Food Research International 101 (2017) 1–16

Contents lists available at ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Review

Phenolic composition and antioxidant potential of grain legume seeds: A review

Balwinder Singh[a], Jatinder Pal Singh[b], Amritpal Kaur[b,*], Narpinder Singh[b]

[a] Department of Biotechnology, Khalsa College, Amritsar 143002, Punjab, India
[b] Department of Food Science and Technology, Guru Nanak Dev University, Amritsar 143005, Punjab, India

ARTICLE INFO

Keywords:
Legume seeds
Phenolic compounds
Antioxidant activity
Processing
Health benefits

ABSTRACT

Legumes are a good source of bioactive phenolic compounds which play significant roles in many physiological as well as metabolic processes. Phenolic acids, flavonoids and condensed tannins are the primary phenolic compounds that are present in legume seeds. Majority of the phenolic compounds are present in the legume seed coats. The seed coat of legume seeds primarily contains phenolic acids and flavonoids (mainly catechins and procyanidins). Gallic and protocatechuic acids are common in kidney bean and mung bean. Catechins and procyanidins represent almost 70% of total phenolic compounds in lentils and cranberry beans (seed coat). The antioxidant activity of phenolic compounds is in direct relation with their chemical structures such as number as well as position of the hydroxyl groups. Processing mostly leads to the reduction of phenolic compounds in legumes owing to chemical rearrangements. Phenolic content also decreases due to leaching of water-soluble phenolic compounds into the cooking water. The health benefits of phenolic compounds include acting as anticarcinogenic, anti-thrombotic, anti-ulcer, anti-artherogenic, anti-allergenic, anti-inflammatory, antioxidant, immunemodulating, anti-microbial, cardioprotective and analgesic agents. This review provides comprehensive information of phenolic compounds identified in grain legume seeds along with discussing their antioxidant and health promoting activities.

1. Introduction

Legume seeds constitute an essential part of the human diet as they are excellent sources of proteins, minerals, vitamins and bioactive compounds (Magalhães et al., 2017). There has been a significant increase in their production worldwide and the food processing industry is developing newer uses of these seeds for producing food products having beneficial effect on human health (Aguilera, Estrella, Benitez, Esteban, & Martín-Cabrejas, 2011). The worldwide production, area harvested and yield of different legume seeds is presented in Supplementary Fig. S1. Legumes are a good source of bioactive phenolic compounds for humans as they play a significant role in many physiological and metabolic processes. Additionally, the diets in developing countries are primarily based on legume and cereal products and recently there has been an increasing interest in following strictly vegetarian diets among Western societies (Sabaté & Soret, 2014). Most of the phenolic compounds are concentrated in the seed coats of the legumes (Amarowicz & Shahidi, 2017; de Mejıa, Castano-Tostado, & Loarca-Pina, 1999; Dueñas, Hernández, & Estrela, 2006; Gan et al., 2016). These compounds function as bioactive compounds and are important determinants of color, taste and flavor of foods. They exhibit free radical-scavenging capacity and the ability to interact with proteins. The bioactive phenolic compounds present in grain legumes (as reactive metabolites and associated antioxidant activity) make them suitable candidates for creating new functional foods (Aguilera et al., 2011). Phenolic compounds are polyhydroxylated compounds, constituting one of the most extensive groups of chemicals present in plant kingdom. These show structural diversity ranging from simple phenolics to complex as well as highly polymerized compounds. The high-molecular weight phenolic compounds having a complex structure are often referred to as polyphenols. These exhibit plenty of biologically significant functions such as protection against oxidative stresses and degenerative diseases. These compounds might offer indirect protection by the activation of endogenous defense systems and with the modulation of cellular signaling processes. Bioactivities (the specific effect produced in human body upon exposure to bioactive compounds) of phenolic compounds exemplify their importance in food products. They have many health benefits, some of which are acting as anticarcinogenic, anti-thrombotic, anti-ulcer, anti-artherogenic, anti-allergenic, anti-inflammatory, antioxidant, immunemodulating, anti-microbial,

* Corresponding author.
E-mail address: amritft33@yahoo.co.in (A. Kaur).

http://dx.doi.org/10.1016/j.foodres.2017.09.026
Received 20 June 2017; Received in revised form 4 September 2017; Accepted 8 September 2017
Available online 09 September 2017
0963-9969/

Table 1
Total phenolic content and polyphenols reported in various grain legume seeds and their coats.

Pulses	Total phenolic content	Technique used	Main identified compounds	References
(i) Dry beans				
Commercial bean varieties	19.1 to 48.3 mg/100 g DW	HPLC-DAD	*p*-coumaric acid, ferulic acid and sinapic acid	Luthria and Pastor-Corrales (2006)
Bean cultivars	11.2 to 25.3 mg CE/g DW	Folin-Denis	–	Rocha-Guzmán et al. (2007)
Commercial bean varieties	–	HPLC-MS	Delphinidin, petunidin, malvidin, quercetin	Lin, Harnly, Pastor-Corrales, and Luthria (2008)
Bean coats	146 to 5798 mg GAE/100 g DW	Folin-Ciocalteu, HPLC	Cyanidin-3-glucoside, cyanidin-3-galactoside, malvidin-3-glucoside, peonidin-3-glucoside, kaempferol, quercetin, rutin, gallic acid	Gan et al. (2016)
Common beans	2.4 to 13.5 μmol trolox/g DW	Folin-Ciocalteu, UPLC	Gallic acid, vanillic acid, protocatechuic acid, catechin, epicatechin, *p*-coumaric acid, ferulic acid, rutin, quercetin	Wang et al. (2016)
Faba bean genotypes	117.8 to 157.6 mg GAE/g DW	Folin-Ciocalteu	–	Chaieb et al. (2011)
Immature faba bean seed varieties	817.0 to 1337.8 mg GAE/kg DW	Folin-Ciocalteu, HPLC-DAD-MS	Prodelphinidin dimers, (+)-Catechin, (−)-Epicatechin, Quercetin 3-*O*-rutinoside, Apigenin 7-*O*-glucoside, Myricetin-3-*O*-glucoside, Quercetin 3-*O*-glucoside, Myricetin	Baginsky et al. (2013)
Mung bean	26.7 ± 1.4 mg GAE/g extract	Folin-Ciocalteu,	–	Zhao, Du, Wang, and Cai (2014)
Pinto bean	33.4 ± 3.0 mg GAE/g extract			
Black kidney bean	32.9 ± 0.1 mg GAE/g extract			
Red kidney bean	27.1 ± 3.0 mg GAE/g extract			
Adzuki bean	90 to 189 mg/g in crude extract and fractions	Folin-Ciocalteu, HPLC-MS	Hydroxycinnamates, procyanidins, gallates, flavonols, dihydroflavonols and dihydrochalcones	Amarowicz et al. (2008)
Kidney beans varieties	0.25 to 35.11 mg GAE/g DW	Folin-Ciocalteu, UPLC-DAD-MS	Pelargonidin, cyanidin, petunidin, delphinidin, malvidin	Kan et al. (2016)
(ii) Lentils				
Lentil varieties (seed coats and cotyledons)	–	HPLC-MS	Protocatechuic acid, catechin, trans-ferulic acid, gallic acid, procyanidins, epicatechin, apigenin, myricetin 3- ramnoside, luteolin 7-glucoside	Dueñas et al. (2006)
Lentil varieties	4.9 to 7.8 mg GAE/g DW	Folin-Ciocalteu	–	Xu et al. (2007)
Lentil varieties	12 mg GAE/g DW	4-aminoantipyrine	–	Han and Baik (2008)
Green lentil	68 mg CE/g DW	Folin–Ciocalteu,	Catechin glucoside, procyanidin dimer, *trans-p*-coumaric acid, quercetin diglycoside,	Amarowicz et al. (2010)
Red Lentil	58 mg CE/g crude extract	HPLC-PAD, HPLC–ESI-MS	*trans*-ferulic acid, kaempferol glucoside	Amarowicz et al. (2009)
Green lentil seed and hull	10.3 mg CE/g DW and 82.9 mg CE/g DW	HCl method	–	Oomah et al. (2011)
Red lentil seed and hull	12.6 mg CE/g DW and 87.2 mg CE/g DW	HCl method	–	
Lentil seed coats	–	HPLC-MS	Gallocatechin, procyanidin C1, malvidin-3-*O*-galactoside, myricetin-3-*O*-rhamnoside, quercetin-3-*O*-galactoside, kaempferol-3-*O*-glucoside, naringenin, luteolin	Mirali et al. (2014)
Green lentil cultivars	5.0 to 7.0 mg GAE/g DW	Folin-Ciocalteu, HPLC-MS	Dihydroxybenzoic acid, catechin glucoside, syringic acid, *trans-p*-coumaric acid,	Zhang et al. (2015)
Red lentil cultivars	4.6 to 7.6 mg GAE/g DW		epicatechin gallate, quercetin-3-glucoside, kaempferol-3-glucoside	
Pardina Lentils		HPLC-PAC and HPLC-MS (ESI)	Dihydroxybenzoic acid, catechin 3-glucoside, procyanidin, *trans-p*-coumaric acid, kaempferol 3-rutinoside, kaempferol 3-glucoside and luteolin 3-7-diglucoside	Aguilera et al. (2010)
				Aguilera et al. (2011)
Lentil	47.6 ± 5.3 mg GAE/g extract	Folin-Ciocalteu	–	Zhao et al. (2014)
Lentil cultivars	Free: 1.37–5.53 mg GAE/g Esterified: 2.32–21.54 mg GAE/g Insoluble-bound:2.55–17.51 mg GAE/g	HPLC-DAD-ESI-MS[n]	Catechin, epicatechin, procyanidins B, methyl vanillate, procyanidin dimer A, and prodelphinidin dimer A	Alshikh et al. (2015)
(iii) Chickpea				
Chickpea variety	0.98 mg GAE/g DW	Folin-Ciocalteu	–	Xu et al. (2007)
Chickpea variety	2.2 mg GAE/g DW	4-aminoantipyrine	–	Han and Baik (2008)
Chickpea variety	0.54 mg CE/g DW	Folin-Ciocalteu	–	Fernandez-Orozco et al. (2009)
Chickpea seed coats and dehulled seeds	0.2 to 32.6 mg CE/g DW and 0.4 to 0.8 mg CE/g DW	Folin-Ciocalteu	–	Segev et al. (2010)
Chickpea variety		HPLC-PAD and HPLC-MS	Dihydroxybenzoic acid, *p*-hydroxybenzoic acid, *trans-p*-coumaric acid, pinocembrin, quercetin 3-*O*-rutinoside, genistein hexoside	Aguilera et al. (2011)
Chickpea varieties	11.4 to 19.4 mg TAE/g DW	Folin-Ciocalteu	–	Nithiyanantham et al. (2012)
Chickpea cultivars	147 and 183 GAE/g DW	Folin-Ciocalteu, UPLC	Gallic acid, chlorogenic acid, catechin, quercetin, ferulic acid	Fratianni et al. (2014)
Chickpea	21.9 ± 2.8 mg GAE/g extract	Folin-Ciocalteu	–	Zhao et al. (2014)
Chickpea varieties	–	HPLC-DAD	*p*-Hydroxybenzoic acid, syringic acid, gentisic acid, luteolin-8-C-glucoside, myricetin-3-*O*-rhamnoside, quercetin-3-*O*-galactoside, quercetin-3-*O*-rhamnoside	Magalhães et al. (2017)

(continued on next page)