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EDITORIAL

Anthocyanins—More Than Nature's Colours

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Research over the past decade has produced incontrovertible evidence for a vast array of health benefits arising from the consumption of fruits and vegetables. In an endeavor to identify the active health-promoting ingredients, many researchers have focused on the properties of the flavonoids, a large class of phenolic compounds that is abundant in such foods. Most prominent among the flavonoids are the anthocyanins—universal plant colorants responsible for the red, purple, and blue hues evident in many fruits, vegetables, cereal grains, and flowers. Represented by over 600 molecular structures as identified to date, anthocyanins are of particular interest to the food colorant industry due to their ability to impart vibrant colours to the product. Now it seems highly likely that they also enhance the health-promoting qualities of foods.

Anthocyanins were incorporated into the human diet many centuries ago. They were components of the traditional herbal medicines used by North American Indians, the Europeans, and the Chinese, and were habitually derived from dried leaves, fruits (berries), storage roots, or seeds. Anthocyanin-rich mixtures and extracts (though not purified compounds) have been used historically to treat conditions as diverse as hypertension, pyrexia, liver disorders, dysentery and diarrhoea, urinary problems including kidney stones and urinary tract infections, and the common cold. They have even been purported to yield improvements to vision and blood circulation.

Recent studies using purified anthocyanins or anthocyanin-rich extracts on in vitro experimental systems have confirmed the potential potency of these pigments. Demonstrable benefits include protection against liver injuries; significant reduction of blood pressure; improvement of eyesight; strong anti-inflammatory and antimicrobial activities; inhibition of mutations caused by mutagens from cooked food; and suppression of proliferation of human cancer cells. Along with other phenolic compounds, they are potent scavengers of free radicals, although they can also behave as pro-oxidants. Because of their diverse physiological activities, the consumption of anthocyanins may play a significant role in preventing lifestyle-related diseases such as cancer, diabetes, and cardiovascular and neurological diseases.

Many questions remain. We do not know, for example, whether these apparent health benefits stem from anthocyanins alone, or from their synergistic interactions with other phenolic compounds. Are the health-promoting qualities of anthocyanin-phenolic mixtures preserved across the various food systems? What is the fate of anthocyanin molecules after consumption? Reports on bioavailability of anthocyanins indicate that less than 1% of consumed anthocyanins is detectable in human plasma and urine. Are the health-protective qualities observed in in vitro studies also displayed in vivo? If so, what might be the mechanism of the biological activity of anthocyanins?

The Third International Workshop on Anthocyanins organized by the Cooperative Research Centre for Bioproducts and Food Science Australia in Sydney, Australia, January 27–29, 2004, provided a forum for discussing the nutritional, physiological, and therapeutical functions of anthocyanins, and the opportunities for development of novel anthocyanin-based functional foods in compliance with regulatory requirements. Through scientific presentations and dialogue among researchers, industry managers, and invited consumers, one aim of the workshop was to popularize the application of anthocyanins as natural food colorants with nutraceutical qualities. Biotechnological progress in meeting the requirements of the food colorant industry and consumers, such as in the genetic engineering for production of selected anthocyanins with enhanced stability and/or health-beneficial properties, was described. Plant cell cultures were suggested as an excellent research tool to explore the "anthocyanin enigma" wherein interactions between anthocyanins and other phenolic compounds or metals can facilitate or even enhance the physiological activities of anthocyanin-rich extracts. Indeed, insightful comparisons were drawn between the effects of anthocyanins on animal cells and their native functions in plant cells. Display and degustation of anthocyanin-based food products was provided by Wild

(Germany), Nutrinova Australia Ltd, Kingfood Australia Ltd, Tarac Technologies Ltd (Australia), and The Natural Confectionery Co (Australia), and served as an encouraging example to both researchers and industry managers through their search for novel anthocyanin-based food products promoting good health.

The program of IWA2004 (International Workshop on Anthocyanins) offered 6 plenary lectures and 19 oral presentations in sessions covering anthocyanins in plant cells—function, biosynthesis, and regulation; application of plant cell cultures and bioprocessing for accumulation of anthocyanins with enhanced commercial/health properties; health beneficial effects of anthocyanins; development of anthocyanin-based functional foods; and anthocyanins and the mystery of red wine color. The presentations were accompanied by 26 posters. We would like to thank 170 authors from 13 countries (Australia, China, Finland, France, India, Japan, Germany, Nepal, New Zealand, Portugal, Taiwan, UK, and USA) for their contributions to the program of IWA2004.

This *special issue* of the *Journal of Biomedicine and Biotechnology* combines selected works presented at IWA2004. It reflects the diversity in presentations and discussion, and aims to disseminate information gathered during the workshop. We thank 63 authors of the submitted papers for their contribution. The preparation of this special issue would not have been be possible without the generous support of 40 experts in various areas of anthocyanin research coming from 19 countries, who extensively evaluated the manuscripts submitted and through their constructive questions and suggestions significantly contributed towards the present form of this issue of the *Journal of Biomedicine and Biotechnology.*

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Izabela Konczak is a Research Scientist with the Food Ingredients and Functionality team of Food Science Australia, Sydney. Her recent projects focus on application of biotechnology for production of selected secondary metabolites with potential application in food and pharmaceutical industries as well as discovery of novel bioactive phytochemicals, studies on their physiological activities, bioavailability, and possible application as nutraceuticals. With 4 years of professional experience in Europe (Poland), followed by over 10 years of postdoctoral research in Japan, New Zealand, Australia, and USA, she has developed interdisciplinary skills across biotechnology, including cell line development, accelerated accumulation of specific secondary metabolites in plant cell cultures, biotransformation, bioprocessing, and genetic modification. She is the author of commercially applied plant cell cultures based technology for rapid multiplication of Sandersonia hybrids (New Zealand) and the Coinventor of technology for production of anthocyanins in sweet potato cell cultures (patents in Japan and Australia). After joining Food Science Australia and the Cooperative Research Center for Bioproducts in the year 2000, she initiated and coorganized the International Workshop on Anthocyanins series aiming at popularizing the knowledge on health-preventive properties of anthocyanin-rich extracts of fruits and vegetables and their enhanced application as natural food colorants and ingredients of functional food products.

Wei Zhang was born on 11 April 1969. He has been a Biochemical Engineer since 1989 and received his PhD degree in biochemical engineering from Dalian Institute of Chemical Physics, Chinese Academy of Sciences, in 1994. He has a strong theoretical and experimental expertise in the areas of integrated bioprocessing, membrane bioreactor, plant cell culture, immobilized cell system, modelling and supercomputer simulation of bioprocesses as well as marine bioproducts engineering. His postdoctoral research career has brought him to work in a number of top universities and institutions including the University of Tokyo (Japan), the University of Cambridge (UK), and Cornell University (USA). As a result, he has published a total of over 100 publications in refereed journals and conferences (in more than 80% as first author). His international experience includes working in China, Korea, Japan, Australia, UK, and USA that brings enormous opportunities for international R&D collaborations. He has been involved in organizing committees of several international conferences as member or chair. He has been giving seminars and presentations in various national and international conferences and research laboratories. He is currently a Senior Lecturer in bioprocessing and Head of Plant Cell Culture Laboratory at the CRC for Bioproducts, Flinders University.

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