

Short Communication

Towards the discovery of novel phytochemicals for disease prevention from native Australian plants: an ethnobotanical approach

Aaron C Tan BSc(Med)Hons^{1,2}, Izabela Konczak PhD¹, Daniel M-Y Sze PhD^{2,3}, Iqbal Ramzan PhD²

¹Food Futures Flagship, CSIRO Food and Nutritional Sciences, Sydney, Australia

²Faculty of Pharmacy, The University of Sydney, Sydney, Australia

³Department of Health Technology and Informatics, The Hong Kong Polytechnic University, Hung Hom Kowloon, Hong Kong SAR

Investigation into phytochemicals from foods for disease prevention has increased substantially in the last few decades. However, a clear strategy on the selection of the most promising foods for research has been lacking. An ethnobotanical approach represents an effective method which may improve the outcomes of phytochemical research. Research on the health properties of native Australian plants is limited. The vast number of edible plants used as foods and medicines by the Australian Aboriginal population creates opportunities for the discovery of novel physiologically active compounds. Within this review, we propose an ethnobotanical approach to accelerate research towards the utilisation of native Australian plants for foods with health-enhancing properties.

Key Words: chronic disease, drug discovery, functional foods, oceanic ancestry group, traditional medicine

INTRODUCTION

The burden of chronic non-communicable diseases, such as cancer, cardiovascular disease and cerebrovascular diseases, represent 46% of the global burden of disease.¹ These are among the leading causes of death worldwide, especially in developed nations. With many chronic diseases being largely preventable, the development of novel and sustainable prevention strategies is essential. Fruits and vegetables are beneficial in a number of chronic diseases such as cancer, cardiovascular disease, stroke, Alzheimer's disease, cataracts and age-related functional decline.² Investigation into novel fruit and vegetable phytochemicals for disease prevention has increased substantially in the past few decades. However, a clear focus on methods of selecting the most promising foods for research is lacking. An ethnobotanical approach represents an effective and valuable method of selecting foods, with Australian Aboriginal plant foods representing an intriguing example.

ETHNOBOTANICAL APPROACH TO SELECTING PLANTS FOR DISEASE PREVENTION

Traditional plant use has provided a major stimulus for research into their potential as a source of health promoting substances across the world. In Europe, examples of pharmacological compounds include digoxin, extracted from foxglove (*Digitalis purpurea*), and recognised for its positive cardiovascular effects long before the active constituent was identified.³ Similarly, etoposide and teniposide currently used in cancer chemotherapy are extracted from *Podophyllum peltatum*, a plant traditionally

used by Native Americans to treat cancer.⁴ This approach has proven to be highly productive, with the most useful drugs derived from plants discovered through this method.⁵

The ethnobotanical approach has often been overlooked in the selection of edible plant substances for disease prevention. A systematic review on selected indigenous foods has previously been conducted,⁶ however the food systems of the Australian Aboriginal population have been omitted. This may be in part due to the time-consuming nature of collecting ethnobotanical data, synthesising literature on traditional practices and often directly communicating with indigenous populations.⁷ Examining the indigenous use of plant foods though, may provide a wealth of potential candidates. This brief review examines the Australian Aboriginal contribution to the ethnobotanical approach to the discovery of novel phytochemicals for disease prevention.

AUSTRALIAN ABORIGINAL PLANT FOOD PHYTOCHEMICALS MAY HAVE PHARMACOLOGICAL ACTIONS

The edible plants used by the Australian Aboriginal popu-

Corresponding Author: Dr Aaron C Tan, CSIRO Food and Nutritional Sciences, 11 Julius Avenue, North Ryde NSW 2113, Australia.

Tel: +612 9490 8371; Fax: +612 9490 8524

Email: Aaron.Tan@csiro.au; tan.aaron.c@gmail.com

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lation as foods and medicines provides potential for the discovery of novel pharmaceutical or functional food compounds, due to several factors including; (i) the botanical diversity developed in geographic isolation over millions of years, (ii) traditional Australian Aboriginal knowledge on their use generated over thousands of years and (iii) recent scientific discoveries and findings.

Botanical diversity developed in distinct isolation

The delicate interplay of continental drift, geological stability and climate has facilitated the evolution of the native flora into a unique and distinct entity. The separation of the Australian land mass from Gondwana and the rest of the world over 65 million years ago, the relative stability against sudden climate changes, and the lack of significant geological activity, has contributed to the intense botanical diversity.^{8,9} In the last few million years however, an increasingly variable climate has geologically shaped the continent into its present form, with the arid and dry central regions, high-rainfall tropical regions of the north and the sub-tropical temperate easterly and southern areas.¹⁰

This unique range of climate zones of the current Australian environment is reflected in the incredible diversity of native flora. The intense environmental changes and stresses over millions of years predispose native flora to contain high levels of protective compounds. The Australian native flora account for approximately 10% of the world's plant species, a majority of which have not been examined for their chemical composition or potential biological activity.¹¹ Indeed, the total number of plant species in Australia, of at least 25,000, is greater than all of Europe combined.⁹ Previous surveys of Australian plants have found large numbers of new compounds, with for example, 40% of 500 alkaloids discovered in Australian plants from 1949 to 1969, being identified as new.¹² Additionally, at least 2,440 species of fruiting rainforest plants were identified in the tropical regions of the continent alone.¹³ This intense diversity allows for plants with novel pharmacological activities to be discovered.

Traditional Aboriginal knowledge of plant use

The Australian Aboriginal people have an extensive history in the Australian environment, of around 45,000 years.¹⁴ This vast period has allowed for the consistent refinement of knowledge on the effectiveness of various plants and foods, and their ideal forms of use.¹⁵ The vast indigenous experimentation of local vegetation over many centuries ensures the exclusion of ineffective or toxic plants from traditional use.¹⁶

There have been numerous attempts to collate the vast Aboriginal knowledge of the native Australian flora. Based on conversations with local Aboriginal populations, Barr *et al.*¹⁷ provided a comprehensive description of over 300 medicinal plant sources from the Northern Territory, encompassing knowledge previously existing only as oral tradition. Lassak and McCarthy similarly described traditional Aboriginal medicinal plants from throughout Australia, detailing specific plants, traditional indications for their use, methods of preparation and any known pharmacological constituents.¹⁸ A truly reliable guide to edible native plants has been provided by Low.¹⁹ Based on 19th

century texts on traditional plant uses as well as the author's own exploratory testing, he described over 150 species from inland areas, the tropics and south eastern regions. The descriptions include methods of preparation and information on nutritional value. Cribb and Cribb also detailed over 200 traditional plant foods, based on previous literature, from first publications of early explorers.²⁰ Numerous other similar texts outline traditional plant use as foods and medicines, describing in-depth the rich history of interaction between Aboriginal populations and their environment.^{13,15,21-24}

Scientific epidemiological evidence for the health benefits of edible Australian native plants however, is limited with minimal consumption in modern western society. This is largely due to early colonists in Australia who resisted Aboriginal foods, due in part to the unique sensory properties which were different to western foods. The range of flavours were adjusted to traditional Aboriginal palates.¹⁵ Early colonists lacked knowledge of appropriate preparation methods for native foods, and additionally, simply did not like local foods.²⁵ The traditional Aboriginal diet however is recognised as beneficial nutritionally to Aboriginal people compared to the contemporary western-style foods they currently consume.²¹ This may be due to the phytochemicals contained within Australian Aboriginal plant foods. Brand-Miller & Holt emphasised that the implications of the use of native foods on Aboriginal health are likely to have been 'protective', providing a range of important phytochemicals.²⁶ In the past few decades, the health of the Aboriginal people has declined dramatically; foods substituted since colonisation are believed to be one factor contributing to this.¹⁵ This is particularly true of diabetes, highly prevalent amongst the modern Aboriginal population, with traditional bush foods believed to protect against its development.²⁷

Furthermore, Aboriginal people had different perceptions of health to modern Western thinking.²¹ They possessed a spiritual connection with their natural resources, placing immense significance on this relationship.¹⁷ Plant foods were often viewed as medicines, believed to strengthen the body against sickness and promote healing.²⁸ This reflects the very nature of traditional medicinal practices, with no division between substances taken for prophylaxis or chronic purposes and for nutritional purposes. This is mirrored in numerous traditional cultures worldwide, from the Tibetans in Asia, to the Albanians in Europe and the Maasai in Africa.²⁹

Unfortunately, much of the traditional knowledge of Australian plant foods is not readily accessible. With an oral tradition of passing knowledge, much of the information is lost or remains with a select few due to a lack of written records, the fragmentation of Aboriginal family groups and the dispossession of many traditional lands.³⁰ Many tribes also valued the information greatly, leading to secrecy and confidentiality between tribes. To date, there have been numerous efforts by botanists and nutritionists to describe native Australian plants and their traditional uses. This has provided some understanding of their value, and several have entered contemporary Australian foods. However, a vast amount of traditional knowledge remains to be captured and utilised. Plant

foods traditionally seen as vital to health and well-being may well prove similarly beneficial today.

Recent scientific evidence on plant foods for nutrition

In a basic nutritional screening study, Australian Aboriginal plant foods were found to contain comparable levels of carbohydrates, fats, proteins, fibre, vitamins and minerals to modern western foods.³¹ Traditional native Australian fruits have also been evaluated for phytochemical content, and several of the most important traditional fruits, have shown promising potential over modern foods. Levels of polyphenolic compounds were significantly higher compared to blueberry, a well known source of beneficial phytochemicals.³² Additionally, a number of fruits, herbs and spices were identified as rich sources of phenolic compounds, vitamin C, vitamin E and lutein, that exert potent antioxidant properties, related to cytoprotection.³³ Among them, Kakadu Plum (*Terminalia ferdinandiana*), a fruit from northern Australia was found to contain the highest level of vitamin C in the world, raging from 3 to 7% of dry weight.³⁴ This fruit, found in regions from north-western Australia to eastern Arnhem land,³⁵ was important traditionally in the local Aboriginal diet, with certain tribes in central Arnhem land regarding the fruit more as a medicine than a food.^{20,35} In areas surrounding Broome, Western Australia, the fruit was pounded and soaked in water to create a drink with an acidic taste,²¹ and in other regions the fruit was also eaten raw for quick energy and refreshment.³⁶

Another example of a native Australian plant food include wattle seeds, prominently those from the *Acacia victoriae* plant,³⁷ among the most important traditional Aboriginal foods in central Australia, representing a staple food.²² Novel compounds from these seeds exhibited strong anticancer, anti-inflammatory and antioxidant activity *in vitro* and in animal models.³⁸⁻⁴⁰ Similarly Illawarra Plum (*Podocarpus elatus*), a fruit from eastern Australia highly valued by local indigenous populations and described as 'amongst the best of the indigenous fruits',²⁰ has recently been found to exhibit significant antioxidant and pro-apoptotic anticancer activity,⁴¹ reduce the proliferation and alter the morphology of colon cancer cells,⁴² and prevent the development of obesity in a mouse model.⁴³ Although these findings are from *in vitro* and animal studies, it demonstrates the immense potential of the most popular traditional native Australian plant foods, and warrants further in-depth investigations.

The information presented suggests that the extremely rich Australian Aboriginal plant foods offer vast opportunities for the discovery of beneficial foods for disease prevention. A successful screening program, examining the most important traditional foods with an ethnobotanical approach for protective physiological activities like antioxidant, anti-inflammatory and immunomodulatory properties, will enrich our knowledge on the unique native Australian plants. Enormous opportunities exist for use of plants globally as novel sources of pharmaceuticals, functional foods or alternative therapies.

CONCLUSION

Novel chronic disease prevention strategies are essential, and consequent research into the pharmacological activi-

ties of dietary phytochemicals from edible plant sources has been expanding. However, recent clinical results of individual foods and phytochemicals have been inconclusive, and an ineffective method of selecting plant sources for research may in part have contributed to this outcome. Therefore an ethnobotanical approach, examining traditional uses of plant foods, may accelerate an efficient discovery process.

Recent research identifying health-enhancing qualities of selected native Australian foods represent an excellent example of the ethnobotanical approach, as highlighted in this review. The unique characteristics of the Australian environment, the significant history of the Australian Aboriginal people, and recent preliminary scientific evidence, combine to suggest the substantial potential of Australian native foods for a chronic disease prevention strategy.

AUTHOR DISCLOSURES

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Aaron C Tan BSc(Med)Hons^{1,2}, Izabela Konczak PhD¹, Daniel M-Y Sze PhD^{2,3}, Iqbal Ramzan PhD²

¹*Food Futures Flagship, CSIRO Food and Nutritional Sciences, Sydney, Australia*

²*Faculty of Pharmacy, The University of Sydney, Sydney, Australia*

³*Department of Health Technology and Informatics, The Hong Kong Polytechnic University, Hung Hom Kowloon, Hong Kong SAR*

由澳洲本土植物中發現具有疾病預防功效的新植物化合物：民俗植物學方法

在過去數十年，從食物找出具有預防疾病功效的植物化合物之探討已大幅增加。但是，卻仍缺乏一個挑選最有希望的食物以進行研究的明確策略。從民俗植物學著手是一個有效的方法，它可以提高植物化合物的研究成果。針對澳洲本土植物的健康特性之研究數量不多。澳洲原住民做為食物及藥物的眾多可食植物中，為發現具生理活性的新化合物創造了機會。在本篇評論中，我們提出民俗植物學方法，以加速進行對利用澳洲本土植物做為健康促進食品的研究。

關鍵字：慢性疾病、藥物發現、功能性食品、大洋洲先民、傳統醫藥