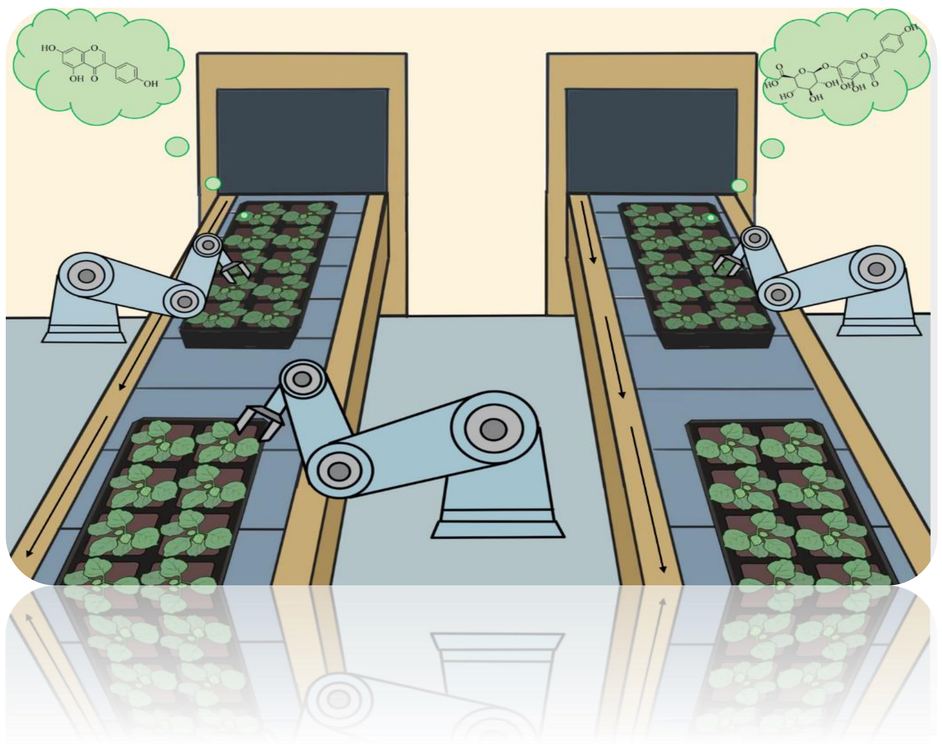
上海交通大學
SHANGHAI JIAO TONG UNIVERSITY

Engineering the expression of plant secondary metabolites-genistein and scutellarin through an efficient transient production platform in Nicotiana benthamiana L.

Author: Xinghao Yao *Corresponding author: Kexuan Tang*

GRAPHIC for TOC



Introduction

Plant natural products (PNPs) are active substances indispensable to human health with a wide range of medical and commercial applications. However, excessive population growth, overexploitation of natural resources, and expensive total chemical synthesis have led to recurrent supply shortages. Despite the fact that the microbial production platform solved these challenges, the platform still has drawbacks such as environmental pollution, high costs, and non-green production. In this study, an efficient platform for the production of PNPs based on the transient expression system of *Nicotiana benthamiana* L. combined with synthetic biology strategies was developed. Subsequently, the feasibility of the platform was verified by a simple "test unit." This platform was used to synthesize two high-value PNPs: genistein (5.51 nmol g^{-1} FW) and scutellarin (11.35 nmol g^{-1} FW). Importantly, this is the first report on the synthesis of scutellarin in heterologous plants. The platform presented here will possibly be adopted for the heterologous production of genistein and scutellarin in tobacco plants as a novel and sustainable production strategy.

Results

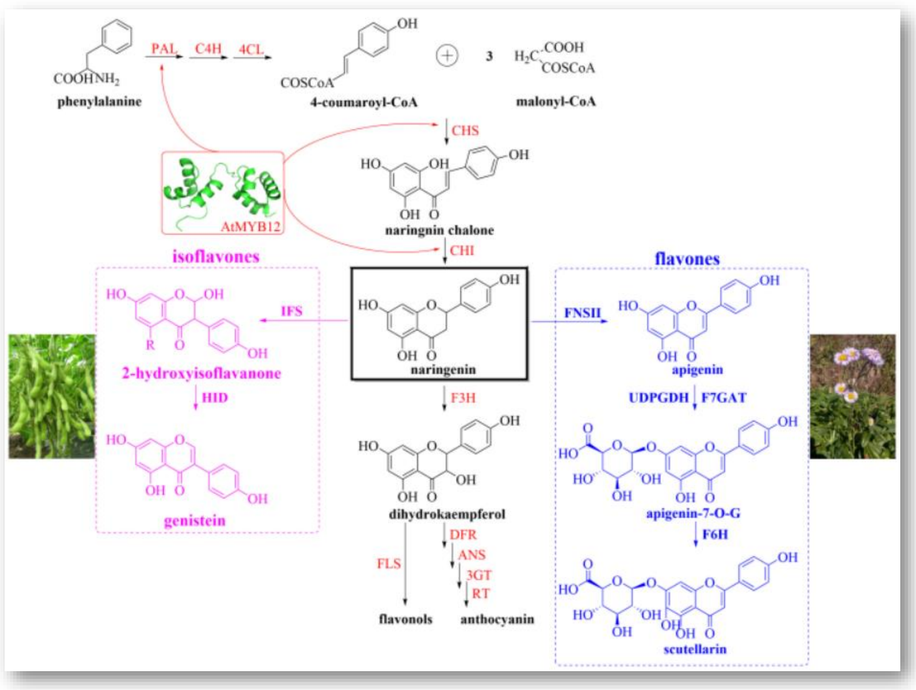


Fig. 1 Schematic overview of the genistein and scutellarin biosynthetic pathways in *N. benthamiana.*

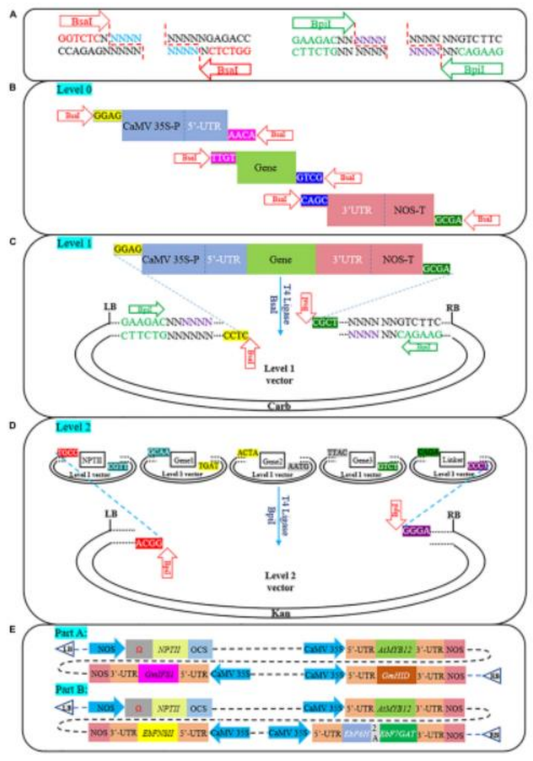


Fig. 2 A schematic illustrating the assembly of multigene constructs based on the GGC.

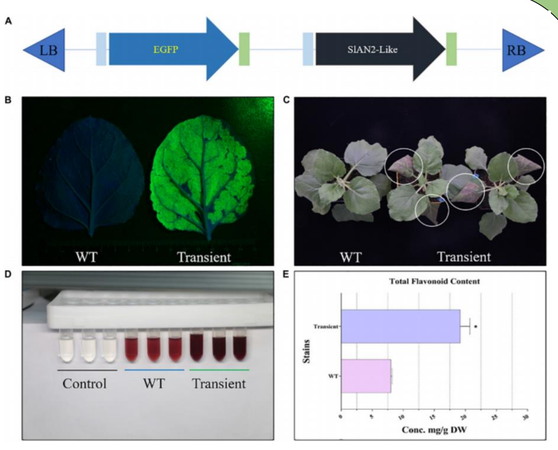


Fig. 3 Pre-test of the novel E-platform.

Highlights

- A novel plant transient production platform was developed based on synthetic biology.
- *N. benthamiana* leaves were engineered to accumulate two high-value PNPs.
- This is the first report on heterologous biosynthesis of scutellarin in plants.

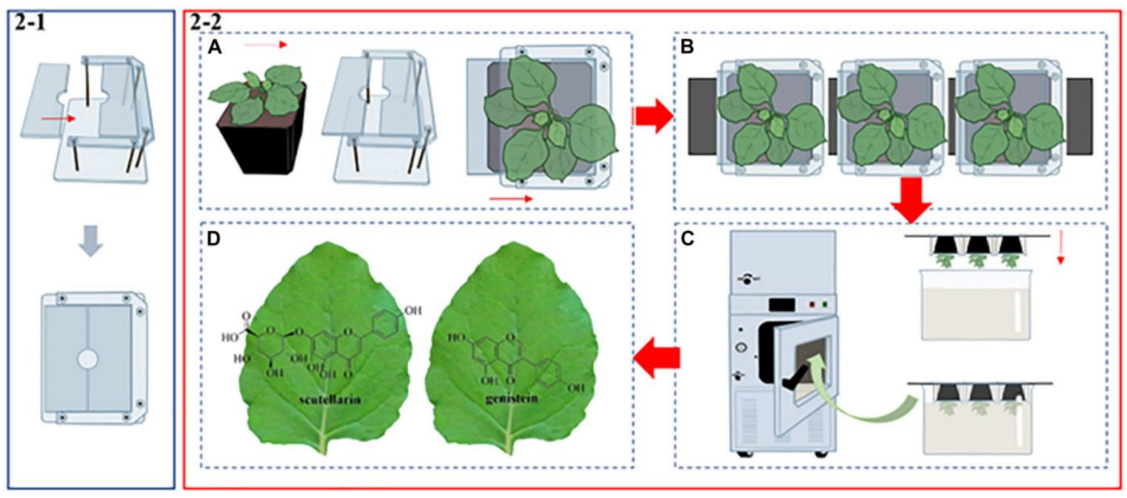


Fig. 4 A schematic diagram of the novel E-platform.

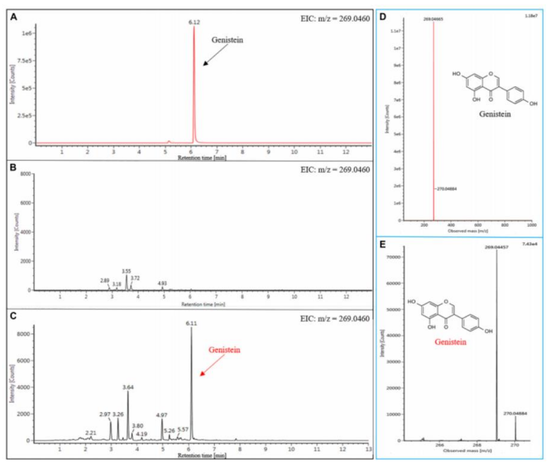


Fig. 5 UPLC-MS analysis of genistein in the leaf extracts from infiltrated *N. benthamiana.*

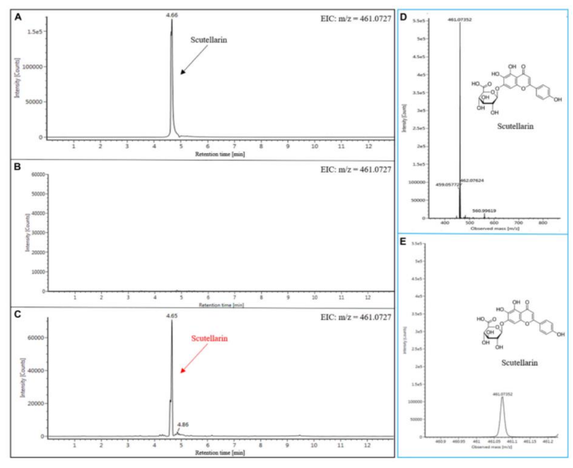


Fig. 6 Heterologous production of scutellarin in *N. benthamiana* tissues.

Conclusion

In this study, genistein and scutellarin were produced rapidly and efficiently using the E-platform. Unlike microbial production systems, this novel E-platform requires only sunlight, H_2O, and CO_2 to produce the desired products without additional nutrient feeding. Uniquely, this is the first report on the synthesis of scutellarin in a heterologous plant. This work not only demonstrates the power and potential of this novel E-platform, but also provides a reference for the large-scale industrial production of high-value PNPs.

Acknowledgement

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