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

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

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

Received on: 18/9/2016 Accepted for publication on: 22/9/2016

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 (Kios-seoglou 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:

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 °C ±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 200°C 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 5°C±1 until used for analysis.

2.2.2. 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 5°C±1 until analysis.

<table>
<thead>
<tr>
<th>Abbreviation of sample</th>
<th>Mixtures (dry weight basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF</td>
<td>100% Wheat flour</td>
</tr>
<tr>
<td>WF-SF10</td>
<td>90% Wheat flour + 10% soy flour</td>
</tr>
<tr>
<td>WF-SF20</td>
<td>80% Wheat flour + 20% soy flour</td>
</tr>
<tr>
<td>WF-SF30</td>
<td>70% Wheat flour + 30% soy flour</td>
</tr>
<tr>
<td>WF-LF10</td>
<td>90% Wheat flour + 10% lupine flour</td>
</tr>
<tr>
<td>WF-LF20</td>
<td>80% Wheat flour + 20% lupine flour</td>
</tr>
<tr>
<td>WF-LF30</td>
<td>70% Wheat flour + 30% lupine flour</td>
</tr>
<tr>
<td>WF-FF5</td>
<td>95% Wheat flour + 5% fenugreek flour</td>
</tr>
<tr>
<td>WF-FF10</td>
<td>90% Wheat flour + 10% fenugreek flour</td>
</tr>
<tr>
<td>WF-FF15</td>
<td>85% Wheat flour + 15% fenugreek flour</td>
</tr>
</tbody>
</table>
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) per 100 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>
<thead>
<tr>
<th>Samples</th>
<th>Protein (%)</th>
<th>Starch (%)</th>
<th>Reducing Sugar (%)</th>
<th>Non-reducing sugar (%)</th>
<th>Fat (%)</th>
<th>Crude fiber (%)</th>
<th>Ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF</td>
<td>11.76 ± 0.46a</td>
<td>82.53 ± 1.76a</td>
<td>0.38 ± 0.021&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.92 ± 0.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.42 ± 0.021&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.59 ± 0.022&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.85 ± 0.016&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>WF-SF10</td>
<td>14.16 ± 0.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>78.86 ± 0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.41 ± 0.029&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.46 ± 0.054&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.41 ± 0.016&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.10 ± 0.012&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.29 ± 0.03&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>WF-SF20</td>
<td>17.17 ± 0.91&lt;sup&gt;a&lt;/sup&gt;</td>
<td>74.82 ± 0.49&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.43 ± 0.008&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.43 ± 0.046&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.38 ± 0.046&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.27 ± 0.035&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.89 ± 0.05&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>WF-SF30</td>
<td>19.05 ± 0.23&lt;sup&gt;a&lt;/sup&gt;</td>
<td>72.14 ± 0.45&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.45 ± 0.026&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.37 ± 0.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.36 ± 0.008&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.39 ± 0.028&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.40 ± 0.022&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>WF-LF10</td>
<td>14.11 ± 0.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>78.09 ± 1.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.37 ± 0.017&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.55 ± 0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.32 ± 0.021&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.05 ± 0.032&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.94 ± 0.014&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>WF-LF20</td>
<td>16.53 ± 0.23&lt;sup&gt;a&lt;/sup&gt;</td>
<td>74.48 ± 0.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.35 ± 0.032&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.57 ± 0.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.23 ± 0.029&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.22 ± 0.044&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.26 ± 0.011&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>WF-LF30</td>
<td>18.53 ± 0.32&lt;sup&gt;a&lt;/sup&gt;</td>
<td>71.50 ± 0.77&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.32 ± 0.024&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.61 ± 0.101&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.89 ± 0.026&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.35 ± 0.025&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.48 ± 0.01&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>WF-FF5</td>
<td>12.29 ± 0.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>81.00 ± 0.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.38 ± 0.016&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.57 ± 0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.85 ± 0.012&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.04 ± 0.037&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.84 ± 0.01&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>WF-FF10</td>
<td>13.28 ± 0.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>79.08 ± 0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.40 ± 0.017&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.63 ± 0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.29 ± 0.016&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.32 ± 0.054&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.05 ± 0.009&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>WF-FF15</td>
<td>14.27 ± 0.18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>77.35 ± 0.47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.43 ± 0.014&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.68 ± 0.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.39 ± 0.041&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.55 ± 0.086&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.28 ± 0.016&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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≤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≤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≤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.
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 Gonzi, 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 compos-
ite flours from 10 to 30% (Table 4). In contrast, increasing the portion of lupine flour from 10 to 30% lead to a decrease in phytate 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.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Phenolic compound mg/100g d.b.</th>
<th></th>
<th></th>
<th>Phytate phosphorus mg/100g d.b.</th>
<th>Phytic acid mg/100g d.b.</th>
<th>Antioxidant activity%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Free</td>
<td>bound</td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WF</td>
<td>5.07 ± 0.76</td>
<td>386.22 ± 0.18</td>
<td>391.29 ± 0.58</td>
<td>119.13 ± 0.71</td>
<td>422.67 ± 1.88</td>
<td>3.74 ± 0.11</td>
</tr>
<tr>
<td>WF-SF10</td>
<td>5.50 ± 0.41</td>
<td>396.12 ± 0.41</td>
<td>401.62 ± 0.82</td>
<td>120.76 ± 0.29</td>
<td>428.45 ± 0.70</td>
<td>7.03 ± 0.79</td>
</tr>
<tr>
<td>WF-SF20</td>
<td>7.42 ± 0.47</td>
<td>408.97 ± 0.14</td>
<td>416.39 ± 0.50</td>
<td>121.57 ± 0.33</td>
<td>431.33 ± 1.25</td>
<td>8.76 ± 0.20</td>
</tr>
<tr>
<td>WF-SF30</td>
<td>9.41 ± 0.32</td>
<td>417.32 ± 0.26</td>
<td>426.73 ± 0.22</td>
<td>123.20 ± 0.98</td>
<td>437.12 ± 2.12</td>
<td>11.18 ± 0.86</td>
</tr>
<tr>
<td>WF-LF10</td>
<td>5.37 ± 0.51</td>
<td>394.78 ± 0.83</td>
<td>400.15 ± 0.94</td>
<td>115.77 ± 0.19</td>
<td>410.75 ± 0.66</td>
<td>6.33 ± 0.55</td>
</tr>
<tr>
<td>WF-LF20</td>
<td>6.25 ± 0.61</td>
<td>407.19 ± 0.98</td>
<td>413.34 ± 1.17</td>
<td>113.41 ± 0.48</td>
<td>402.38 ± 1.71</td>
<td>8.38 ± 0.59</td>
</tr>
<tr>
<td>WF-LF30</td>
<td>7.55 ± 0.37</td>
<td>414.75 ± 0.53</td>
<td>422.30 ± 0.57</td>
<td>110.15 ± 0.69</td>
<td>390.81 ± 2.26</td>
<td>10.16 ± 0.68</td>
</tr>
<tr>
<td>WF-FF5</td>
<td>5.10 ± 0.59</td>
<td>398.00 ± 1.44</td>
<td>403.10 ± 1.71</td>
<td>119.94 ± 0.11</td>
<td>425.55 ± 0.84</td>
<td>5.27 ± 0.60</td>
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<tr>
<td>WF-FF10</td>
<td>7.64 ± 0.29</td>
<td>405.80 ± 0.16</td>
<td>413.44 ± 0.46</td>
<td>120.70 ± 0.25</td>
<td>428.24 ± 0.88</td>
<td>6.11 ± 0.73</td>
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<tr>
<td>WF-FF15</td>
<td>8.45 ± 0.45</td>
<td>412.37 ± 0.30</td>
<td>420.82 ± 0.45</td>
<td>122.39 ± 0.50</td>
<td>434.24 ± 1.77</td>
<td>7.18 ± 0.67</td>
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</tbody>
</table>

Values are the mean of replicate determinations on dry weight basis (d.b.) with standard division. The different letters at the column means significant differences at (p<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


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الملخص

أجريت هذه الدراسة بهدف تقييم الخصائص الكيميائية والوظيفية ومضادات الأكسدة للدقائق المركب من دقيق القمح ودقيق البقلويات. تم تحضير دقيق البقلويات من فول الصويا منزوع الدهن والترمس الحلو المنتوق وبدور الحلبة المحتمسة. والدقيق المركب تم إعداده من دقيق القمح (استخلاص 72%) ودقيق البقلويات. وتسهم خلط دقيق القمح إلى دقيق فول الصويا أو دقيق الترمس كانت 90: 30: 70، 30، 80، 20: 10، 0، 5: 0.5، 0.95 على التوالي. ولقد أظهرت النتائج ارتفاع نسبة البروتين، الألياف الخام والرماد في الدقيق المركب عن تلك الموجودة بدقائق القمح، وهذه المكونات ارتفعت نسبةها بالدقيق المركب كلما زادت نسبة دقيق البقلويات به. وعند مقارنة الزيادة في البروتين والألياف الخام والرماد بالدقيق المركب من 70% دقيق قمح و30% دقيق صويا أو 30% دقيق ترمس كنسبة مئوية من تلك الموجودة بدقائق القمح وجد أنها 11.89% و36.5% للبروتين، 57.6% لاللياف الخام، 13.8% والزمرة و13.9% لاللياف الخام، 128.8% و124.9% للرماد على التوالي. وبالإضافة إلى ذلك فقد أظهر الدقيق المركب تسوّق في الخصائص الوظيفية، وارتفاع نسبة المركبات الفينولية وكذلك نشاط مضادات الأكسدة عن تلك التي قدرت بدقائق القمح. ولقد أحوي الدقيق المركب من دقيق القمح والصويا ودقيق القمح والترمس على كميات مرتفعة طفيفة من حامض ألفينيك بينما انخفض حامض ألفينيك في الدقيق المركب من دقيق القمح والترمس مقارنة بتلك الموجودة بدقائق القمح. وسوف يتم التعرف علي الخصائص الطبيعية واللذذوية والحساسية للخبز المصنوع من الدقيق المركب في النشر القادم.