Anthocyanin

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Anthocyanin is a natural soluble pigment in the flavonoid group. Approximately 635 or more structures have been found in nature and more than 30 types of anthocyanins and anthocyanidins have been identified based on the number and position of the hydroxyl group. The common aglycones are pelargonidin (Pg), cyanidin (Cy), peonidin (Pn), delphinidin (Dp), petunidin (Pt), and malvidin (Mv), but Cy-3-glucoside was widely distributed. Anthocyanins are mostly absorbed through the gastric wall with absorption rates of 10–22%, depending on chemical structure, and the bioavailability is approximately 0.26–1.8%. Anthocyanins produce antimicrobial, antioxidant, and anti-inflammatory effects and play a role in the prevention and treatment of numerous chronic conditions, such as obesity, diabetes mellitus (DM), cardiovascular disease (CVD), eye diseases, and in suppressing cancer cell growth.

Keywords: anthocyanins ; RCT ; systematic review ; meta-analysis ; obesity criteria ; inflammatory biomarkers

1. Introduction

The prevalence of obesity among adult South Koreans in 2018 was 35.7% [1]. With the development of several anti-obesity foods, different attempts have been made to verify the antioxidant, insulin-sensitivity, and anti-inflammatory effects of anthocyanins [2][3][4]. However, there is a considerable lack of research on obesity effects [5][6]. Although the effect on antioxidation, reduction of lipids, and CVD biomarkers could be found, the body composition of obesity biomarkers (body weight (BW), body mass index (BMI), and waist circumference (WC)) might not change. [4][7][8][9] However, in many reports, juçara berry juice (131.2 mg/day for 6 weeks) had reduced the risk of metabolic diseases, and dried purple carrots (118.5 mg/day for 4 weeks) reduced lipids, body composition, and inflammation in obese adults [10][11]. We also found that anthocyanins (31.45 mg/day for 8 weeks) had an effect on overweight/obese adults (n = 63) [3]. After 8 weeks, a black bean test group, compared to a placebo group, showed reduced arteriosclerosis indicators (total cholesterol/high-density lipoprotein cholesterol (TC/HDLc), and low-density lipoprotein cholesterol/HDLc (LDLc/HDLc)), as well as significantly lowered BW, BMI, and WC. Although we determined the positive effects of anthocyanins concerning body composition, lipid profile, and inflammation, the effects depended on the types of anthocyanin, period of use, and subject.

2. Effects of Anthocyanin Supplementation on Reduction of Obesity Criteria

The previous SR-MAs for anthocyanins reported on dyslipidemia [12], vascular inflammation [13], lipid composition and inflammation [14], heart disease [15], hypertension [16][17][18], DM [19], and antioxidation [20]. Thus far, only a few have been conducted on obesity-related studies for the anti-obesity effect of a flavanol complex [20] and the weight-reducing effect of resveratrol (400–800 mg/day, 1–24 weeks) [21]. In this SR-MA, we excluded the anthocyanin complex or other variants for the anti-obesity effects of anthocyanin. A notable advantage of the SR-MA is that the risk of error is reduced, which increases the reliability as the overall sample size is increased by compiling different small-scale studies. The anti-obesity effects of various anthocyanins reviewed in this analysis are thus expected to contribute to the generalization.

When the total subjects in 11 RCTs (*n* = 833) were categorized into healthy individuals (five RCTs, non-OB; BMI < 25) and obese individuals (four RCTs, OB; BMI ≥ 25), the BMI of healthy individuals was significantly reduced compared to that of the OB group. In the SR-MA anti-obesity effect of flavonols (58 studies), the BMI was reduced by 0.28 kg/m^2 in the flavanol-intake group, and it was reduced in group with BMI ≥ 25 more than the control [20]. Our study found that anthocyanins had a stronger effect in healthy individuals compared to those who were obese. The risk factors of diseases might not have affected the results because CVD, hyperlipidemia, or DM patients were included in both the non-OB and OB groups. In other RCT studies, the anthocyanin supplementation in chokeberry juice (28.5 mg/day) [22], blueberries (375 mg/day) [2], and *Vaccinium* extract (180 mg/day) [23] for 4–6 weeks had protective effects on oxidative stress, dyslipidemia, and inflammatory obesity in CVD patients. The refined anthocyanin intake of blueberry (320 mg/day) for 24 weeks reduced dyslipidemia and insulin resistance in DM patients (n = 58) [24]. These findings indicated that anthocyanin

supplementation had a beneficial effect in patients with OB, CVD, and DM. Thus, the substantial BMI reduction in the non-OB group after supplementation suggests that anthocyanins can prevent obesity.

In this SR-MA, BMI was significantly reduced in the low-dose group (seven RCTs; ≤ 300 mg/day) and short-dose period (seven RCTs; 4–8 weeks) compared to the group with high-intake (two RCTs for 300 and 500 mg/day) or longer duration (two RCTs for 12 and 24 weeks). It was hard to draw a conclusion when only two studies had doses higher that 300 mg/day and ran longer than 12 weeks. The ethnic difference according to anthocyanin supplementation was such that the BMI was reduced in individuals from the Middle East, but since only a single RCT was assessed, the finding remains inconclusive. The effect on WC was not significant in this study, which was consistent with the results of other studies [25]. The BW also increased in the non-OB group (four RCTs; BMI < 25) that had a dose of ≥300 mg/day within 4 weeks compared to the control. A significant increase in BW was observed among Europeans, whereas the BW among Koreans decreased, but as only a single RCT was assessed, a definite conclusion could not be made.

As collectively suggested by this SR-MA, a positive effect on BMI and BW reduction was anticipated for anthocyanin supplementation of ≥300 mg/day for 4 weeks, so further studies should be conducted regarding the dosage response. It was extremely difficult to estimate the daily intake or recommended level of anthocyanins due to large differences across different countries (Korea, 3.3–95.5 mg/day; U.S., 12.5 mg/day; and Europe, 30 mg/day) and individual dietary patterns [26][27][19]. Considering the mean absorption rate of 10–20%, approximately 30 mg/day upon the intake of 300 mg/day might be assumed to have a positive effect on human metabolism. Moreover, when we applied the results of anthocyanin RCTs to those who wanted to reduce BMI, we recommended minimum levels over shorter periods to reduce any risk of obesity.

3. Conclusions

We found that the anthocyanin supplementation of 300 mg/day or less for 4 weeks was sufficient to reduce BMI and BW compared to the results from higher-dose and longer-treatment RCTs. Considering the daily intake, types of supplementation, and absorption rate, further RCTs should be conducted regarding the dose- or period-dependency responses on various obese biomarkers, such as adipocytokines.

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