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REVIEW

Global production, processing and utilization of lentil: A review

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Abstract

Lentil is a highly nutritious legume with an ample quantity of carbohydrates and good amount of proteins, minerals, vitamins, phytochemicals and fibres. Although it has been used as staple food since ancient times, its usage has been limited in developed countries, especially due to the lower protein digestibility, presence of anti-nutritional factors, flatulence and poor cooking qualities. Processing of lentils including dehulling and splitting and isolation of major fractions, e.g., proteins and starches are some of the strategies that can be adopted to add value and increase consumption of these legumes. This review paper intends to provide detailed overview of lentil's global production, nutritional composition and processing methods of lentil. Methods of isolation/characterization of lentil protein and starch and their subsequent application in foods are also presented.

Keywords: lentil, production, cooking quality, anti-nutritional factors, processing, protein, starch

1. Introduction

Lentil (*Lens culinaris*) is an edible pulse. It is also known as red dhal, masur or split peas and is considered an important source of dietary protein in the developing countries. It is an excellent source of complex carbohydrates and dietary fibres, vitamins and minerals (Adsule *et al.* 1989). Lentil ranks fifth in the global production of pulses and its yield varies between 850 to 1 100 kg ha⁻¹ (Williams *et al.* 1993; Carman 1996). According to FAO statistics (FAOSTAT

2014), average annual global production of lentil was reported to be 4.457 million metric tonnes during 2009 to 2013 (Fig. 1). Lentil is relatively drought-enduring plant that is grown worldwide; however, major lentil producing countries are Canada, Turkey, USA, Australia and India contributing more than three fourth of total world's lentil production (Alexander 2015).

Pulses including lentils are the edible seeds of leguminous plants. Lentils are consumed globally as whole grain or in the form of decorticated and split kernels. It is a staple food in the Middle East and South Asia and is often eaten with cereal grains, such as rice (Nygaard and Hawtin 1981). It is an affordable source of dietary protein in many parts of the world, especially in South Asia where plant-based diet is a staple food. It is equally popular in Sub-Saharan Africa, West Asia, North America, Middle East, Europe and Australia (Kumar *et al.* 2013). The common lentil-based foods are *masur daal* (lentil soup) and *Koshary* (lentil whole seed with rice) in the Middle East, and whole seed soups in Europe and North America (Jenner 1985). A dish of lentil soup may supply about half of the daily protein requirement

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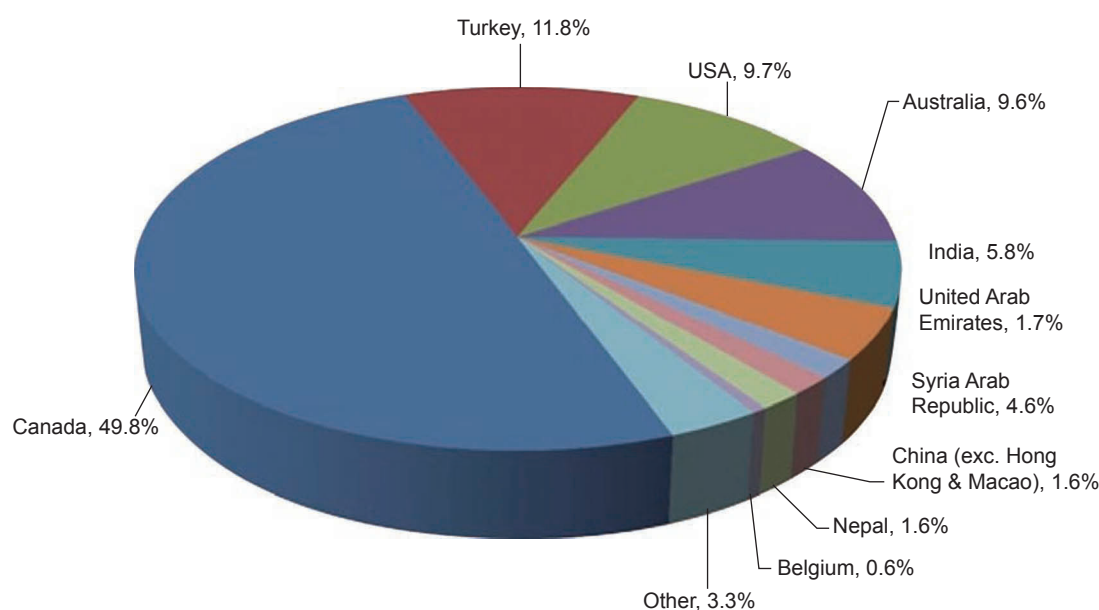


Fig. 1 Global lentil production: 2009–2013 (adapted from FAO 2016)

for an adult individual (El-Nahry *et al.* 1980). Lentil flour is mixed with cereals to make breads, cakes, noodles and infant formula (Farooq and Boye 2011; Rathod and Annapure 2017; Turfani *et al.* 2017). Lentil is well-known for its ability to induce short-term satiety and a low glycaemic response and thus helps maintain body weight, especially due to the presence of β -glucans (Kim *et al.* 2005). Lentil also contains phytochemicals including phenolic acids, flavanols, saponins, phytic acid and condensed tannins and presents a good antioxidant properties (Durazzo *et al.* 2013). Furthermore, lentil also contains notable quantities of both soluble and insoluble fibres and minerals (Kumar *et al.* 2013). Studies has shown that consumption of pulses including lentils provide health benefits including reduced risk of cardiovascular disease, cancer, diabetes, osteoporosis, hypertension, gastrointestinal disorders, adrenal disease and reduction of low-density lipoprotein (LDL) cholesterol (Hu 2003; Philanto and Korhonen 2003; Tharanathan and Mahadevamma 2003; Jacobs and Gallaher 2004; Boye *et al.* 2010). Due to these reasons, per capita consumption of lentil as a whole grain or in its processed form has been increased that has resulted in five-fold increase in its global production during the last five decades. The increase in the sown area is reported to be 155% and average yield has been doubled from 528 to 1 068 kg ha⁻¹ (FAOSTAT 2014).

Since different crops and pulses have different nutritional value, their further utilization is influenced by the chemical and nutritional composition and ease of downstream processing, which is again influenced by the structural composition of the seed, variety and maturity of the seeds.

Therefore, this review paper intends to provide detailed information on the seed composition and nutritional attributes of lentil, method of processing and its utilization in various food formulations. Methods for lentil protein and starch isolation, characterization and application as important food ingredients are reported in considerable details.

2. Taxonomy of lentil

Lentil (*L. culinaris*) is a bushy annual herb of the Leguminosae family (Adsule *et al.* 1989). The plant is typically 20–45 cm tall and produces many small purse-shaped pods containing 1–2 seeds in each (Erskine *et al.* 2009). Its taxonomic description is as follows: Kingdom, Plantae; Subkingdom, Angiosperm; Division, Eudicots; Subclass, Rosids; Order, Fabales; Family, Fabaceae; Sub-family, Faboideae; Tribe, Viciae; Genus, *Lens*; Species, *culinaris*.

Lentil has been cultivated and consumed as food since 9500 to 13000 years ago.

3. Lentil seed structure

Lentil seeds are lens-shaped tiny seeds with colors ranging from yellow to red-orange to green, brown or black. The main anatomical parts of lentil seed are: seed coat, cotyledons, and embryo including the radical, plumule, and embryonic axis (Fig. 2). The seed coat, cotyledons and embryo constitute approximately 8, 90 and 2% of the dry seed weight, respectively (Singh *et al.* 1968). Cotyledons are composed of parenchymatous cells, which contain

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