

indicating that quality improvement in berry crops can align sensory and functional quality under suitable nutrition (Duan et al., 2023). Therefore, for *R. chingii*, moderate water control and balanced fertilizer management, especially schemes that avoid excessive nitrogen and integrate organic and inorganic nutrient sources, are likely to favor the coordinated accumulation of medicinal actives and support higher-value production for both food and medicinal uses (Wu et al., 2024).

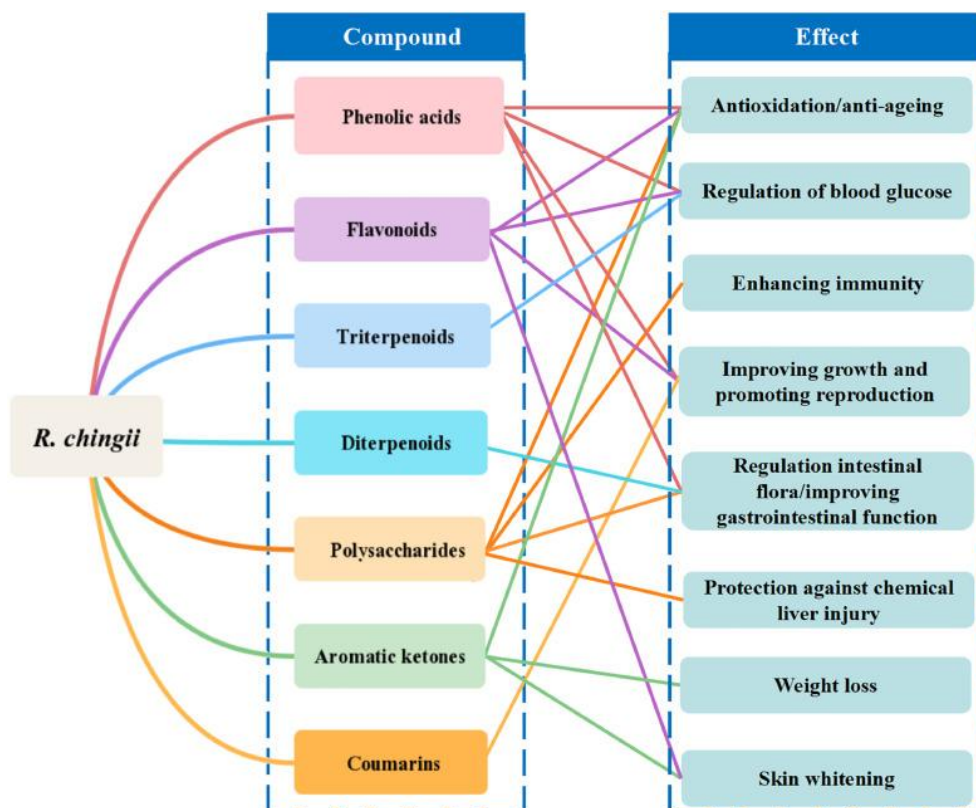


Figure 2 Correlation diagram of chemical components and efficacy of Rubi fructus (Adopted from Wu et al., 2024)

5 Mechanisms of Water-Fertilizer Regulation in *Rubus chingii*

5.1 Regulatory effects of water and fertilizer conditions on photosynthesis and carbon assimilation

Water and fertilizer conditions regulate yield and quality formation first by controlling leaf photosynthesis, stomatal behavior, canopy carbon gain, and the subsequent distribution of assimilates among vegetative organs and fruits. In fruit-tree models, carbon assimilation is explicitly linked to leaf area, canopy radiation interception, and organ growth demand, while carbohydrate allocation depends on source supply, sink demand, and root-shoot functional balance (Rahmati et al., 2018). Under water deficit, peach vegetative growth declines first through a direct reduction in sink strength and then through an indirect reduction in photosynthesis, showing that drought limits both carbon acquisition and the capacity of shoots to use assimilates (Rahmati et al., 2018). In bell pepper, elevated CO₂ increased biomass under mild and moderate water stress by boosting leaf photosynthesis, increasing stomatal number and openness, and improving leaf-level water-use efficiency, but this benefit weakened as soil water deficit became severe (Fan et al., 2020). These results indicate that carbon assimilation in *R. chingii* should depend on maintaining a water supply sufficient to preserve stomatal conductance, photosynthetic capacity, and active vegetative sinks, while avoiding excessive vegetative consumption that competes with fruit growth.

Fertilizer supply modifies this process by affecting photosynthetic enzymes, sugar metabolism, and the partitioning of photoassimilates to reproductive organs. In cotton, drought sharply reduced net photosynthesis, stomatal conductance, intercellular CO₂, and Rubisco activity when potassium was absent, whereas potassium application alleviated these declines and improved biomass accumulation and assimilate partitioning. Potassium also maintained higher leaf sucrose under drought by regulating sucrose phosphate synthase, sucrose synthase, and acid invertase activities, indicating that nutrient supply affects not only carbon fixation but also carbon