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## Editorial

# Plant Tissue Culture and Biosynthesis Provide a Fast Way to Produce Active Constituents of Traditional Chinese Medicines

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The plant kingdom has provided literally thousands of natural products with widely diverse chemical structures and a vast array of biological activities. Many of them have seen subsequent application in discovery of new drugs and the pharmaceutical industry and clinical therapeutic application. Due to their structural complexity, these compounds are generally amenable only through multistep syntheses and/or direct isolation from the living plant. Multi-step syntheses, although providing obvious challenges in development of synthetic strategies, are rarely used in any practical production of such natural products which were often required in large scale for their use as drugs. Looking back to the development of Chinese medicinal plant tissue culture in the last century in China, the tissue culture methodology and biosynthesis technology have played a very valuable role in modern Chinese medicine research.

The active constituents in traditional Chinese medicine (TCM) have been isolated from wild or cultured medicinal plants in the field for thousands of years. Since 1934, the tissue culture studies in China have kept up with the international development in the fields. Progress has been made by Chinese researchers in nearly every branches of tissue culture.

Nowadays, the application of bioengineering technology, such as plant tissue culture and biosynthesis, provides a fast alternative way to produce active constituents of TCM. Here, first of all, we congratulate to Prof. Wen-yuan Gao's research to get gratifying progress in the field of biological engineering, especially in plant tissue culture, and also congratulate to the publication of Bioengineering of TCM by Shanghai Science and Technology Publishers in 2014. Prof. Gao's work on plant tissue culture is one of the outstanding achievements in the field of research. After reading the article titled "Production of Active Compounds in Medicinal Plants: From Plant Tissue Culture to Biosynthesis" (CHM, 2017, 9(2): 115-125), I delighted to recommend this text to the readers.

In recent decades, plant cell, tissue, and organ cultures have emerged as an alternative over whole plant cultivation for the production of secondary metabolites which are used as pharmaceuticals, flavours, fragrances, colouring agents, food additives, and agrochemicals (Paek et al, 2014). Plant tissue cultures can not only produce active ingredients but also as experimental materials for studies on synthetic biology. More recently, active ingredients biosynthesis of medicinal plants are being achieved through genetic and metabolic engineering approaches.

In 1993, Phyton acquired a manufacturing plant in Ahrensburg, Germany (near Hamburg) and created the largest GMP PCF® facility in the world, with fermentors up to 75 000 L in size. Phyton is now the world's largest producer of taxane APIs, and possesses the capacity to meet over half the world's demand for Paclitaxel and Docetaxel API. In the instruction of paclitaxel injection produced by Bristol-Myers Squibb clearly stated that paclitaxel comes from the natural biosynthesis of the fermentation process. In Korea, the scale of adventitious root culture of *Panax ginseng* and *Echinacea purpure* have reached to 1–10 kL (Murthy et al, 2014a; 2014b). In 2016, the tissue cultured ginseng adventitious root, produced by Tonghua Dongbao Pharmacy, has been approved by the Chinese government as new resource food.

Professor Gao's group focused on the plant tissue culture of *Panax ginseng*, *Panax quinquefolium*, *Panax notoginseng* and *Glycyrrhiza uralensis*, producing ginsenoside, glycyrrhizic acid, polysaccharide and so on. They have optimized culture condition and realized large scale bioreactor culture, constituting 500 L bioreactor scale. The technologies of *Panax ginseng* and *Panax quinquefolium* adventitious roots have been transferred to Practical Company in Dalian where was conducting industrialized production. Besides, the contents of active compounds in tissue cultures were increased by using the elicitors screened, which is attributed to the upregulated of functional genes in biosynthesis pathway. Their work has been published in

Scientific Reports, Industrial Crops and Products, Journal of Biotechnology and so on (Wang et al, 2016; 2013; Li et al, 2016).

In recent years, more and more TCMs resources are becoming endangered and their prices are increasing quickly. Hence, the conservation and sustainable utilization of TCMs resources are becoming more and more important. Along with the rapid development of TCMs industry, the amount of wild resources could not meet the need. Besides applying the good agriculture practice (GAP) of TCMs resources, to develop the advanced biotechnology such as tissue culture and biosynthesis is another important way to provide the active constituents of TCMs. We should keep in mind that China have been using and exporting the most amounts of TCMs resources in the world.

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