

and 3,5-O-dicaffeoylquinic acid peaked at the Taiju stage rather than the latest stage. In Fubaiju, literature summarized within the grading study noted that chlorogenic acid and 3,5-O-DCQA were higher at initial bloom than at full bloom, while luteolin-7-O-glucoside varied little across the Hangbaiju flowering period (Yang et al., 2025). Even so, full bloom can remain commercially acceptable because flower heads are morphologically complete and easier to standardize, and moderate environmental conditions can concentrate harvest timing and improve flower yield near marketable stages (Liu et al., 2025). Therefore, full-flowering harvest is suitable when a balance is needed between visual maturity, operational convenience, and acceptable internal quality, but it usually does not maximize the full spectrum of active ingredients.

3.3 Effects of harvesting at the late flowering stage on the quality of Hangbaiju

Harvesting Hangbaiju at the late flowering stage generally reduces core bioactive quality, especially for flavonoids, chlorogenic acid derivatives, and some antioxidant-related markers. In Hangbaiju metabolomic analysis, flavones and caffeoylquinic acids accumulated at higher levels in S1 and S2 and then gradually declined from S3 to S5, with S5 corresponding to the stage when the outer whorl of ray florets began to decay (Figure 1) (Lu et al., 2024). The broader chrysanthemum developmental study under UV-B likewise showed that flavonoid and chlorogenic acid contents were highest at the bud stage rather than later stages, while soluble sugar, amino acid, and vitamin C increased as flowers developed, demonstrating that late harvest shifts quality away from medicinal phenolics toward some nutritional traits (Ma et al., 2016). In *Chrysanthemum indicum*, eventual-stage samples differed clearly from initial and full-bloom samples, and most varying constituents were lower at the eventual stage than at initial or full bloom (Yang et al., 2024).

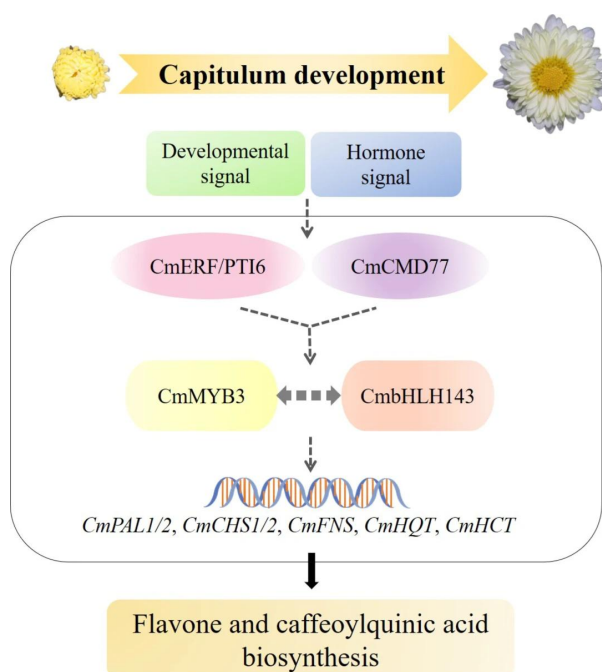


Figure 1 Mechanisms of flavone and CQA accumulation during the development of chrysanthemum capitulum (Adopted from Lu et al., 2024)

Image caption: The dotted lines represent the predicted interaction relationship or hypothetical regulatory network (Adopted from Lu et al., 2024)

Late harvest may still increase flower yield and opening degree, but these gains tend to come with weaker medicinal and sensory advantages. The Hangbaiju stage-comparison study found that yield increased obviously as collection time was deferred, yet overall evaluation still identified the Taiju stage as the best harvest time when functional constituents, yield, and timing were considered together. Comparison of commercial Hangbaiju types also showed that the later-harvested Duoju, collected when both ray and tubular florets were fully opened, had lower caffeoylquinic acids and weaker antioxidant activities than the earlier-harvested Taiju (Gong et al., 2019). Because harvest time also affects inflorescence diameter, and larger-diameter samples are associated with lower