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Changing soybean isoflavone composition and concentrations under two different storage conditions over three years

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Abstract

Soybean in Asia have been consumed in various forms, including soymilk, tofu and fermented products such as miso, temph and sufu. It is popularly regarded as a healthy food, partly owing to the isoflavones contained in their seeds. The objective of this study was to evaluate the variation of isoflavone concentration in soybean (*Glycine max* (L.) Merrill) seeds under different storage conditions for long storage periods. Isoflavone concentrations varied from 699.7 to 2581.6 μg g^{-1} with cropping year, and acetylglucoside groups and glycitein were only detected in small amounts or traces in the eight soybean cultivars. The Daweon cultivar showed a variation between storage at room (−2039.0 μg g^{-1}) and low temperature (−1822.0 μg g^{-1}) over three years, while the isoflavone concentration in the Hannam cultivar only varied slightly (room temperature: −91.6 μg g^{-1}, low temperature: −81.2 μg g^{-1}). With storage at room temperature, the acetylglucoside group (+7.2 μg g^{-1}) slightly increased the isoflavone concentration, while the other three groups decreased it. In particular, the malonylglucoside group (−519.0 μg g^{-1}) showed a severe decrease. In the Myeongjunamul cultivar, genistin (+105.0 μg g^{-1}) resulted in the highest increase, while malonylgenistin (−958.7 μg g^{-1}) resulted in the greatest decrease in the Daweon cultivar. With storage at low temperature, other than malonylglucoside (−438.1 g g^{-1}), the other three groups, aglycon (+11.4 μg g^{-1}), glucoside (+45.2 μg g^{-1}) and acetylglucoside (+12.8 μg g^{-1}), increased the isoflavone concentration. Genistin (+136.0 μg g^{-1}) in the Muhan cultivar showed the highest increase, and malonylgenistin (−833.4 μg g^{-1}) in the Daweon cultivar showed the greatest decrease for storage under low temperature for three years. The variation of isoflavone concentration was positively correlated with the two different storage conditions ($r^2 = 0.33$), and total isoflavones were correlated with the concentration of the malonylglucoside ($r^2 = 0.88$***) and glucoside ($r^2 = 0.80$***) groups. Our study suggests that it may be feasible to improve the preservation method of soybean isoflavones as high functional substances for longer storage periods.

Keywords: Soybeans; Isoflavone; Low temperature; Room temperature; Storage period; HPLC

1. Introduction

The soybean (*Glycine max* (L.) Merrill) originates from north-eastern Asian regions such as China and Korea, where it has long been cultivated as a summer crop. In Korea, about 140,000 tons were produced in NAQS (2003). In Asian countries, where soybean consumption is high, the average intake of isoflavones is 40–80 mg per day (Adlercreutz et al., 1995). Isoflavones are mainly found in the flavonoid form in soybean seeds and are known for their many chemical actions, such as their antioxidative properties, and their uses as anticancer agents. They are classified into four groups: aglycons, glucosides, malonylglucosides and acetylglucosides.

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Soybean isoflavones provide potentially beneficial effects for several of the most common diseases afflicting human beings, including cancer (Holt, 1997). Recently, studies have provided increasing evidence that soybeans might have cancer-preventative properties. In many studies, isoflavones have been shown to have potential benefits for reducing the risk of various cancers (Graber, June, Samuelson, & Weiss, 1992; McCabe & Orrenius, 1993; Messina, Persky, Setchell, & Barnes, 1994; Mousavi & Adlercreutz, 1993), other pharmaceutical roles (Keung & Vallee, 1993; Sargeant, Farnadale, & Sage, 1993), anticarcinogenic properties by acting as antiestrogens (Adlercreutz et al., 1986), antioxidant properties (Chung, Kim, Ahn, Chi, & Lee, 2000; Lee, Chung et al., 2002), activity as tyrosine protein kinase inhibitors (Akiyama et al., 1987) and aromatase inhibitors (Adlercreutz et al., 1993), estrogenic properties (Miksicek, 1993) and antifungal properties (Weidenborner, Hindorf, Jha, Tsotsonos, & Egge, 1990). Among the 12 individual isoflavones, genistein and daidzein were especially reported to inhibit the growth of human breast cancer (Peterson & Barnes, 1991) and prostate cancer cell lines in culture (Peterson & Barnes, 1993), but by mechanisms independent of inhibition of the binding of steroids to their receptors (Lori, Barnes, Kenneth, & Barnes, 1993). This health claim places soybean products into a select category of functional foods that possess unique medicinal as well as nutritional values.

The acetylglucoside series was detected at greater concentrations in the hypocotyls of soybeans than in the cotyledons (Wang & Murphy, 1993). Tsukamoto et al. (1995) noted that about 80–90% of total seed isoflavones were located in the cotyledons. The remainder was in the hypocotyls, where the concentration of isoflavones was higher on a weight basis than in the cotyledons. Isoflavone concentrations are affected by the environment, the genotype and interaction between these factors. The environment had a greater effect than the genotype (Hoeck, Fever, Murphy, & Grace, 2000; Lee, Chung et al., 2003; Lee, Yen, Ahn, & Chung, 2003; Wang & Murphy, 1994). Eldridge and Kwolek (1983) reported that the total isoflavone concentration varied from 1160 to 3090 $\mu g\ g^{-1}$ among four soybean cultivars grown in the same environment, and from 460 to 1950 $\mu g\ g^{-1}$ across four locations. Wang and Murphy (1994) found that the total isoflavone concentration of a single cultivar ranged from 1176 to 3309 $\mu g\ g^{-1}$ among years and from 1176 to 1749 $\mu g\ g^{-1}$ among locations within the same year. Conversely, Yang and Chung (2001) only reported isoflavone concentration of 6.5–25.2 $mg\ g^{-1}$.

Isoflavone concentrations were increased by low temperature at maturation, and three malonylglucosides were easily converted into glucoside groups that were unstable under high heat (Kudou, Shimoyamada, Imaura, Uchida, & Okubo, 1991; Tsukamoto et al., 1995). These researchers only analyzed isoflavones of soybean seed with respect to genotype, environment and their interaction. It was also reported that the glucoside conjugates of isoflavones were converted to isoflavone aglycons during manufacturing by the effect of β-glucosidase (Toda, Sakamoto, Takayanagi, & Yokotsuka, 2001). Franke, Custer, Cerna, and Narala (1995) reported that certain processing methods such as boiling, milling and protein coagulation in tofu products did not significantly destroy daidzein or genistein, while other methods such as roasting (high heat treatment) showed a 15–21% loss of daidzein and genistein. Recently, Hou and Chang (2002) studied the transformation and conversion of soybeans isoflavones as affected by 4 storage conditions, 84% relative humidity (RH) at 30 °C for 9 months and in 57% RH at 20 °C and cold (4 °C), and an uncontrolled ambient garage for 18 months. The conversion percentage of β-glucosides and malonylglucosides in total isoflavones fluctuated from 99% to 3% in 84% relative humidity (RH), 30 °C for 9 months storage, but, in 57% RH, 20 °C and ambient conditions, the glucoside forms increased with storage time, but malonylglucosides tend to decrease. These results suggest that soybeans must be stored in the proper storage conditions to get best benefits for its constituents and to prevent inter-conversion between aglycones and glycosides of isoflavones until utilization after harvesting.

Nowadays, there are ever increasing amounts of agro-products including soybeans that are traded between countries. In Korea, most soybean imports and exports are transported by ship or aircraft, and this process can take long periods. Many scientists have studied the relation between isoflavones and cultivation environments, which include different locations and temperature, but until now, little information has been available on variations of isoflavone composition and concentrations among soybean seeds with respect to different storage conditions and storage periods.

The main purpose of this study was to investigate the variation of isoflavone concentrations in soybean seeds with other storage conditions over longer storage periods. It is hoped to provide basic information related to the utilization its value as a food stuff or additive through preserve isoflavones for longer periods.

2. Materials and methods

The eight soybean cultivars, which include Muhan, in this experiment, were cultivated at Yeojoo, where they were grown in the experimental fields of the Konkuk University in 1999 cropping year. The popular cultivars differed in maturity, height, seed weight, growing habit