

(GC), were known to increase the expression and activity of antioxidant enzymes.^{147,148} Commonly, catechin is found in foods and edible plants, such as green tea, cacao, and red wine. Interestingly, the levels of catechins and epicatechins are 15 times higher than that of resveratrol in red wine; green and black teas are known to be rich in catechin.

The supplementation of green or black tea extract was reported to extend the lifespan of flies.^{149,150} Similarly, Kitani *et al.* reported that green tea water extract, at a concentration of 80 mg l⁻¹, extended the lifespan of C57L/6JNIA male mice by 6.4% without any changes to body weight.¹⁵¹ Li *et al.* showed that 10 mg ml⁻¹ catechins extracted from green tea extended the lifespan of Oregon-R wild type *D. melanogaster* by 15.7% and increased resistance to oxidative stress.¹⁵² They also showed that green tea catechin increased the activity of SOD1, SOD2, and catalase in *D. melanogaster*, and did not extend the lifespan of SOD mutant flies, indicating that the longevity effect of catechin is mediated by the activation of antioxidant enzymes.¹⁵² The longevity benefit of catechin was also investigated in *C. elegans*. Supplementation of 200 μM catechin increased the survival of N2 wild type worms, independent of internal bacterial growth, but dependent on akt2, daf2, and mev1.¹⁵³ In addition, EGCG—a main active ingredient of green tea—extended the lifespan of worker honeybees (*Apis mellifera scutellata*)¹⁵⁴ and healthy Wistar rats.¹⁵⁵ Catechin also showed a longevity benefit in animals with a high-fat diet. Supplementation of 10 mg ml⁻¹ green tea catechin extended the mean lifespan of flies fed with 10% lard fatty acid.¹⁵⁶ Moreover, supplementation of 0.25% epicatechins in drinking water for 15 weeks to obese diabetic mice (db/db) significantly reduced the mortality rate from 50% to 8.3%.¹⁵⁷ However, not all studies were able to show a lifespan-extending effect from catechin. In particular, Zhang *et al.* showed that EGCG improved the survival time under stressed conditions, and they were unable to show any influence of lifespan-extending effect on *C. elegans* under normal conditions.¹⁴⁷

13.3.4 Others

Other phytochemicals have been actively investigated for their anti-aging properties, including vitamins, lipoic acid, carotenoids, anthocyanins, saponin, and morphine.

Alpha-tocopherol, also known as vitamin E, is a well-known potent antioxidant. The lifespan-extending effect of α -tocopherol has been demonstrated in rotifer, *S. cerevisiae*, worms, flies, and rodents. The optimal concentration for the longevity effect of α -tocopherol is different in each species. For example, in single-cell organisms, such as rotifer and yeast, the longevity effect of α -tocopherol was shown in the concentration range of 0.05–10 000 μg ml⁻¹, and 80–200 μg ml⁻¹ in *C. elegans*, 5–10 μg ml⁻¹ in *D. melanogaster*, and 250–5000 μg g⁻¹ in rodents.¹⁵⁸ However, not all reports confirmed the longevity benefits of α -tocopherol. In 2003, supplementation of 20 μg ml⁻¹ α -tocopherol was reported to extend the lifespan of Canton-S wild type *D. melanogaster* by 16%.¹⁵⁹ However, Zou *et al.* failed to show the longevity