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Characterization of lipids, proteins, and bioactive compounds in the seeds of three *Astragalus* species

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ABSTRACT

Despite the interest of legumes for food and feed purposes, the phytochemicals of *Astragalus armatus* (AA), *A. caprinus* (AC), and *A. gombiformis* (AG) have not been reported in-depth yet. Thus, the lipid contents, fatty acids composition, proteins, and bioactive compounds in the seeds of these species were investigated. Total lipids were ranged from 12.2 (AG) to 36.5 g 100 g^{-1} DW (AC) and consisted of oleic acid, linoleic acid, α-linolenic acid, and palmitic acid. The crude protein contents were in the range from 52.2 (AG) to 54.7 g 100 g^{-1} DW (AA). Globulin and albumin were the predominant soluble protein fractions. The seeds consisted significantly of different contents of total polyphenols (3.4–6.5 mg GAEg^{-1} DW), total flavonoids (1.24–5.15 mg QEg^{-1} DW), and total condensed tannins (12–23.2 mg CEg^{-1} DW). The extracts mainly consisted of quinic acid, *p*-coumaric acid, and cirsiliol. All these findings can be assets for functional foods and/or food ingredients.

1. Introduction

Astragalus is the largest genus of Fabaceae including about 3000 well-known species, found in arid, semi-arid, and continental zones of western North America, Central Asia, North and South Africa (Lock & Simpson, 1991). The most common use of plants belong to *Astragalus* genus are as fodder crops for both livestock and wild animals in dry regions although several species have been frequently in trade as of use in foods, pharmaceutical industries, medicines, cosmetics, tea flavoring agents, coffee substitutes, and sources of natural gums (Rios & Waterman, 1997). For instance, some species were the origin of many commercial thickening agents and stabilizers such as Tragacanth (E 413) (Golmohammadi, 2013). From a nutritional point of view, seeds of *Astragalus* species are rich sources of protein, polyunsaturated fatty acids (PUFA), carbohydrates, vitamins, and microelements which are the most important nutrients for human beings. In fact, health problems and diseases related to the deficiency of these essential nutrients in the human diet are well documented. Nevertheless, in recent decades, the availability of food rich in proteins and fatty acids is becoming even more limited and, consequently, expensive. For this reason, the search of alternative source of these nutrients, especially of non-conventional plants, has become an important research trend (Mahmoudi, Boughalleb, Bouhamda, Abdellaoui, & Nasri, 2018; Mahmoudi et al., 2019), to meet the growing demand and to find alternative crops that can be grown in marginal soils. Generally, legume seeds are generating considerable interest and represent a vital source of the human diet rich in minerals, lipids, proteins, and bioactive compounds (Magalhaes, Taveira, Cabrita, Fonseca, Valentão, & Andrade, 2017).

Among the socioeconomic valuable species of *Astragalus* genus in the rural and arid Tunisian regions, we focused on *Astragalus armatus*, *A. caprinus*, and *A. gombiformis* which are common in North Africa. In fact, these plants are frequently used in folk medicine as a tonic; against cough, fever, pain, and against bites of snakes and scorpions; stomach, hypertension, and diabetes disorders (Bouaziz, Yangui, Sayadi, & Dhouib, 2009). Indeed, recent evidence showed that the seeds of *A. gombiformis* are rich in polysaccharides (Chouana et al., 2017). Besides, *A. armatus* seeds were found to contain galactomannans, proteins, lipids, neutral sugars, mineral elements, and fibers showing high immunomodulatory, anti-complement, and antioxidant activities (Boual et al., 2015). Furthermore, the aerial parts of *A. armatus* contain several bioactive compounds including flavonol glycosides and triglycoside such as narcissin, nikotiflorin, and mauritianin (Khalfallah et al., 2014).

So far, no research has been found that investigated lipids, proteins, and antioxidant potentials of the seeds of these species. According to

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