активність гемоглобіну зменшувалася на 15,14±1,24%. Слід зазначити, що додавання до робочого розчину гліцерину призводить до кращого збереження загальної антирадикальної активності гемоглобіну, після охолодженні мікроносіїв до –196±1 °С. Так, додавання 70% гліцерину до робочого розчину дозволяло отримати рівень збереженості антирадикальної активності гемоглобіну після низькотемпературного впливу на 20 % кращий, у порівнянні з мікроносіями без додавання гліцерину.

Висновки. Інкапсулювання гемоглобіну у композитні мікроносії дозволяє зберегти його загальну антирадикальну активність після дії низьких температур (охолодження до –196±1°С зі швидкістю 100 град/хв). Найбільш ефективними виявилися композитні мікроносії з додаванням гліцерину. Існує пряма залежність між концентрацією гліцерину у робочому розчині і відсотком збереження загальної антирадикальної активності інкапсульованого білка після впливу факторів пов’язаних з дією низьких температур.

INFLUENCE OF ENDORHIZOSPHERIC MICROBIOTA ON METABOLISM IN MEDICINAL PLANTS

Kravchenko V. M., Seniuk I.V., Riyad Qamouta, Harrouch Hamza
National University of Pharmacy, Kharkiv, Ukraine
biochem@nupn.edu.ua

Introduction. Many plant roots are involved in the pharmaceutical and food industries due to their abundances of secondary metabolites with high pharmacological activities, such as ginseng and licorice. Considering that the over-excavation of wild resources is causing habitat destruction and biodiversity wreck, people have started the domestic cultivation of medicinal plants to meet the increasing demand for their roots. However, the annual yield of medicinal products originated from the roots of the cultivated species are generally limited, because medicinal plants are often difficult to breed and their roots’ quality is relatively low compared with the wild resources in general. Besides with the plant genotypes, climatic characteristics, soil physiochemical properties, and growth years, soil microbiomes are expected to be significantly associated with the abundances of the bioactive ingredients in roots. Soil microbes are known to be actively recruited via root exudates and grow on plant-derived metabolites at the endorhizosphere. In return, some endorhizospheric microbes, namely endophytes, could improve their hosts’ growth, pathogen resistance, and abiotic stress tolerance during their symbiosis, while some of them could stimulate the in planta signal transduction-induced secondary metabolism of their host plants for the production of pharmaceutically important compounds. Compared with the endophyte-free Withania somnifera, the ones inoculated with some endophytic individuals, being isolated from the leaves, roots, and seeds of *W. somnifera* and being unable to produce withanolides alone, had significantly higher contents of the pharmaceutically active steroidal lactones 12-deoxy withstramonolide and withanolide A in roots after a 3-month cultivation, which was probably due to the endophyte-associated increasing of in planta indole 3-acetic acid (IAA).

Glycyrrhiza uralensis Fisch, which is a salt- and drought-tolerant legume, is natively grown or artificially planted in arid to semi-arid sandy soil in and around central Asia. Its roots are rich in pharmaceutically active flavonoids, some of which are unique to licorice. For example, ILQ, a member of chalcone glycosides, is practically applied on various disease preventions and treatments due to its antidepressant, anticancer, antioxidative, and anti-inflammatory activities. The flavonoid contents in licorice are significantly influenced by the environmental factors. Meanwhile, the endophyte-free G. uralensis roots were found to have significantly lower contents of bioactive components than the normal ones after a 3-month pot cultivation, suggesting that endophytic microbiota could regulate the accumulation of secondary metabolites in licorice roots. Interestingly, the endophytic microbiota compositions were also significantly influenced by the environmental factors, as well as the content of total flavonoids in licorice roots.

The aim of the study. Based on the analysis of literature data to study the influence of endorizosphere microbiota on the metabolism of medicinal plants.

Materials and Methods. Various electronic databases such as Science Direct, PubMed, Wiley, along with Google Scholar search engine were used for the literature survey.

Results and Discussion. Bioinformatic analysis of the 42 *G. uralensis* root-associated flavonoid profiles and their responding edaphic factors and endophytic bacterial communities suggested that soil moisture and soil temperature were key abiotic factors to influence the root-associated ILQ accumulation and the influences might be partially performed through some endophytes. The integrated effect of temperature, soil moisture, and one key endophyte R. rhizolycopersici GUH21 on *G. uralensis* root-associated flavonoid accumulation was confirmed in the pot experiment. Interestingly, the enhancement of GL production was also observed in the experimental seedlings. GL content was positively correlated with flavonoid content in the 2-yearold *G. uralensis* roots. The differential gene expression analysis of the experimental and control *G. uralensis* roots indicated that the significant improvement of secondary metabolism was due to a complicated transcriptional regulation. Considering that transcription factors (TFs) played the key roles during the plant transcriptional regulation, the TF-encoding DEGs being associated with secondary metabolism were paid much attention to. Generally, it was inferred that both the relatively high watering and the relatively low temperature should respond for the enhanced secondary metabolite backbone production through their hierarchical transcription activation of the flavonoid biosynthetic genes and the redox regulation genes, while both *R. rhizolycopersici* GUH21 and the relatively high-level watering might respond for the recharge of UDP-glucose, which could be added on the secondary metabolite backbones to synthesize in planta bioactive glycosides, through their indirect inhibition of the secondary cell wall polysaccharide production and the lateral root formation in *G. uralensis* root cells.

Plant growth-promoting rhizobacterium (PGPR) Pseudomonas simiae WCS417 could promote the production of scopolin, a plant-derived coumarin, and the excretion of scopoletin, the aglycone form of scopolin, in roots of the model plant Arabidopsis thaliana by triggering the expression of root-specific TF MYB72 and the MYB72-regulated β-glucosidase BGLU42. In turn, the scopoletin exudation was found to inhibit the growth of soil-borne fungal pathogens and preserved *P. simiae* in the rhizosphere of *A. thaliana*. These results indicated that *P. simiae* and the secondary metabolism of A. thaliana had virtuous interactions between each other. Analogously, the influences between *R. rhizolycopersici* GUH21 and the *G. uralensis* secondary metabolism were expected to be bi-directional. Accordingly, some flavonoids secreted from legume roots, such as 7,4′-dihydroxyflavone, 2′-O-methylisoliquiritigenin, naringenin and genistein, could recruit soil-borne rhizobia into the plant nodules for the nitrogen fixation under the nitrogen-deficient conditions.

Conclusions. Therefore, it is expected that G. uralensis might use its special root flavonoid exudates to recruit the R. rhizolycopersici GUH21 inoculum for the root nodulation and then nitrogen fixation to supply more ammonium ($NH4^{+}$) for plant growth and secondary metabolism. This hypothesis would be investigated in our further study. Our finding enriches the beneficial plant-microbe interaction types and would be significant for the planting of high-quality medicinal plants in the future.