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Review

Genistein as antioxidant and antibrowning agents in *in vivo* and *in vitro*: A review

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ABSTRACT

Genistein is a phytoestrogen with diverse biological activities. It is a potent antioxidant and antibrowning agent in *in vivo* and *in vitro*. Genistein acts as a preventative and therapeutic effects for cancers, postmenopausal syndrome, osteoporosis and cardiovascular diseases in animals and humans. Gensitein possesses cancer related enzyme-inhibitory effect and substantially inhibits skin carcinogenesis and cutaneous aging induced by ultraviolet (UV) light in mice and photodamage in humans. Two-stage skin carcinogenesis showed genistein exhibited a moderate inhibition of ornithine decarboxylase activity through blockage of DNA adducts formation. The anticancer, anti-inflammatory, cardio-protective and enzyme-inhibitory effects of genistein might be related to their antioxidant activities. Genistein also altered the Maillard reaction pathway by trapping the advanced glycation end products (AGEs) both in biological and protein-lactose suspensions. As a result, soy isoflavone can be used to enrich or fortify different types of food products.

Contents

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1. Introduction

One of the most important roles of diet is to provide sufficient nutrients to meet the nutritional requirements of an individual. Nutritional sciences are advancing from the classical concepts of avoiding nutrient deficiencies to nutritional adequacy. There have been increasing scientific evidences that consuming some foods and food components may have additional bio-functional effects and may reduce the risk of diseases and specifically contribute to maintain state of health and well-being. Among such health enhancing foods, soybeans and derived products (soy protein, soymilk, tofu, etc.) are attracting the attention of health professionals. Nowadays, health concerns necessitate the development of functional food containing isoflavones. Soy protein and soy isoflavone could be used to enrich or fortify the milk products. Milk products are one of the important food products in the world. Therefore, research on the incorporation of genistein into milk products will not only help to produce functional food, but also in the later application, adding the value of soy which is becoming important crop throughout the world.

There are plausible epidemiological indications that soy foods can potentially help to reduce the risk of developing several diseases, the specific components occurring in these foods that are responsible for these potential beneficial health effects remain partially unknown. Identification of soybean phytochemicals that may be related to these possible positive health effects of soybeans has been, and continues to be, an active research area for the last decade. In this context, several compounds were characterized in soybeans, including phytosterols, protease inhibitors, inositol hexaphosphate, saponins and isoflavones, among others [1]. Soybeans contain 1–3 mg/g of isoflavones. Asian people consume approximately 50 mg of isoflavones per day, whereas the average daily intake of isoflavones in Western countries has been estimated to be <1 mg per day [2–4]. Indeed, there are several epidemiological studies indicating that in Asian countries; where soybeans are consumed regularly in considerable quantities, presented a lower incidence of certain diseases, such as cancer, cardiovascular diseases and osteoporosis, in relation to Western countries [5,6].

The necessity of dietary modification in the cancer risk reduction has recently drawn widespread attention due to the differences in human cancer mortality. Most of the existing worldwide cancer often depends on lifestyle and dietary habits [7,8]. Among anticancer active compounds in soybeans, genistein, is the most important agent that has been extensively investigated for its chemopreventive and anticancer activities [9]. The aim of this review is to give detailed outlines about the genistein and its bioavailability and to focus on its applications in the field of anti-cancer *via* antioxidant mechanism as well as antibrowning agent's in modern food industries and research.

2. Isoflavone structure

Isoflavones are generally consisting of two benzyl rings joined by a three-carbon bridge, which may or may not be closed in a pyran ring. They are known as flavonoids, which are the largest and found in wide range of plant phenolics [10,11]. The soybean contains the highest amount of isoflavones, up to 3 mg/g dry weight [10,12]. The isoflavones have basically three types, with each type being present in four chemical forms. Isoflavones in soybean are mainly found as aglycones (genistein, daidzein, glycitein) (Fig. 1), β-glucosides (daidzin, genistin, glycitin), malonyl-β-glucosides (6′×-O-malonyldaidzin, 6′′-O-malonylgenistin, 6′′-O-malonylglycitin) and acetyl-β-glucosides (6′′-O-acetyldaidzin, 6′′-O-acetylgenistin, 6′′-O-acetylglycitin) [13]. Aglycones are flavonoid molecules without any attached sugars or other derivatives. Aglycones are especially important among other isoflavone because they are readily bioavailable to humans [13]. β-glucosides may also carry additional small molecular modifiers, such as malonyl and acetyl groups. Sugar-linked flavonoids are called glucosides due to their glucose linkage to flavonoids.

3. Why genistein?

Researches revealed that soy isoflavones and their glycosides were associated with a lower of cardiovascular disease [14], hormone-dependent breast and prostate cancers [15], colon cancer [16], menopausal symptoms [17], osteoporosis [18], atherosclerosis [19] and also improved the arterial elasticity in menopausal women similarly to hormone replacement [20]. Epidemiologic studies showed that Asian women had fewer symptoms of menopausal syndrome than non-Asian women due to higher consumption of soy and soy products [21,22]. Genistein also proposed as a treatment for osteoporosis for postmenopausal women and elderly men [23]. In 1999, the US Food and Drug Administration approved a health claim for the cholesterol-

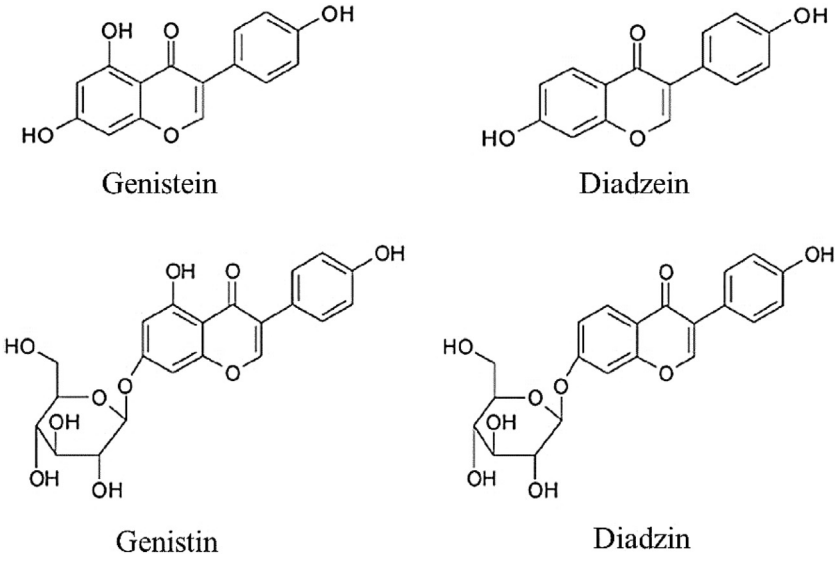

Fig. 1. Chemical structure of genistein, diadzein, genistin and diadzin.