., Mensa-Wilmot, Y.; Saalia, F.K.; Hung, Y.C. and Patterson, S.P. (2004). Baking performance and consumer acceptability of raw and extruded cowpea flour breads. Journal of Food Quality, 27: 337-351.

Mohamed, A. A.; Rayas-Duarte, P.; Shogren, R. and Sessa, D. (2006). Low carbohydrates bread: Formulation, processing and sensory quality. Food Chemistry, 99: 686–692.

Morr, C. V.; German, B.; Kinsella, J. E.; Regesntein, J. P.;Van Buren, J. P.; Kilara, A.; *et al*. (1985). A collaborative study to develop a standardized food protein solubility procedure. Journal of Food Science, 51:1715-1718.

Moure, A.; Sineiro, J.; Dominguez, H. and Parajo, J.C. (2006). Functionality of oilseed protein products: A review. Food Research International, 39: 945-963.

MSTAT-C. (1989). A microcomputer program for the design, management, and analysis of agronomic research experiments, Ver. 1.2, Michigan State University, East Lansing, MI 48824.

Narayana, K. and Narasinga Rao, M. S. (1982). Functional properties of raw and heat processed winged bean (Psophocarpustetragonolobus) flour. Journal of Food Science, 47, 1534-1538.

Pearce, K. N. and Kinsella, J. E. (1978). Emulsifying properties of proteins: Evaluation of a turbidimetric technique. Journal of Agricultural and Food Chemistry, 26:716-723.

Plahar, W.A.; Okezie, B.O.and Gyato, C.K., (2003). Development of a high protein weaning food by extrusion cooking using peanuts, maize and soybeans. Plant Foods Human Nutrition, 58: 1-12.

Ramos, S. (2007). Effects of dietary flavonoids on apoptotic related to cancer chemoprevention. Journal Nutritional Biochemistry, 18:427-442.

Riaz, M.N. (1999). Healthy baking with soy ingredients. Cereal Foods World, 44:136-139.

Rochfort, S. and Panozzo, J., (2007). Phytochemicals for health, the role of pulses. Journal of Agricultural and Food Chemistry, 55:7981-7994.

Sandberg, A. S.; Carlsson, N. G. and Svanberg, U. (1989). Effects of inositol tri-, tetra-, penta-, and hexaphosphates on in vitro estimation of iron availability. Journal of Food Science, 54(1): 159-161.

Saura-Calixto, F. and Goni, I. (2009). Definition of the mediterranean diet based on bioactive compounds. Critical reviews. Food Science and Nutrition, 49: 145-152.

Serrem, C.; Kock, H. and Taylor, J. (2011). Nutritional quality, sensory quality and consumer acceptability of sorghum and bread wheat biscuits fortified with defatted soy flour. International Journal of Food Science and Technology, 46: 74-83.

Singleton, V. L. and Rossi, J.A. (1965). Colorimetry of total phenolics with phosphomolybdicphosphotungstic acid reagent. American Journal of Enology and Viticulture, 16: 144-158.

Sosulski, F. W.; Humbert, E. S.; Bui, K. and Jones, J. O. (1976). Functional properties of rapeseed flour concentrates and isolates. Journal of Food Science, 41: 1348-1354.

Sreerama, Y. N.; Sashikala, V. B.; Pratape, V. M. and Singh, V. (2012). Nutrients and antinutrients in cowpea and horse gram flours in comparison to chickpea flour: Evaluation of their flour functionality. Food Chemistry, 131: 462-468.

Tang, C. H. and Ma, C. Y. (2009). Effect of high pressure treatment on aggregation and structural properties of soy protein isolate. LWT – Food Science and Technology, 42: 606-611.

Vucenik, I. and Shamsuddin, A. M. (2006). Protection against cancer by dietary IP6 and inositol. Nutrition and Cancer, 55(2): 109-125.

Yasumatsu, K.; Sawada, K.; Moritaka, S.; Misaki, M.; Toda, J.; Wada, T.; *et al*. (1972). Whipping and emulsifying properties of soybean products. Agricultural Biological Chemistry, 36:719-727.

Youssef, M. K. E.; Abdel-Gawad, A. S. and El-Rify, M. N. (1987). Effect of germination, boiling and roasting processes on protein fractionation and solubilization and the amino acid composition of fenugreek seeds. Assiut J. Agric. Sci., 18 (2): 259 - 273.

Zielijski, H.; Michalska, A.; Ceglijska, A. and Lamparski, G. (2008). Antioxidant properties and sensory quality of traditional rye bread as affected by the incorporation of flour with different extraction rates in the formulation. European Food Research and Technology, 226: 671-680.

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Website: http://www.aun.edu.eg/faculty_agriculture *E-mail: ajas@aun.edu.eg*

الدقيق المركب من دقيق القمح ودقيق البقوليات .
١. التركيب الكيميائي ، الخواص الوظيفية ونشاط مضادات الاكسده

عبد الله صالح عبدالجواد[١]، محمد رشوان عبدالعال[١]، عيد السيد عبدالعزيز النجار[٢]، محمد احمد حسن[٢]

[١]قسم علوم وتكنولوجيا الأغذية – كلية الزراعة – جامعة اسيوط
[٢]قسم علوم وتكنولوجيا الأغذية – كلية الزراعة – جامعة الأزهر – اسيوط

الملخص

أجريت هذه الدراسة بهدف تقييم الخواص الكيمائية والوظيفية ومضادات الأكسدة للدقيق المركب من دقيق القمح ودقيق بعض البقوليات. تم تحضير دقيق البقوليات من فول الصويا منزوع الدهن والترمس الحلو المنقوع وبذور الحلبة المحمصة. والدقيق المركب تم إعداده من دقيق القمح (استخلاص ٧٢%) ودقيق البقوليات. ونسبة خلط دقيق القمح الي دقيق فول الصويا أو دقيق الترمس كانت ٩٠ ، ٨٠ ، ٧٠ : ١٠ ، ٢٠ ، ٣٠ بينما نسبة خلط دقيق القمح إلي دقيق الحلبة كانت ٩٥ ، ٩٠ ، ٨٥ : ٥ ، ١٠ ، ١٥ علي التوالي. ولقد أظهرت النتائج ارتفاع نسبة البروتين ، الألياف الخام والرماد في الدقيق المركب عن تلك الموجودة بدقيق القمح ، وهذه المكونات ارتفعت نسبتها بالدقيق المركب كلما زادت نسبة دقيق البقوليات به. وعند مقارنة الزيادة في البروتين والألياف الخام والرماد بالدقيق المركب من ٧٠% دقيق قمح و٣٠% دقيق صويا أو ٣٠% دقيق ترمس كنسبة مئوية من تلك الموجودة بدقيق القمح وجد أنها ٦١,٨٩% و٥٧,٥٦ % للبروتين، ١٣٥,٥% و١٢٨,٨% للألياف الخام و٢٨٠,٩% و١٣٤,٩% للرماد علي التوالي. وبالإضافة إلي ذلك فقد أظهر الدقيق المركب تفوق في الخواص الوظيفية ، وارتفاع نسبة المركبات الفينولية وكذلك نشاط مضادات الأكسدة عن تلك التي قدرت بدقيق القمح. ولقد أحتوي الدقيق المركب من دقيق القمح والصويا ودقيق القمح والترمس علي كميات مرتفعة طفيفة من حامض ألفيتيك بينما انخفض حامض ألفيتيك في الدقيق المركب من دقيق القمح والترمس مقارنة بتلك الموجودة بدقيق القمح. وسوف يتم التعرف علي الخواص الطبيعية والتغذوية والحسية للخبز المصنع من الدقيق المركب في النشر القادم.