Research Advances in Functional Constituents of Chickpea

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Abstract Based on the generalization and summary of the research on the functional constituents of chickpea at home and abroad in recent years, the research advances in some rich functional constituents including isoflavones, proteins and peptides, carbohydrates, saponins and trace elements in chickpeas was reviewed in this paper. It provides a basis for the research, development and utilization of the functional constituents of chickpea in the future.

Key words Chickpea, Functional constituents, Advances

1 Introduction

Chickpea, belonging to the Leguminosae family, also known as chicken pea and peach pea, is an annual or biennial herb. Its seed shape is strange, with sharp and protruding seed coat surface, like eagle mouth, hence the name. Chickpea has a long history of cultivation and is one of the edible legume crops with a large cultivated area in the world[1-3]. It is now mainly distributed in warmer and drier areas, with Asia having the largest acreage. Pakistan and India are the world's most important chickpea producers[4]. China's chickpeas are mainly distributed in Xinjiang, Qinghai, Gansu and Yunnan[6-7].

Chickpea is rich in protein, amino acids, isoflavones, saponins, flavanones, organic acids, sugars, vitamins, crude fiber and trace elements. In the *Uighur Catalogue of Drug Standards of the Ministry of Health of the People's Republic of China*, it is known as "the flower of nutrition, the king of beans"[8-10]. As a traditional Uygur medicinal and edible plant resource, chickpea is mainly used to treat diabetes, kidney deficiency, hyperlipidemia, dysentery, bronchitis, cholera, constipation, dyspepsia, malnutrition and so on. Modern studies have found that the active constituents of chickpea have many physiological functions, such as reducing blood glucose, blood lipid, cholesterol, and anticancer, antioxidant effects, with broad prospects for edible and medicinal resource development. In this paper, the research progress of functional active constituents of chickpea in China in recent years was reviewed in order to promote the basic research and development of chickpea in China, increase the popularization and utilization of chickpea, and further provide theoretical basis for the development of deep processing industry.

2 Studies on the functional constituents of chickpea

2.1 Isoflavones The biochanin A has the highest content in chickpea, accounting for 30% of the total isoflavones, followed by formononetin and daidzein[11-12].

Isoflavones are a kind of secondary metabolites widely existing in legumes, and are similar to β-estradiol in structure. Therefore, it has estrogenic activity, also known as plant estrogen, with certain biological activity and health care function[13]. The isoflavones contained in chickpea have the function of lowering blood lipid and blood glucose to a certain extent. Isoflavones play a certain role in regulating lipid metabolism in hyperlipidemia mice[14], can prevent hyperlipidemia in mice and significantly reduce cholesterol[15]. Chickpea diet can significantly reduce serum cholesterol in diet-induced hypercholesterolemic rabbits[16]. The biochanin A and mangiferin play a major role in lipid-lowering in hyperlipidemic mice[17]. Genistein has obvious antidiabetic activity[18]. Crude flavonoids can reduce serum cholesterol in diabetic mice and effectively regulate and control blood glucose[19]. Chickpea isoflavones can inhibit the proliferation of tumor cells. It selectively inhibits the proliferation of cancer cells by inhibiting the growth and proliferation of cancer cells. Studies have shown that biochanin A can inhibit the phosphorylation of ERK and Akt, thus regulating the occurrence and development of oral squamous cell carcinoma, and can also regulate the AhR channel, and inhibit breast cancer[20-21]. Tan Yongxia[22] *et al.* found that biochanin A-7-O-β-D-glucoside and biochanin A and mangiferin were isolated from dried chickpea seeds and germinated seeds, respectively. The results showed that the composition types changed with different physiological periods. The biochanin A and mangiferin were isolated from dried chickpea seeds by Gao Peng[23].

2.2 Carbohydrates Sugars exist widely in nature and they are natural polymers contained in plants. They have attracted more and more attention because of their biological activity and medici-

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nal effects.

Current studies have shown that the polysaccharides contained in chickpea have certain antioxidant, anti-fatigue and converzyme-inhibitory activity[24-26].

2.3 Saponins Plant saponins are widely distributed in nature. Because of their anti-inflammatory, anti-tumor, antibacterial function, and light side effects, plant saponins have become the focus of current research.

Chickpea saponins can decrease the content of total triglyceride in serum, increase the content of high density lipoprotein cholesterol and enhance the activity of catalase and superoxide dismutase in liver of diabetic mice. This indicates that chickpea saponins can reduce and regulate blood glucose and lipid[27], and improve the antioxidant capacity and glucose metabolism of diabetic rats[28].

2.4 Proteins and peptides Chickpea has high protein content and is a complete protein with high nutritional value. In particular, the content of essential eight amino acids in human body is high and the proportion is reasonable, so it is a high quality plant protein source. The protein content of dried chickpea seeds was 15% - 30%, and it was easily digested and absorbed by human body[29]. The bioactive peptides have certain effects of lowering blood glucose and blood lipid, anti-oxidation, anti-tumor and regulating cholesterol.

Chickpea protein contains 18 kinds of amino acids, the total amino acid content is 868.7 mg/g, the essential amino acid content is 353.1 mg/g, and its amino acid score is 60.5, indicating that its nutritional value is higher than that of general cereals and miscellaneous beans[30]. By decomposing chickpea protein, it was found that the polypeptide products obtained from chickpea protein have obvious antioxidant activity, which indicated that chickpea protein could be used as a high quality source for the development of antioxidant health food and the development of new antioxidant peptides in pharmaceutical industry[31-33]. The effect of chickpea peptide on hepatoma mice was studied, and it was found that different doses of chickpea peptide could inhibit the growth of H22 tumor[34]. Chickpea protein was hydrolyzed and isolated by alkaline protease, and the rat experiment was carried out by gavage. In vitro experiments showed that the highest inhibition rate of cholesterol was 71.55%. *In vivo* experiments showed that the cholesterol content in rats was reduced by 22.39% when 100 mg/kg dose was given intragastrically[35].

2.5 Trace elements Trace elements play an important role in enhancing and improving the immune function of the human body, and the lack of some elements will cause disorders of body function and even lead to the occurrence of diseases[36]. Chickpea is rich in trace elements such as Fe, Mn, Zn and Cr. Fe is an important component of hemoglobin, which has the physiological functions of hematopoiesis and immunity. Mn is a component of pyruvate decarboxylase, which plays an important role in the synthesis of protein, DNA and other substances. It is an activator of the enzyme system and plays a certain role in scavenging superoxide and enhancing the immune function of the body[37]. Zn is involved in the synthesis of immune-related enzymes, can enhance the immunity of the body, and has anti-inflammatory and antibacterial effects. Cr is involved in human fat metabolism and improves hematopoietic ability[38]. Xu Xin *et al.* determined the average content of Fe, Mn, Zn and Cr in chickpea by plasma emission spectrometry at 46.73, 17.10, 15.65 and 2.70 mg/kg, respectively. There were significant differences in the content among different varieties, and the content of Fe, Zn and Cr in chickpea was higher than the average value in soybean[36].

3 Conclusions and discussions

Chickpea is an important food crop in India, Africa, Central and South America. The main planting areas in China are distributed in Xinjiang, Qinghai, Gansu and Yunnan provinces. It is not only an important minor grain crop, but also an important medicinal crop. At present, the research of chickpea in China is relatively lacking, and it focuses on the research and utilization of functional active constituents, mainly including isoflavones, saponins, proteins, polysaccharides and trace elements. At present, the results show that the active constituents of chickpea have many physiological functions, such as reducing blood glucose, blood lipid, cholesterol, anticancer, antioxidant function. They are important edible and medicinal crops. However, there are few studies on the in-depth development of its functional products and quality standard identification, and the correlation between different chickpea varieties, cultivation techniques and each functional constituent has not been reported. The content and types of functional constituents in seeds at different growth stages (fresh seed during filling period, dry seed during mature period) and different plant parts may be quite different, so more in-depth and comprehensive studies can be carried out in these aspects.

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