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ORIGINAL ARTICLE

Molecular characterization of glucosinolates and carotenoid biosynthetic genes in Chinese cabbage (*Brassica rapa* L. ssp. *pekinensis*)

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Abstract The present study aimed to investigate the contents of glucosinolates (GSLs) and carotenoids in eleven varieties of Chinese cabbage in relation to the expression level of the important transcription factors. MS and HPLC analysis identified the presence of 13 GSLs (progoitrin, sinigrin, glucoalyssin, gluconapoleiferin, gluconapin, glucocochlearin, glucobrassicanapin, glucoerucin, 4-hydroxyglucobrassicin, glucobrassicin, 4-methoxyglucobrassicin, neoglucobrassicin and gluconasturtiin) and four carotenoids (lutein, zeaxanthin, α-carotene and β-carotene). GSL contents were varied among the different cabbage varieties. The total GSL content ranged from 2.7 to 57.88 μmol/g DW. The proportion of gluconapin (54%) and glucobrassicanapin (22%) was higher in all the varieties, respectively. Results documented the variation in total and individual carotenoid contents that have also been observed among different varieties; however, the total carotenoid contents ranged from 289.12 to 1001.41 mg kg^{-1} DW (mean 467.66). Interestingly, the proportion of lutein (66.5) and β-carotene (25.9) were higher than α-carotene (5.1) and zeaxanthin (2.5%). Consequently, the expression level of the regulatory gene, MYB28 was higher in 'K0648' and was directly proportional to GSL content. Similarly, the expression levels of 1-PSY were higher in

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'K0112'; however, the expression levels of 2-ZDS, 3-LCYB, 4-LCYE, 5-CHXB and 7-NCED genes showed no significant difference. In addition, the correlation between GSL and carotenoid contents and gene expression level showed moderate significant difference in each Chinese cabbage.

1. Introduction

The vegetables that belonged to the *Brassicaceae* family are economically important in the Korean vegetable market. Many commonly consumed vegetables such as broccoli, cabbage, cauliflower, Chinese cabbage, turnip, common radish and horseradish belonged to the *Brassicaceae* family. Among them, Chinese cabbage (*Brassica rapa* L. ssp. *pekinensis*) is one of the most important *Brassica* vegetables because of its regular consumption rate in Korea (Cartea et al., 2011; Cho et al., 1999). Several classes of secondary metabolites such as carotenoids, flavonoids, glucosinolates (GSLs), and other phytochemicals have been identified and quantified from the Chinese cabbage. Their compositions and contents depended on the cultivation conditions (Reif et al., 2013; Lee et al., 2015). The phytochemicals, especially GSLs and other functional compounds exhibit potential medical applications such as antidiabetic and anti-cancer agents; therefore, the interest toward this vegetable is increasing worldwide.

Plant pigments such as anthocyanins and carotenoids widely involved the metabolic and physiological regulation of plant metabolism (Park et al., 2012). Similarly, these pigment compounds play an important role in defensive mechanisms apart from the essential nutrients. Among the pigments, α- and β-carotene are the main backbone and intermediary metabolites for the synthesis of vitamin A. Vitamin A protects the human body from xerophthalmia, blindness, and premature death. Moreover, lutein and zeaxanthin have recently been recognized to be beneficial for eye health to the prevention of age-related macular degeneration (Krishnadev et al., 2010).

In *Brassica* vegetable, GSL biosynthesis is regulated by various responses. In the case of biotic and abiotic stress responses, R2R3-MYB transcription factors (TFs) are maintained the GSL biosynthesis. MYB TFs can be divided into 2 groups: MYB28, MYB76, and MYB29 control the biosynthesis of high aliphatic GSLs, while MYB51, MYB122, and MYB34, alternatively called high indolyl GSLs, can be manipulated to coordinately control the suite of enzymes that synthesize indolyl GSLs (Fig. 1) (Kim et al., 2014). Recently, Kim et al. (2013) reported GSL contents and transcription factors in different organs of Chinese cabbage. Additionally, Tuan et al. (2012) reported the carotenoid accumulation and expression of carotenogenesis gene development in Chinese cabbage (Fig. 2). However, gene expression and accumulation of GSLs and carotenoids in different varieties of Chinese cabbage have not been reported. Therefore, the objectives of this study were to quantify the gene expression and levels of GSLs and carotenoids and to discuss the correlation between them in 11 varieties of Chinese cabbage.

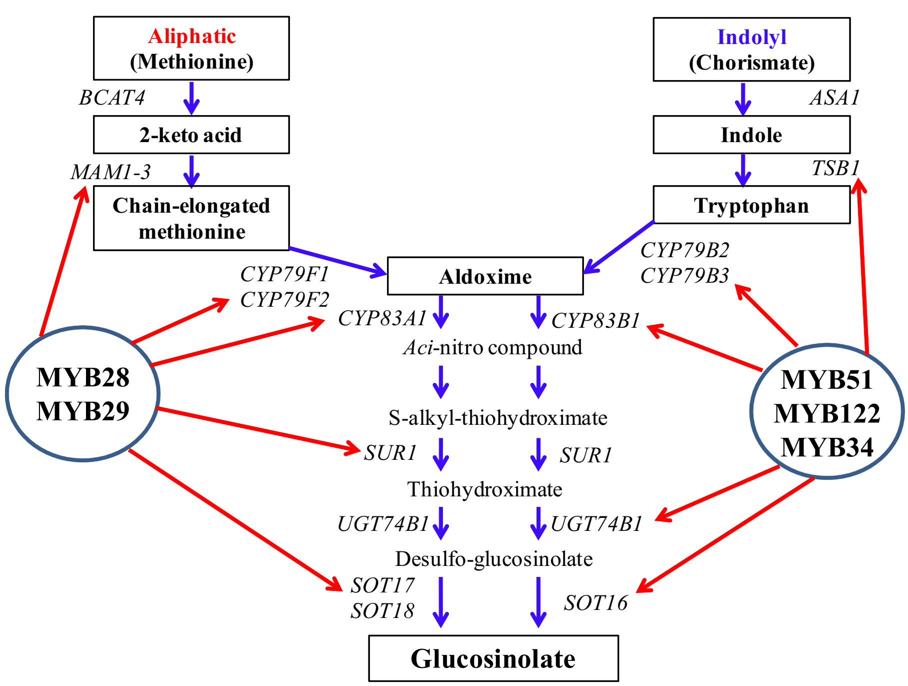

Figure 1 Schematic representation of glucosinolate biosynthesis (Yatusevich et al., 2010). In this study MYB28, 29, 34, 122 were used.

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