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Ginseng Adventitious Root Bioengineering: The Biology of Root Specific Secondary Metabolism

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Ginseng (*Panax ginseng* C.A. Meyer) produces as astonishing diversity of secondary phytochemicals (eg. ginsenosides, biophenols etc.) and proteins in roots with important biological functions. In the past, research on root biology has been hampered by the underground growth habit of ginseng roots and by the lack of a suitable experimental system. But, recent advance bioreactors technology in bioengineering of ginseng adventitious roots produce enhanced metabolic productivity of root cells, greatly increase the root specific secondary functional phytochemicals economics

of biotechnology processes and contributed to our understanding of this remarkable plant organ biology. Combined with genomic and proteomic data, bioreactor technology is set to transform all stages of phytochemicals discovery and development. Current challenges are to improve productivity of ginsenosides from adventitious roots and that impart the desired functionality. The engineering of improvements in these properties will depend on a deep understanding of the ginsenoside biosynthetic metabolism and of how the structure of ginsenosides relates to a functional effect when incorporated into a food matrix.