YYÜ TAR BİL DERG
(YYU J AGR SCI)
2018, 28(özel sayı): 199-207

Geliş tarihi (Received): 03.05.2018
Kabul tarihi (Accepted): 18.12.2018

Araştırma Makalesi/*Research Article (Original Paper)*

Phenolics Content and Antioxidant Capacity of Mung Bean (*Vigna radiata* L.) Seed

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Abstract: Mung bean (*Vigna radiata*) is a summer growing legume and widely consumed in the Asian cuisine. In recent years, the functional properties of mung bean have received attention, particularly with respect to antioxidant, antitumor, anti-diabetic effects. In this research investigated the antioxidant capacity and phenolic compound profiles of dried mung bean seeds. The total phenolic content, DPPH$^{\bullet}$ scavenging activity, ferric-reducing antioxidant power (FRAP), ABTS$^{\bullet+}$ scavenging activity were determined after methanol and acetone extractions. HPLC analyse was used to identification mung bean phenolic compounds. The total phenolic content of mung bean seed was determined as 47.16 mg GA eq / g extract (504.65 mg / 100 g seed) and 66.05 mg GA eq / g extract (526.41 mg / 100 g seed) after methanol and acetoneuse as extractans, respectively. The dominant phenolic compounds of seeds were hydroxybenzoic acid derivatives. The radical scavenging activity of mung bean extracts against ABTS$^{\bullet+}$ was 1.093 mmol Trolox / g acetone extract. This study compared the antioxidant capacity of mung bean with literature data of antioxidant properties widely consumed different bean varieties such as red and white beans. Obtained results suggest that mung bean can be evaluated as functional ingredient with high antioxidant activity in several foods therefore larger field productions can be achieved for this legume.

Keywords: Phenolic content, *Vigna radiata,* DPPH$^{\bullet}$ scavenging activity, FRAP, ABTS

Maş Fasulyesinin (*Vigna radiata* L.) Fenolik Bileşikleri ve Antioksidan Kapasitesi

Abstract: Maş fasulyesi (*Vigna radiata*) Asya mutfağında yaygın tüketilen yazlık bir baklagil çeşididir. Son yıllarda maş fasulyesi özellikle antioksidan, antitumor, antidiyabetik gibi fonksiyonel özellikleri açısından dikkat çekmektedir. Bu araştırmanın amacı kurutulmuş maş fasulyesi tohumlarının antioksidan kapasitesini ve fenolik bileşik profilini araştırmaktır. Bu amaçla metanol ve aseton extratlarında toplam fenolik madde, DPPH$^{\bullet}$ radikal giderim aktivitesi, ferrik iyon indirgeme kapasiteleri**,** ABTS$^{\bullet+}$ katyon radikali giderim aktivitesi belirlenmiştir. Maş fasulyesinin fenolik bileşiklerini belirlemek amacıyla HPLC analiz yöntemi kullanılmıştır. Maş fasulyesinin toplam fenolik madde miktarı metanol ve aseton ektratlarında sırasıyla 47.16 mg GA eq / g ekstrat (504.65 mg / 100 g tane) and 66.05 mg GA eq / g ekstrat (526.41 mg / 100 g tane) olarak belirlenmiştir. Çalışmada, dominat fenolik bileşiklerin hidroksibenzoik asit ve türevleri olduğu bulunmuştur. Maş fasulyesinin aseton ekstresinde ABTS$^{\bullet+}$ katyon radikali giderim aktivitesi 1.093 mmol Trolox / g extract olarak belirlenmiştir. Bu çalışmada ayrıca maş fasulyesinin antioksidan kapasitesi, literetürde kırmızı ve beyaz fasulye gibi yaygın tüketilen fasulye çeşitlerinin antioksidan kapasiteleri ile karşılaştırılarak değerlendirilmiştir. Elde edilen bulgular sonucunda maş fasulyesinin yüksek antioksidan kapasitesi gibi çeşitli gıdalarda fonksiyonel ingredient olarak değerlendirilebileceği ve bu nedenle bu baklagilin daha geniş alanlarda üretilebileceği düşünülmektedir.

Anahtar kelimeler: Fenolik bileşikler, *Vigna radiata,* DPPH$^{\bullet}$ radikal giderim aktivitesi, FRAP, ABTS

Introduction

Recently studies conducted on potential health benefits of beans due to the presence of some bioactive phenolic constituents. These bioactive constituents able to keep from reactive oxygen species, which are capable some reactions causing many serious diseases (Amarowicz and Weidner, 2009). Plant Phenolics are secondary metabolites involved in the defence mechanisms against microbial pathogens, various environmental stresses and insect herbivores (Kumar et al. 2014). Plant-derived these components have played an important role in the

treatment and avoid human diseases. Therefore, the biological screening provides a scientific basis for validating the traditional utilization of medicinal plants. These bioactive constitutes of grain legumes make them suitable for creating new functional foods (Aguilera et al. 2011). Antioxidant activity of phenolic compounds present in edible grain legume seeds have been investigated in recent studies (Karamać et al. 2004, Amarowicz et al. 2008, Orak et al. 2016).

Mung bean (Vigna radiata L.) included to Fabaceae family and known as green gram or moong bean, as well as. Mung bean has been consumed as traditionally worldwide for more than 3500 years, especially in Asian countries (Kumar and Xu, 2018). Mung bean has high nutrient value similarly to soybean and kidney bean, and it is richness for proteins, minerals and vitamins and essential amino (Mubarak, 2005). Besides these nutrients, mung beans possess certain bioactive food components, which contain polyphenols. Based on the including to these components and efficacy of these bioactive components, mung beans have a great role in respect to antioxidant activity, detoxification, and also exhibits chemo-preventive effects (Ganesan and Xu 2017). Mung bean consumed in several cuisines as traditionally, therefore health promoting effects of mung bean seeds associated with the anti-inflammatory effects of diets in Asian countries (Luo et al. 2016). Dried mung bean seeds can be eaten in several ways such as cooked, fermented in western cultures, its sprouts are generally used as salad vegetable (Lambrides, 2007).

In this study, we aimed to determine the antioxidant capacity and phenolic compounds of mung bean seeds, which potentially functional properties. Identification of bioactive compounds such as phenolic compounds, flavonoids from plants have received attention for discover of therapeutic agents and to knowledge new sources of phytocompounds for the synthesis or to understand the actual significance of traditional remedies.

Materials and Methods

Plant materials

In this study, mung bean obtained from Field Crops Department, Agricultural Faculty of Namık Kemal University as material. Seeds were obtained from harvested plants at dry maturated stage at July.

Chemicals and reagents

Gallic acid, *p*-coumaric acid, 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), 2,4,6-tri (2-pyridyl)-s-triazine (TPTZ), 6-hydroxy-2,5,7,8-tetramethyl-chroman-2-carboxylic acid (Trolox), and trifluoroacetic acid (TFA)were obtained from Sigma-Aldrich (Saint Louis, MO, USA). Apigenin was purchased from Extrasynthese S.A. (Genay, France) The solvents and other chemicals, if not otherwise specified, were acquired from Avantor Performance Materials (Gliwice, Poland).

Preparation of extracts

Extraction

Dried seed samples were milled with a laboratory mill and polyphenol extraction were done by using methanol 80 % (v/v) and acetone 80 % (v/v) as solvent. Sample : extractan ratio were 1:10 (v/w), and samples were shaken by using a shaking water bath (SW22, Julabo, Seelbach, Germany) at 70 °C for 15 min. The extractions were repeated three times and solvents were evaporated under vacuum using a rotary evaporator (Rotavapor R-200 (Büchi Labortechnik, Flawil, Switzerland). Samples were lyophilisated with a Labconco freeze dryer (Lyph Lock 6 freeze-dry system, Labconco, Kansas City, MO, USA) for analyses.

Total phenolic compounds content

The total phenolic content (TPC) of mung bean extracts and seeds was determined by spectrophotometric method with Folin-Ciocalteu's reagent (Karamać et al., 2015). The TPC was expressed as mg gallic acid equivalents (GA eq) per g of extract or per 100 g of seeds.

Trolox equivalent antioxidant capacity

Trolox equivalent antioxidant capacity (TEAC) of mung bean was determined using the ABTS discoloration assay described by Re et al (1999). The absorbance was measured at 734 nm. The results were expressed in terms of mmol Trolox equivalents per g of extract or seeds

DPPH radical scavenging activity

The method described by Brand-Williams et al. (1995) was used to determine DPPH• radical scavenging activity of mung bean extracts. The extracts were dissolved in range 2-10 mg/mL. These solutions (0.1 mL) were mixed with methanol (2 mL) and 1 mM DPPH (0.25 mL. The samples were allowed to stand in dark for 20 min and next the absorbance was measured at 517 nm. The radical scavenging activity was calculated as a percentage of DPPH discoloration. EC_{50} values, defined as the amount of extract needed to scavenging 50% of the DPPH•, were estimated from the curves of absorbance versus extract concentration.

Ferric-reducing antioxidant power

Ferric-reducing antioxidant power (FRAP) of mung bean was determined according method previously described by Benzie and Strain (1996). Fe^{3+}-TPTZ complex was generated at pH 3.6 (300 mM acetate buffer) by mixing 10 mM TPTZ in 40 mM HCl and 20 mM ferric chloride (1:1, v/v). Then, mung bean extract solution (75 µL) and water (225 µL) was added to complex solution (2.25 mL). The absorbance was read at 593 nm. Ferrous sulfate was used to prepare calibration curve. The results were expressed as µmol Fe^{2+} equivalents per g of extract or seeds.

Phenolic compounds analysis

The phenolic compounds of mung bean extracts were analysed with Shimadzu HPLC system (Kyoto, Japan) containing two LC-30AD pumps, CBM-20A system controller, DGU-20A5R degassing unit, SIL-30AC autosampler and SPD-M30A photodiode array detector (PAD). Separation was performed using Luna C8(2) (4.6 × 150 mm, particle size 3 µm, Phenomenex, Torrance, CA, USA) column and gradient system of mobile phase (A - acetonitrile-water-trifluoroacetic acid, 5:95:0.1, v/v/v and B - acetonitrile-trifluoroacetic acid, 100:0.1, v/v) with flow rate of 1 mL/min. The PDA scanned through the wavelength range 200-400 nm. The quantification of phenolic compounds was carried out base on calibration curves of corresponding standards.

Statistical analysis

Antioxidant activity assays and HPLC analyse were performed in triplicate. Results were reported as means ± standard deviations. Analyse of variance (one-way ANOVA) followed by the least significant difference (LSD) test was conducted using statistical package of MSTAT-C software. Differences were considered to be statistically significant when $p < 0.05$.

Results and Discussion

Extraction yield and total phenolic content

The extraction yield and total phenolic contents of mung bean in extracts and seeds are shown in Table 1. The yield of mung bean seed extractions were 10.7 % from methanol extract and 7.97 % from acetone extract (Table 1). The total phenolic content (TPC) of mung bean seed was 47.16 mg GA eq/g extract (505 mg GA eq/100 g seed) and 66.05 mg GA eq/g (527 mg GA eq/100 g seed) in methanol and acetone extracts, respectively (Table 1). Although total phenolic content of acetone extract of mung bean found higher than methanol extract, there was no significant difference between seed TPCs.

Table 1. Extraction yield and total phenolic content in mung bean

Extract	Extract yield (%)	TPC (mg GA eq/ g extract)	TPC (mg GA eq/ 100 g seed)
MeOHext	10.70	47.16 ± 0.23b	505 ± 2a
ACEText	7.97	66.05 ± 2.09a	526 ±16a

* Data are reported as the mean ± standard deviation (n=3). In the same column values having different letters differ significantly (P<0.05).

Zhang et al. (2013) determined that acetone-water extract of mung bean had the higher TPC (5.07 mg GA eq/g) than methanol extract with indicating that acetone-water was a better solvent for extraction of phenolics from mung bean. In recent years, the functional properties of beans have received attention, particularly with respect to antioxidant effects and their total phenolic content. Therefore we compared the phenolic content of mung bean

with literature data of widely consumed different bean varieties along with mung bean and the reported studies were summarized in Table 2. The total phenolic content of mung bean determined in our study with value of 526 mg GA eq/100 g seed was higher than results showed by Marathe et al. (2011), Shi et al. (2016), Zhao et al. (2014), and similar to that presented by Zhang et al. (2013), Krishnappa et al. (2016), Khang et al. (2016) as seen Table 2. Lee et al. (2011) showed that mung bean contained a higher level of phenolics (about 4.01 GA eq/ g) than the soy beans (1.17 GA eq/g). According to Marathe et al. (2011) categorisation, the legumes depending on their phenolic content into three groups, as low (<1.0 mg GA eq/g), moderate (1.0–2.0 mg GA eq/g) and high (>2.0 mg GA eq/g). By this categorization, mung bean took placed in high content legume class. When compared the our results related to widely consumed white and red beans (*Phaseolus vulgaris* L.), mung bean exhibited similar total phenolic content to red bean, however nearly 8 and 26 fold more total phenolic content than white and kidney bean varieties, respectivly (Orak et al., 2015, 2016). Summarising, by comparing the results of the present investigation with

Table 2. The total phenolic content and main phenolic compounds of some different bean seeds reported in literature

Genotypes	TPC	units	main phenolic compounds	References
mung bean	1.83	mg GA/g seed	nd	Marathe et al. 2011
twenty Chinese mung bean cultivars	2.05-2.38	mg GA/g seed	phenolic acids (syringic, caffeic, p-coumaric, and ferulic acids)	Shi et al. 2016
ten commercial dry mung bean, China	5.07	mg GAE/g seed	salicylic acid, p-coumaric acid, ferulic acid, vitexin isovitexin	Zhang et al. 2013
green gram seeds from local market, India	4.86	mg GAE/g seed	Free phenolic acids, tannic acid, gallic acid,ferulic acid and sinapic acid	Krishnappa et al. 2016
commercial mung bean, Vietnam	5.80	mg GAE/g dry sample	nd	Khang et al. 2016
Mung bean	9.94	mg/g dry weight (DW)	vitexin and isovitexin	Peng et al. 2008
green mung bean sprout	2.09	mg GAE/ g (DW)	Gallic acid, p-coumaric acid, catechin, rutin, vitexin and isovitexin	Gan et al. 2016
56 mungbean genotypes from genebank of Korea	1.61 to 3.46	mg/g dry weight (DW)	Thirty types of phenolic compounds, including 11 flavonoids, 16 phenolic acids, pyrogallol, resveratrol, and vanillin	Kim et al. 2013
sixty mung bean genotypes	nd	-	catechin, chlorogenic acid, caffeic acid, p-coumaric acid, t-ferulic acid, vitexin, isovitexin, myricetin, quercetin and kaempferol	Meenu et al. 2016
mung bean **pinto bean** **black kidney bean** **red kidney bean**	26.7 33.4 32.9 27.1	mg GAE/g extract		Zhao et. al. 2014
red bean	55	mg CA /g extract.		Amarowicz and Troszynska, 2008
common red bean	3.58	mg GA /g of seed	nd	Marathe et al. 2011
two red bean varieties	1.69-4.85	mg GA /g seed	caffeic acid and rutin equivalent compounds	Orak et al. 2015
twenty nine white, red and	5.87–14.14	mg GA /g seed	nd	Akond et al. 2011

black common beans				
seven improved Brazilian common beans genotypes	4-0	mg GA/g seeds	nd	Rezende et al. 2017
kidney beans varieties	0.25 to 35.11	mg GAE/g DW	Pelargonidin, cyanidin, petunidin, delphinidin, malvidin	Kan et al. 2016
ten white bean varieties	0.33-0.63	mg GA /g of seed	caffeic acid equivalent compounds	Orak et al. 2016

those of earlier reports, it is evident that mung beans contained relatively high amounts of TPC than those reported in other types of beans and mung beans (Table 2).

Identification and quantification of phenolic compounds

Phenolic profiles of mung bean extracts in methanol and acetone extracts were screened by using DAD-HPLC technique. The HPLC chromatograms of mung bean extracts recorded at 290 nm are characterised by the presence of eight (1–8) peaks with a retention time of 1.8, 2.4, 6.8, 8.7, 9.3, 9.5, 10.6 and 15.1 min (Fig. 1) corresponding to phenolic compounds. Based on retention time and UV spectrum compounds 1-4 were classified as hydroxybenzoic acid derivatives. Compound 5 was assumed as hydroxycinnamic acid derivative. Spectra of compounds 6, 7 and 8 were comparable to that of apigenin and compounds were identified as apigenin derivatives. Contents of compounds 1–8 in the extracts and seeds of mung bean are given in Table 3. Gallic acid and *p*-coumaric acid were used as standards for quantification of hydroxybenzoic and hydroxycinnamic derivatives, respectively. Content of compounds 6-8 was expressed as apigenin equivalents

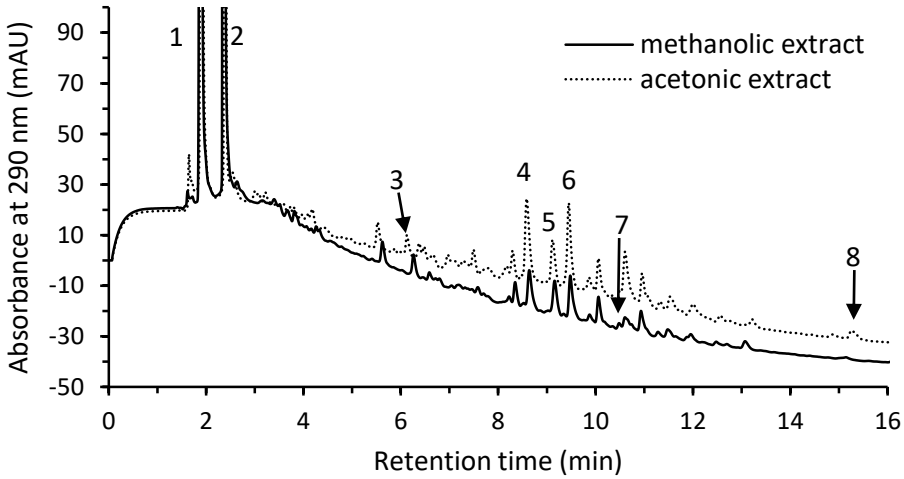


Figure 1. HPLC chromatograms of phenolic compounds of mung bean extracts recorded at 290 nm**.**

According to Table 3, compounds 1 and 2 were the most dominant phenolics in the extracts of mung bean. Compound 1 was found in the highest amount in methanol extract (5.74 mg/ g extract and 614.2 µg/g seed). The compound 2 followed it with high value of 3.54 mg/g (378.8 µg/g seed) in methanol extract. Acetone extracts explored lower content with value of 5.14 (409.6 µg/g seed) and 2.19 mg/g (174.5 µg/g seed) for these compounds, respectively (Table 3). Two other compounds expressed as gallic acid equivalents (compounds 3 and 4) were presented in mung bean in lower amounts (Table 3). Gallic acid is a hydroxybenzoic phenolic compound and the common phenolic acid found in beans (Wang et al. 2016). The seed coat (hull) of legume seeds primarily contains *p*-hydroxybenzoic, protocatechuic, gallic, vanillic and syringic acids (Amarowicz & Pegg, 2008). In reported studies we found only a few study which detected the gallic acid in mung bean. Kim et al. (2013) determined the gallic acid below the limit of quantification for 56 mung bean of Korean varieties. Nair et al. (2015) also determined low gallic acid content (from 9 to 45 µg/g) in mung bean lines grown in India. On the other hand, Krishnappa et al. (2016) determined higher gallic acid content (14.6 mg/g seed) from our findings. In comparison with other bean varieties, red sword bean and black sword bean coats contained high amounts of gallic acid (987 and 543 mg/100 g DW (dry weight), respectively) (Gan et al., 2016).

Compound 5; hydroxycinnamic acid derivative, was determined only in acetonic extracts. The content of this compound was 0.08 mg/g in extract and 6.4 µg/g in seed (Table 3). Shi et al (2016) and Gan et al. (2016) also reported the presence of *p*-coumaric acid in mung bean.

In our study it was not determined the presence of caffeic or ferulic acids that are typical hydroxycinnamates for beans (Amarowicz et al., 2008). In turn, Shi et al. (2016) between hydroxycinnamic acids identified three phenolic acids (caffeic acid, *p*-coumaric acid, and ferulic acid) in twenty Chinese mung bean cultivars.
Compounds 6, 7, 8 were classified as flavones and their content was expressed as apigenin equivalents. The content of compound 6 was the highest in these class phenolics at 0.21 mg/g extract (22.5 µg/g seed) and 0.37 mg/g extract (29.5 µg/g seed) in methanol and acetone extracts, respectively. Compound 7 determined only in methanol extract at level 0.016 mg/g extract (1.71 µg/g seed). The content of compound 8 was 0.07 mg/g in acetone extract and it was not detected in methanol extract. In recent studies the presense of vitexin (apigenin 8-C-glucoside) and isovitexin (apigenin 6-C-glucoside) in mung bean were recorded by Peng et al. (2008), Yao et al. (2011) and Zhang et al. (2013) (Table 2). The presence of apigenin or its derivatives in mung bean seeds is highlighted the value of mung bean, because studies have shown several beneficial health effects of these compounds, including antioxidant, anti-inflammatory, hypoglycaemic and hypocholesterolaemic activities (Arnoldi et al., 2015; Shukla and Gupta, 2010).

Table 3. Content of individual phenolic compounds in mung bean

Compounds	MeOHext (mg/g extract)	MeOHext (µg/g seed)	ACEText (mg/g extract)	ACEText (µg/g seed)
compound 1*	5.74 ± 0.22a	614.2 ± 2.3a	5.14 ± 0.24a	409.6 ± 10.1a
compound 2*	3.54 ± 0.14b	378.8 ± 14.9b	2.19 ± 0.10b	174.5 ± 7.9b
compound 3*	0.08 ± 0.01d	8.6 ± 1.1d	0.08 ± 0.04e	6.4 ± 3.1e
compound 4*	0.23 ± 0.01e	24.6 ± 1.0e	0.53 ± 0.02c	42.2 ± 1.6c
compound 5**	nd	nd	0.08 ± 0.00e	6.4 ± 0.1e
compound 6***	0.21 ± 0.01cd	22.5 ± 0.9cd	0.37 ± 0.01d	29.5 ± 0.9d
compound 7***	0.016 ± 0.01e	1.71 ± 0.8e	nd	nd
compound 8***	nd	nd	0.07 ± 0.01e	5.58 ± 0.7e

*Contents of compounds expressed as gallic acid equivalents. ** expressed as *p*-coumaric acid equivalents. ***expressed as apigenin equivalents. Data are reported as the mean ± standard deviation (n=3). In the same column values having different letters differ significantly (P<0.05).

Reported studies reveal that the mung bean is a good source of **phenolic acids**;
*such as **p-coumaric acid, ferulic acid;** (Shi et al 2016, Nair et al 2015, Zhang et al 2013, Khang et al 2016, Meenu et al 2016) **caffeic acid;** (Silva et al 2013, Meenu et al 2016) which are belong to **hydroxycinnamic acids**;
*such as **gallic acid**, (Nair et al 2015, Krishnappa et al 2016, Peng et al 2008) **syringic acid** (Shi et al 2016 Khang et al 2016) are belong to **hydroxybenzoic phenolic acids**;
*and **flavonoids** such as **catechin** (Peng et al 2008, Meenu et al 2016, Nair et al 2015), **quercetin** (Nair et al 2015, Meenu et al 2016) **vitexin and isovitexin** (Zhang et al 2013, Meenu et al 2016,Yao et al 2011, Peng et al 2008), one study detected the presence of **resveratrol** in mung bean (Kim et al 2013).

Antioxidant potential of mung bean seeds

The antioxidant activities of mung bean extracts and seeds determined as TEAC and FRAP are given in Table 2. The acetone extract exhibited much higher $ABTS^{\bullet+}$ scavenging activity (1.093 mmol Trolox/g extract; 0.087 mmol Trolox/g seeds) than methanol extract (0.742 mmol Trolox/g extract; 0.077 mmol Trolox/g seeds). Shi et al. (2016) determined the lower $ABTS^{\bullet+}$ radical-scavenging capacity from our findings that ranged from 3.82 ± 0.25 to 13.44 ± 1.76 µmol/ g seed in twenty Chinese mung bean cultivars. Higher TEAC values were determined by Zia-Ul-Haq et al. (2013) (21.2–31.1 µmol Trolox/g) for four mung bean (*Vigna radiata* L. Wilczek) varieties indigenous to Pakistan. When compared $ABTS^{\bullet+}$ scavenging activity of mung bean with that of other legumes, TEAC capacity of mung bean was higher than those of broad bean (0.58 mmol Trolox/g extract), red lentil (0.68 mmol Trolox/g extract), red bean (0.149–0.493 mmol Trolox/g extract) (Amarowicz et al., 2004; Orak et al., 2015), , however lower than adzuki bean (1.76 mmol Trolox/g extract) (Amarowicz et al., 2008). According to our recent research mung bean exhibited two or three fold more TEAC capacity compared to widely consumed white bean varieties (*Phaseolus vulgaris* L.) (27- 43 µmol Trolox/g extract) (Orak et al., 2016). Ferric reducing antioxidant power (FRAP) of extracts and seeds of mung bean were shown in Table 3. Acetone extract showed

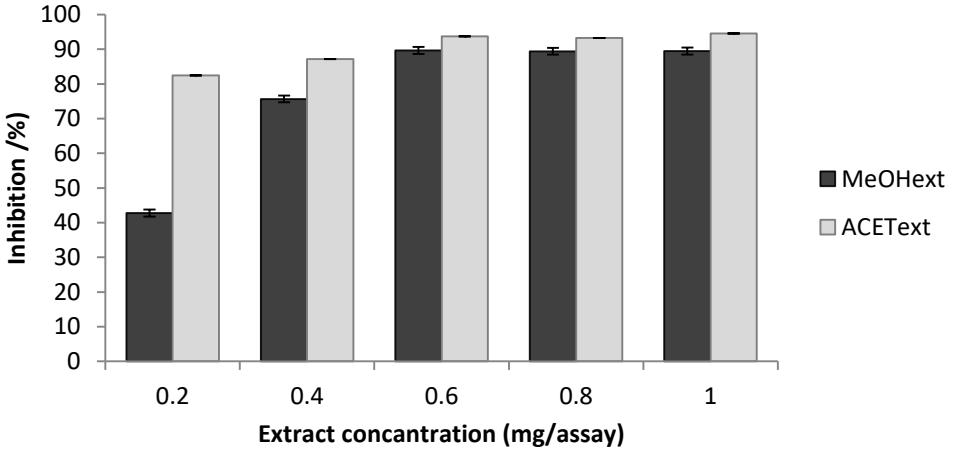
higher antioxidant activity (632.5 µmol Fe^{2+}/ g extract) than methanol extract (271.82 µmol Fe^{2+}/g). The ability of mung bean to reduce Fe^{3+} was found similar to red common bean (Orak et al., 2015) however nearly 3 or 4 fold higher than widely consumed white bean varieties (66 -89 µmol Fe^{2+}/g) (Orak et al., 2016). According to a previous research (Lee et al., 2011) the FRAP of the mung bean extracts (31.85 µmol Fe^{2+}/g defatted seed) was significantly higher than that of the soy bean extracts (8.23 µmol Fe^{2+}/g defatted seed). Also Djordjevic et al. (2011) found that mung bean extract had significantly greater reducing power than that of the soy bean extract.

Table 4. Trolox equivalent antioxidant activity (TEAC) and ferric-reducing antioxidant power (FRAP) of the in mung bean

Extract	TEAC (mmol TE/ g extract)	TEAC (mmol TE/ g seed)	FRAP (µmol Fe^{2+}/ g extract)	FRAP (µmol Fe^{2+}/ g seed)
MeOHext	0.742 ± 0.055	0.077 ± 0.001	271.8 ± 1.26	29.08 ± 0.13
ACEText	1.093 ± 0.026	0.087 ± 0.002	632.5 ± 5.16	50.43 ± 0.41

* Data are reported as the mean ± standard deviation (n=3). In the same column values having different letters differ significantly (P<0.05).

DPPH radical scavenging activity is widely used method to test antioxidant activity of samples. This radical react with hydrogen donors such as phenolic compounds and fade colours in assay solutions. As shown in Fig 3, the mung bean extracts showed significantly higher radical scavenging activities even at lower concentrations, however acetone extract demonstrated higher antiradical activity against DPPH• than the methanol extract. In the case of acetone extracts, phenolic compounds of mung bean were more active. The DPPH• scavenging activity of mung bean obtained in this study was stronger than that of the extract of the red bean (Orak et al., 2015). Anwar et al. (2013) determined lower IC_{50} value (between 16.4 µg/mL and 42.9 µg/mL) for mung bean seed in different extraction methods.



MeOHext (EC 50) = 0.089 mg/mL; ACEText (EC 50) = 0.053 mg/mL

Figure 3. Antiradical activity of mung bean extracts against DPPH• radical (n=3).

Conclusions

In recent years, the functional properties of mung bean have received attention, and this study evaluated the antioxidant capacity and phenolic compound profiles of mung bean seeds in methanol and acetone extracts and these constituents of mung bean compared with literature data of antioxidant properties widely consumed different bean varieties. According to investigations, mung beans showed strong antioxidant capacity with high total phenolic content. In each of extracts of mung bean, several phenolic compounds were detected and classified as hydroxybenzoic and hydroxycinnamic acids derivatives and as flavones. The hydroxybenzoic acid derivatives were dominant. Obtained results suggest that mung bean can be used as functional ingredient with high antioxidant activity in foods such as soup, pasta and can be increasing of consume in human diet. Therefore larger field productions can be achieved for this legume.

Acknowledgements

H. Hülya Orak thanks to Council of Higher Education (YOK) in Turkey for financial support for her studies and collaborations with Institute of Animal Reproduction and Food Research of the Polish Academy of Sciences in Olsztyn at 2015

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