Australian Government

Rural Industries Research and Development Corporation

RURAL INDUSTRIES
Research & Development Corporation

Collation of Health Literature for Tropical Fruits and Extracts

DECEMBER 2013

RIRDC Publication No. 13/014

Australian Government

Rural Industries Research and
Development Corporation

Collation of health literature for tropical exotic fruits and extracts

by Kent Fanning and Yan Diczbalis

December 2013

RIRDC Publication No. 13/014
RIRDC Project No. PRJ-006577

ISBN 978-1-74254-507-3
ISSN 1440-6845

Collation of health literature for tropical exotic fruits and extracts
Publication No. 13/014
Project No. PRJ-006577

Researcher Contact Details

Kent Fanning
39 Kessels Road
COOPERS PLAINS QLD 4108

Email:	Kent.Fanning@daff.qld.gov.au

In submitting this report, the researcher has agreed to RIRDC publishing this material in its edited form.

RIRDC Contact Details

Rural Industries Research and Development Corporation
Level 2, 15 National Circuit
BARTON ACT 2600

PO Box 4776
KINGSTON ACT 2604

Phone:	02 6271 4100
Fax:	02 6271 4199
Email:	rirdc@rirdc.gov.au.
Web:	http://www.rirdc.gov.au

Electronically published by RIRDC in December 2013
Print-on-demand by Union Offset Printing, Canberra at www.rirdc.gov.au
or phone 1300 634 313

Foreword

In this report the nutrient and phytochemical composition of a range of tropical exotic plants has been detailed, with literature summaries of the bioactivity and health properties of whole fruit consumption. The bioactivity of non-edible fruit and plant part extracts has also been reviewed.

This data could be used to promote the consumption of tropical exotic plants.

There is very little data for Australian grown tropical exotic fruits compared with fruit grown overseas. However, there are Australian research groups now undertaking work in the area of phytochemical profiling and bioactivity testing of Australian grown fruits.

Achachairu appears to be the best opportunity for developing extracts for use in food and nutraceutical applications.

This report is an addition to RIRDC's diverse range of over 2000 research publications and it forms part of our New and Developing Plant Industries R&D Program, which aims to facilitate projects/industries that advance import replacement and export creation/expansion, and identify opportunities for, and facilitate the development of, new industries that are well placed to make a substantial contribution to rural and regional development in the future.

Most of RIRDC's publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Craig Burns
Managing Director
Rural Industries Research and Development Corporation

About the Author

Dr Kent Fanning has been involved in researching the composition and potential health benefits of tropical fruits since he began with DAFF in July 2007. He has written two publications reviewing tropical fruits. He is currently working on a range of projects examining the phytochemical content of temperate, sub tropical and tropical horticultural produce and associated processed products.

Yan Diczbalis is in the Horticulture & Forestry Science division of DAFF. He has thirty years experience working with tropical and exotic fruits and has contributed to relevant promotional materials including ‘Tropical Tastes’ (DEEDI). He has also plays a very significant role in promoting tropical and exotic fruit at the annual ‘Feast of the Senses’ event in Innisfail.

Abbreviations

LDL – low density lipoprotein

HDL – high density lipoprotein

Contents

Executive Summary

What the report is about

In this project we have collated data on the nutrient and phytochemical content of tropical exotic fruits, the evidence for health effects from consumption of these fruit and the use of extracts from edible and non-edible parts of these plants. The knowledge of Australian fruit compared with that grown overseas is presented together with opportunities for future work by Australian researchers. Opportunities for developing commercial extracts for use as food or nutraceutical uses are also presented.

Who is the report targeted at?

- Tropical exotic fruit growers and marketers.
- Researchers who are involved and/or interested in tropical exotics research.

Where are the relevant industries located in Australia?

The tropical exotic fruit industry is based predominantly in north Queensland and the Northern Territory. Some fruit is also grown near the coast in central Queensland, south east Queensland and northern New South Wales.

Background

Research into nutrient content, phytochemical content and potential health benefits of tropical exotics has traditionally been far less than the work done on temperate fruits. There is also little known about how Australian grown fruit compare with that of fruit grown overseas. Furthermore, both edible and non-edible fruit and plant parts used in traditional medicine may have commercial opportunities for Australian producers.

Aims/objectives

The four objectives of this project were

- To collate compositional and health literature for tropical and exotic fruits, with a focus on information from Australian grown produce.
- To highlight where cultivars, growing practices and supply chain handling may differentiate Australian grown fruits from fruit from other countries.
- To identify opportunities for extracts to be developed from fruit or non-edible parts of fruit trees to be used in food and/or nutraceutical and/or pharmaceutical products.
- To recommend further research and development activity that would help support further knowledge of the compositional and health benefits of Australian grown tropical fruit.

Methods used

Extensive literature searches together with detailed analysis of the tropical exotics industry in Australia in comparison with the industry in other countries.

Results/key findings

There is an accumulating body of literature detailing the nutrient and phytochemical content of tropical exotics. However, there is very little data available for fruit grown in Australia. No specific advantages were identified for Australian grown fruit on the basis of cultivar difference or growing/handling practices. There is evidence from animal and/or human feeding trials for the health benefits of fruit consumption of some of the studied fruits from the literature. The best opportunities for developing extracts for use in food or in nutraceutical applications exist for achachairu, due to the significant volume of fruit being grown in a single location with no apparent import competition. The use of extracts in improving health and well being from several other fruits have ranging levels of scientific evidence, with commercial products from other countries available internationally. However, the economic viability for production of the extracts from Australian grown fruit is still unclear from this study.

Implications for relevant stakeholders

- The information in this report on the nutrient content and benefits of fruit consumption could be developed into promotional and/or educational materials.
- Waste fruit (including seeds, peels etc) may be able to be utilised in food or nutraceutical applications. Achachairu has the most potential, of the fruits studied, due to the relatively high production volume, single growing location and lack of international competition.

Recommendations

- Undertake work to put the nutritional and health benefit information for these fruits into suitable formats (web based etc) for promotional and/of educational purposes.
- Develop and present a proposal to FSANZ to develop NUTTAB records for the fruits that do not currently have one.
- Develop a suitable forum to keep a connected and coordinated approach for tropical fruit research in Australia, following on from the 2008 Tropical fruits in human nutrition and health conference. It is anticipated that research will continue through relatively small student projects.
- Develop a plan to investigate opportunities for utilisation of retail-rejected Achachairu fruit as flesh/peel/seed products/extracts for food and nutraceutical uses.

Introduction

The increasing epidemiological evidence for the health benefits of fruit and vegetable consumption is attracting great interest. There is burgeoning research into unearthing the mechanisms behind these observed benefits. However, knowledge on the health properties of tropical exotic fruit products appears to lag behind that of temperate crops such as apples, pears, plums and berry fruit as well as crops grown in warm dry climates such as citrus, olives and pomegranate. This is despite most tropical exotics being recognised for health or medicinal properties by populations indigenous to the areas where they are customarily grown. Some of this traditional knowledge has stimulated health research. This combined with nutritional compositional analysis, is indicating which properties of tropical exotics can contribute to the health and well-being of consumers.

More knowledge of the nutrient and phytochemical composition data and specific health effects of Australian grown fruit may provide a useful tool for promoting consumption of this fruit. This knowledge may also position Australian grown fruit favourably versus imported product.

Other non-edible parts of many fruit trees have been used in traditional practices. Often the non-edible parts of plants have specific phytochemicals not found in the fruit itself or a higher content than in the fruit.

In preparing for the Tropical fruits in human nutrition and health conference in 2008 (held at Couran Cove, South Stradbroke Island) a review of the traditional uses, nutritional content, antioxidant activity and health literature for 28 tropical fruits currently grown in Queensland was undertaken. This was entitled The health benefits of tropical fruit grown in Queensland, Australia (Fanning, Murray *et al*. 2009) and was published in the conference proceedings. This work did not focus on data specifically for Australian grown fruit, or the phytochemical content of the edible, specific fruit extracts or non-edible parts. A much smaller consumer-friendly booklet was also published and released at the conference, Queensland tropical fruit – The healthy flavours of North Queensland (2008). This booklet was designed to accompany the previously published book Tropical Tastes – Fruit, foods and flavours of north Queensland. Tropical Tastes content has been used to educate and promote tropical exotic fruits and also received wider publicity through the RACQ's Road Ahead magazine last year.

The first aim of this project was to gather useful information on the nutrient and phytochemical content and health attributes of tropical exotic fruits relevant to the Australian industry. Where there was the data, this report makes a comparison of data for Australian grown versus fruit grown in other countries, with the influence of cultivar differences also considered.

The second aim of this project was to review the literature and identify possible opportunities for developing extracts from the edible fruit or other parts of the plant for use in food and/or nutraceutical and/or pharmaceutical products.

Objectives

- To collate compositional and health literature for tropical and exotic fruits, with a focus on information from Australian grown produce.
- To highlight where cultivars, growing practices and supply chain handling may differentiate Australian grown fruits from fruit from other countries.
- To identify opportunities for extracts to be developed from fruit or non-edible parts of fruit trees to be used in food and/or nutraceutical and/or pharmaceutical products.
- To recommend further research and development activity that would help support further knowledge of the compositional and health benefits of Australian grown tropical fruit.

Methodology

The fruit list for this project was based upon the RIRDC report by Yan Diczbalis titled Tropical exotic fruit industry strategic direction setting 2010-2015 (Diczbalis 2010). Pertinent background information was extracted from this publication for this report and formed part of the basis for consideration of cultivar, agronomic and post harvest practices between Australia and fruit grown overseas.

The content of two previously published documents examining the nutrient content and health benefits of tropical fruit consumption (The health benefits of tropical fruit grown in Queensland, Australia (Fanning, Murray *et al.* 2009), Queensland tropical fruit – The healthy flavours of north Queensland (2008)) were used as the starting basis for the collation of information.

In examining the recent literature for nutrient composition, phytochemical composition and bioactivities of the various fruits the following literature databases were searched using the listed terms.

- Science Direct
- Web of Knowledge
- Scirus
- National Library of Australia – Trove.

Terms:

- abiu OR (*Pouteria caimito*) OR caimito OR luma OR aboi OR pouteria
- Achachairu OR (*Garcinia humilis*)
- black sapote OR (*Diospyros digyna*)
- breadfruit OR (*Artocarpus altilis*)
- carambola OR (*Averrhoa carambola*)
- (Duku-langsat) OR (*Langsium domesticum*)
- durian OR (*Durio zibethinus*)
- guava OR (*Psidium guajava*)
- hog plum OR (*Spondias cythera*) OR fiji apple OR ambarella OR vi apple OR otaheite apple
- jaboticaba OR (*Myrciaria cauliflora*)
- jackfruit OR (*Artocarpus heterophyllus*) OR jackfruit
- longan OR (*Dimocarpus longan*)
- mamey sapote OR (*Pouteria sapota*)
- mangosteen OR (*Garcinia mangostana*)

- pitaya OR (dragon fruit) OR (*Hylocereus undatus*)OR (*Hylocereus costaricensis*) OR (*Selenicereus megalanthus*)
- pomelo OR pummelo OR (*Citrus grandis*)
- rambutan OR (*Nephelium lappaceum*)
- rollinia OR (*Rollinia deliciosa*) OR biriba
- sapodilla OR (*Manilkara zapota*) OR chico
- soursop OR (*Annona muricata*) OR guanabana
- star apple OR (*Chrysophyllum caimito*)

The Unites States Department of Agriculture (USDA) online nutrient reference database (http://ndb.nal.usda.gov/ndb/foods/list) and the Australian equivalent, NUTTAB (administered by Food Standards Australia New Zealand, http://www.foodstandards.gov.au/consumerinformation/nuttab2010/nuttab2010onlinesearchabledatabase/onlineversion.cfm) were searched for entries of nutritional information of each fruit. In regards to the results reported, if there was suitable data indicating that the edible part of the fruit contained vitamin content ≥10% of recommended dietary intake, or fibre content ≥10% of daily intake, per 100g (as described in the Australian and New Zealand Food Standards (ANZFS 2008)), than this was specifically included under the heading 'Nutrient and phytochemical composition'.

Results

Nutrient composition data for breadfruit, carambola, durian, guava, jackfruit, longan, mamey sapote, mangosteen, pummelo, rambutan, sapodilla, soursop and star apple were present in the USDA nutrient database. There were only entries for three of the studied fruit, guava, jackfruit and rambutan, in the NUTTAB nutrient database.

A recent review on the phytochemical contents and bioactivity of fruits including breadfruit, mangosteen, guava, soursop and pummelo (Pierson, Dietzgen *et al.*), and the Food Research International special issue on exotic fruits (Exotic Fruits: Their Composition, Nutraceutical and Agroindustrial Potential, Volume 44, Issue 7, August 2011), are valuable background reading.

Abiu (*Pouteria caimito*)

Background and growing situation in Australia

Abiu originates from South America in the tropical regions of Peru and Brazil. The yellow fruit is round to oval in shape and some varieties have a nipple like protrusion at the end of the fruit. The fruit is best eaten fresh to reveal the subtle caramel flavoured flesh. There are a number of selections which include Gray, Z2, Z4 and E4. There are a total of 610 trees with 73.8% (450 trees) in north Queensland and 122 trees in the NT. Abiu was regarded as an exotic fruit with potential (Ross 1997). Production is generally not a problem. The fruit bruises easily and the major challenge is getting unbruised fruit to market.

Nutrient and phytochemical content

Abiu is a good source of Niacin and an excellent source of Vitamin C. One hundred grams of the fruit contains 34% of the RDI for Niacin (Morton 1987) and 122% of the RDI for Vitamin C (Morton 1987).

The total phenolic content of fruit flesh and seed have been determined with seed content higher than flesh (Contreras-Calderon, Calderon-Jaimes *et al.* 2011). Phenolic acid profile (Fukuji, Tonin *et al.*), elemental analysis (Oliveira, Almeida *et al.* 2006) and volatile profile of flesh (Maia, Andrade *et al.* 2003) have all be undertaken. Several triterpenes from the bark have been isolated (Ardon and Nakano 1973).

Achachairu (*Garcinia humilis*)

Background and growing situation in Australia

Achachairu is a fruit recently introduced from Bolivia. It is related to mangosteen and is borne on a tree similar in appearance but with smaller lancolate leaves and more sun tolerant. The trees of the variety "A-SE" (17,000 trees) are owned (under plant variety rights) by one company and planted in an area south of Townsville. The fruit is bright yellow in colour and egg shaped. The white crisp flesh, surrounding a single seed is slightly acidic in nature and is delicious fresh. The skin can be used to make a refreshing drink and the flesh also lends itself to being used in purees and juices.

Potential as a food ingredient

There is interest to develop processed food products utilising retail rejected fruit in Australia.

Nutrient and phytochemical content

The achacha website (http://www.achacha.com.au/) has comments regarding the content of potassium, vitamin C, folate and sugar content of fruit flesh, as well as the presence of hydroxycitrate in the skin. However there was no data found in the literature search.

Bioactivity and health properties

Seed extracts have shown pain reducing ability in several rodent pain models (Dal Molin, Silva *et al.*). A polyisoprenylated benzophenone identified as guttiferone was isolated and seen to be more potent than the crude seed extract (Dal Molin, Silva *et al.*). This compound has also been identified in bark and stem extracts and has been shown to bind to liver X receptors as an agonist (Herath, Jayasuriya *et al*. 2005). Agonists of these receptors may mediate increased cholesterol efflux, reduced plasma LDL content and increased plasma HDL content.

Black Sapote (*Diospyros digyna*)

Background and growing situation in Australia

Black Sapote or chocolate pudding fruit is native to Mexico and a close relative of persimmon. The fruit is easily produced in the tropics from a variety of seedling selections. Large squat fruit are preferred to the smaller oval types. The fruit is a culinary fruit because it is best used in recipes where it is used in association with chocolate or as a replacement for chocolate colouration. The fruit are climacteric and can be picked green mature. They are best to consume when fully softened. The tree is hardy and is used successfully as a windbreak. The tree is well adapted to warmer sub tropical areas as well as the wet coast of north Queensland. There are an unquantified number of trees in northern Australia. Market demand is increasing due to interest in the fruit from chefs.

Nutrient and phytochemical content

The black sapote is an exceptional source of vitamin C with one hundred grams of fruit containing 4.8 times the RDI (Morton 1987).

The total phenolic content (Yahia, Gutierrez-Orozco *et al.* ; Arellano-Gomez, Saucedo-Veloz *et al.* 2005), phenolic profile (Yahia, Gutierrez-Orozco *et al.*), carotenoid profile and content (Yahia, Gutierrez-Orozco *et al*. ; Arellano-Gomez, Saucedo-Veloz *et al.* 2005), and vitamin E content have been described for the fruit (Yahia, Gutierrez-Orozco *et al.*).

Breadfruit (*Artocarpus altilis*)

Background and growing situation in Australia

Breadfruit is native to the Pacific islands and is inexorably connected to Captain Bligh who was responsible for transporting the trees from Tahiti to the West Indies. The fruit is an important staple food in the Pacific and can be used for making crisps and chips. The tree is truly tropical in its requirements and is ideally suited to NT. In Queensland its range is currently restricted to areas north of Cairns or elevated areas, free of the influence of cold air drainage, south of Cairns. The survey suggests there are nearly 500 trees with 350 trees (74.2%) located in north Queensland. The remaining 120 trees are planted in the rural areas adjacent to Darwin.

Potential in other uses

Breadfruit is used as a whole and pulp flour (Adepeju, Gbadamosi *et al*.), however there are opportunities for its use as a starch in applications such as use as a dusting starch (Nwokocha and Williams) and tablet disintegrant (Adebayo, Brown-Myrie *et al.* 2008).

Nutrient and phytochemical content

Breadfruit is an excellent source of vitamin C (USDA). One hundred grams of fruit contains 72% of the RDI.

Several studies have compared nutrient and phytochemical content across cultivars, comparing tannins (Appiah, Oduro *et al*.), mineral content (Jones, Ragone *et al*.) and carotenoid content (Englberger, Alfred *et al*. 2007). The large variation in these components indicates the opportunities to select for nutritionally superior varieties (Jones, Ragone *et al*. ; Englberger, Alfred *et al*. 2007). Stilbenes, arylbenzofuran, flavanone, flavones and sterols have been characterized in the fruit (Amarasinghe, Jayasinghe *et al*. 2008).

Bioactivity and health properties

In vitro anticancer activity has been shown by extracts from different parts of the plant. Wood extract has shown apoptotic inducing ability in breast cancer cell line (Arung, Wicaksono *et al*. 2009). Geranyl chalcone derivatives from leaves have shown moderate cytotoxicity to a range of human cancer cells (Wang, Xu *et al*. 2007). Arcommunol A has also shown chemoprotective properties in a range of cancer cell lines (Hsu, Shyu *et al*.).

An extract from heartwood of the breadfruit tree has been shown to give fibroblast lattices of wrinkled skin the ability to contract (which was lost without treatment in the studied in vitro system) (Viyoch, Buranajaree *et al*.). The authors proposed that this ability to rejuvenate the metabolism and reorganisation of collagen may underlie a wrinkle treatment.

Lectins extracted from seeds, frutackin, inhibit fungal growth and development (Badrie, Broomes *et al*.).

Leaf extracts have shown ACE-inhibitory activity with the high content of glycosidic and phenolic compounds being implicated as responsible, at least partly, for the activity (Siddesha, Angaswamy *et al*.). The authors stated that this work supported the traditional use of leaf material for the treatment of hypertension. The authors proposed that further studies that looked to isolate and better determine which phytochemicals were most responsible for these effects should be undertaken.

The inclusion of breadfruit in the diet of residents of the Caribbean has been promoted by certain health professionals for its potential usefulness in aiding the management of conditions such as diabetes and hypertension (Badrie, Broomes *et al*.).

Carambola (*Averrhoa carambola*)

Background and growing situation in Australia

Carambola or star fruit has been widely grown as a back yard fruit tree along the SE coast of Queensland and northern Australia. Commercial plantings exist from northern NSW, southern and central Queensland and the rural regions surrounding Darwin. The main commercial cultivars are B2, B10, B17, Arkin, Fwang Tung and Giant Siam (Diczbalis and McMahon 2004). The fruit is primarily grown for the food service market where it is used as a garnish surrounding fruit platters. The survey indicates there are 2,200 trees (65.7%) planted in Queensland with the bulk of commercial trees in regional areas surrounding Rockhampton and Bundaberg. The remaining 1,150 trees are grown in the Darwin rural area. The estimated production potential of carambola, at a yield of 45 kg/tree is 150 tonnes valued at $1.21M. Opportunities exist for industry expansion if the fruit can be introduced to the larger Australian market. The fruit is highly versatile as a fresh fruit and a refreshing juice.

Potential as a food ingredient

Esterified insoluble fibres from starfruit may have opportunities as carriers of nutrients in food systems to deliver certain vitamins/phtyochemicals (Hsu, Lin *et al*. 2009).

Nutrient and phytochemical content

Carambola is an excellent source of Vitamin C, with a typical large fruit (124g) containing 107% of the RDI (USDA).

The flavonoid (Liu, Zhang *et al*. 2009) and phenolic (Yap, Ho *et al*. 2009) contents of the fruit have been defined. Alkyl phenols and benzoquinones have been identified in wood samples (Chakthong, Chiraphan *et al*.). Leaves have been shown to contain - beta-sitosterol, apigenin-6-C-beta-L-fucopyranoside and -apigenin-6-C-(2"-O-alpha-L-rhamnopyranosyl)-beta-L-fucopyranoside (Moresco, Queiroz *et al*.).

Bioactivity and health properties

Topically applied extracts of the leaves have significantly reduced edema and myeloperoxidase activity in a croton oil-induced ear edema model of inflammation in mice (Cabrini, Moresco *et al*.). Isolated compounds, from the extracts, apigenin-6-C-beta-L-fucopyranoside and apigenin-6-C-(2 "-O-alpha-L-rhamnopyranosyl)-beta-L-fucopyranoside, were much less effective than the whole extracts in reducing edema.

Leaf extracts have shown induction of hypoglycaemia in normal mice (Shejuty, Joyanta *et al*.) and rats (Ferreira, Fernandes *et al*. 2008), and lowered fasting blood glucose levels in hyperglycaemic rats (Cazarolli, Folador *et al*. 2009). Apigenin-6-C- -1-fucopyranoside was seen to lower blood glucose and stimulate glucose-induced section in hyperglycaemic rats (Cazarolli, Folador *et al*. 2009). The mechanism for the activity is increased muscle glycogen synthesis (Cazarolli, Folador *et al*. 2009) and not a result of hepatic gluconeogenesis and/or increased uptake of glucose by muscle tissue (Ferreira, Fernandes *et al*. 2008).

Leaf extracts have also caused hypotension in normal rats (Soncini, Santiago *et al.* ; Vasconcelos, Gondim *et al*. 2008).

Extracts of the fruit have shown the ability to restore hepatic disturbances induced by carbon tetrachloride in mice (Azeem, Mathew *et al.*) and rats (Padhy, Yedukondalu *et al*. 2008). A range of effects have been seen with reduction of liver function enzymes, increased reduced glutathione levels, improvement of other biochemical indices and corresponding improvements in hepatic structure (Azeem, Mathew *et al.* ; Padhy, Yedukondalu *et al*. 2008).

Carambola pomace, when included in hamsters' diets as a source of dietary fibre, has shown potential benefits to gut health (Chau, Chien *et al*. 2005; Chau and Chen 2006). However consumption of carambola and carambola juice has resulted in neural and renal damage in people with kidney problems (Neto, Robl *et al*. 1998; Chang, Hwang *et al*. 2000; Chen, Fang *et al*. 2001; Fang, Chen *et al*. 2001; Chang, Chen *et al*. 2002; Chen, Chou *et al*. 2002; Neto, da Costa *et al*. 2003; Tse, Yip *et al.* 2003; Andersson and Sundh 2004; Chang and Yeh 2004; Chen, Fang *et al*. 2005; Tsai, Chang *et al.* 2005; Niticharoenpong, Chalermsanyakorn *et al*. 2006; Wang, Liu *et al*. 2006; Fang, Chen *et al*. 2007; Cassinotto, Mejdoubi *et al*. 2008; Fang, Lee *et al*. 2008; Marin-Restrepo and Rosselli 2008). Both the fruit and juice also inhibit liver enzyme activity, which can alter prescription drug pharmacokinetics (Hidaka, Fujita *et al*. 2004; Hosoi, Shimizu *et al*. 2008).

Duku–Langsat (*Langsium domesticum*)

Background and growing situation in Australia

Duku-Langsat is a relatively unknown fruit in Australia although well known in Thailand, Malay Peninsula and the Indonesian islands. The fruit are borne in grape like clusters on the trunk and main branches of the tree. The fruit is covered in a leathery skin which is easily peeled to reveal two to three translucent flesh segments. Immature fruit produce latex at the edge of the broken skin. Fruit may contain one greenish seed similar in size to a pumpkin seed. In most cases the seeds are aborted. The flesh has a refreshing flavour with a hint of acidity. The survey revealed a surprising number of trees in northern Queensland and the NT. There are 1200 trees planted in north Queensland (68.7%) with a further 550 trees (31%) in the NT.

Nutrient and phytochemical content

Total phenolic content, vitamin C, carotenoid content and vitamin E content have been described in fruit flesh (Isabelle, Lee *et al*.).

Bioactivity and health properties

Extracts of fruit skin and leaf have reduced parasite populations of two strains of falciparum in vitro (Yapp and Yap 2003). Similarly, three tetranortripernoids and five triterpenoids, extracted from seeds, were shown to have antimalarial activity (Saewan, Sutherland *et al*. 2006).

Durian (*Durio zibethinus*)

Background and growing situation in Australia

Durian, the "King" of tropical fruit, perfectly represents the term "exotic fruit". A fruit armoured with spines and a pungent odour when ripe. The creamy edible flesh surrounding the seeds has a flavour similar to garlic custard. The bulk of trees accounted for in the survey are in the NT (3,107 or 62.2% of total). The remaining 1,888 trees in Queensland are the survivors following cyclone Larry. Pre Larry stock-take suggested that there were up to 13,000 durian trees planted in north Queensland. The estimated production potential of durian, at a yield of 12 kg/tree is 60 tonnes valued at $0.48M.

Nutrient and phytochemical content

Durian is an excellent source of vitamin C (49% RDI/100g) and thiamin (34% RDI/100g) (USDA).

Flesh content of phenolic acids, flavonoids, flavonols and anthocyanins have been studied (Haruenkit, Poovarodom *et al*. 2007; Toledo, Arancibia-Avila *et al*. 2008). Varietal differences have been observed for phenolics, carotenoids and vitamin C content (Ashraf, Maah *et al*. ; Ashraf, Maah *et al*.) (Leontowicz, Leontowicz *et al*. 2008; Toledo, Arancibia-Avila *et al*. 2008).

Bioactivity and health properties

Durian in the diets of rats has shown the ability to inhibit rises in total cholesterol and LDL that result from high cholesterol feeding regimes (Haruenkit, Poovarodom *et al*. 2007; Leontowicz, Leontowicz *et al*. 2007; Leontowicz, Leontowicz *et al*. 2008; Leontowicz, Leontowicz *et al*. 2008). Other effects observed in these studies include increased plasma antioxidant activity (Haruenkit, Poovarodom *et al*. 2007; Leontowicz, Leontowicz *et al*. 2007; Leontowicz, Leontowicz *et al*. 2008), restoration of normal blood glucose levels (Leontowicz, Leontowicz *et al*. 2007), reduced histopathology in liver and aorta (Leontowicz, Leontowicz *et al*.) and altered plasma fibrinogen composition (Leontowicz, Leontowicz *et al*. 2008).

An ethanol extract of durian fruit was seen to show gastro-protective effects in rats, with inhibition of gastric lesion development, decreased pyloric-ligation induced basal gastric secretion, and reduced gastric mucosal injury observed (Paulsi and Dhasarathan).

A durian shell extract was seen to reduce ammonia and S02 induced coughing in mice, as well as mediating a pain relieving effect in an acetic acid induced pain model (Wu, Xie *et al*.).

Polysaccahride gels from shell/husk have shown immune stimulating effects in shrimp (Pholdaeng and Pongsamart) and chickens (Chua, Nurhaslina *et al*. 2008), wound healing ability when used as a film dressing in dogs (Chansiripornchai and Pongsamart 2008), and have been tested for use in cosmetic applications showing positive *in vitro* effects on facial skin capacitance and firmness (Futrakul, Kanlayavattanakul *et al*.).

Guava (*Psidium guajava*)

Background and growing situation in Australia

Guava is well known for its use as an ingredient in tropical juices. The skin and interior flesh containing small seeds are edible when immature as a crisp fruit or as a mature soft fruit. Flesh colour varies with variety from white to salmon pink. The white fleshed fruit are supplied to the market as mature unripe for fresh fruit consumption. The pink fruit are supplied for fresh fruit consumption as ripe fruit. The fruit, in particular the pink fleshed varieties, have recently gained notoriety with exposure on Master Chef®. Guava is an underrated fruit with major plantings in The NT (3,290 trees or 86.2% of total production). The remaining 525 trees are grown in north Queensland. The estimated production potential of guava, at a yield of 30 kg/tree is 114 tonnes valued at $0.5M.

Nutrient and phytochemical content

A typical guava (55g) is an exceptional source of vitamin C, providing over 3 times the RDI, and provides 10% DI of fibre (USDA).

Phytochemical content of many parts of the plant have been described including the fruit (Oliveira, Lobato *et al*. ; Pierson, Dietzgen *et al*. ; Thuaytong and Anprung ; Chandrika, Fernando *et al*. 2009) and leaves (Metwally, Omar *et al*. ; Oloyede ; Peng, Peng *et al*. ; Pierson, Dietzgen *et al*. ; Witayapan, Songwut *et al*. ; Yang, Hsieh *et al*. 2008; El Sohafy, Metwalli *et al*. 2009; Fu, Luo *et al*. 2009; Kuan-Chou, Chiu-Lan *et al*. 2009).

Bioactivity and health properties

The health benefits of guava, particularly leaf extracts, have received more attention than most other tropical exotics, which is evidenced by a number of recent reviews (Gupta, Jagbir *et al*. ; Metwally, Omar *et al*. ; Milind and Ekta ; Payal, Vikas *et al*. ; Pierson, Dietzgen *et al*. ; Sanda, Grema *et al*. ; Gutiérrez, Mitchell *et al*. 2008).

Anti-diabetic

A specific, commercially available guava leaf tea, marketed in Japan, was recently reviewed which detailed the benefits of its anti-hyperglycaemic and anti-hyperlipidemic activity in human trials (Deguchi and Miyazaki). A number of studies have reported the effects of guava leaf extracts in diabetic rats with reduced blood glucose (Shen, Cheng *et al*. 2008), increased plasma insulin level (Shen, Cheng *et al*. 2008), increased glucose utilisation (Prasad, Alka *et al*. 2008; Shen, Cheng *et al*.

2008), reduced serum triglyceride (Chuang, Shen *et al*. 2008), reduced LDL (Chuang, Shen *et al*. 2008), reduced lipid per oxidation (Soman, Rauf *et al*.) and reduced glycated haemoglobin (Soman, Rauf *et al*.) (Soman, Rajamanickam *et al*.). Various flavonoids from the leaf (quercetic, kaempferol, apigenin) have shown high inhibitory activities of alpha-glucosidase and alpha-amylase in vitro (Wang, Du *et al*.), with quercetin shown to be the major compound, in guava leaf tea, that enhances glucose uptake in rat hepatocytes (Cheng, Shen *et al*. 2009).

Extracts from fruit peel have shown similar effects in diabetic rodents with reduced blood glucose levels (Rai, Mehta *et al*. ; Rai, Jaiswal *et al*. 2009), reduced urine glucose levels (Rai, Jaiswal *et al*. 2009), increased haemoglobin levels (Rai, Jaiswal *et al*. 2009), increased body weight (Rai, Jaiswal *et al*. 2009), decreased triglyceride (Rai, Mehta *et al*.)., decreased total cholesterol (Rai, Mehta *et al*.)., decreased LDL (Rai, Mehta *et al*.), as well as reversal of smooth muscle response impairment (Liu, Peng *et al*.).

Bark extracts have also lowered blood glucose levels in mice with induced hyperglycaemia (Prasad, Qureshi *et al*. 2008).

In rats injected with streptozotocin, a compound that induces diabetes by damaging pancreatic beta-cells, fruit extracts have also shown the ability to reduce loss of islet beta-cells (Huang, Yin *et al*.).

Intake of guava bud in PNG residents may help to ameliorate the diabetic effect of chewing betel quid (Owen, Martineau *et al*. 2008).

Anti-cancer

The relative *in vitro* activity and different mechanisms of pulp, peel and seed fractions in mediating observed anticancer effects has recently been described (Bontempo, Doto *et al*.).

Guava leaf extracts have shown cytotoxicity to a range of human cancer cells including prostate (Ryu, Park *et al*.), ovarian and leukaemia (Levy and Carley). Leaf extracts have also shown the ability to reduce tumour size in a xenograft mouse tumour model (Chen, Peng *et al*.). Guava branch extract has shown cytotoxic effect on colon carcinoma cells (Lee and Park).

Anti-hypertensive

Guava puree fed to spontaneously hypertensive rats has lowered body weight and systolic blood pressure (Ayub, Norazmir *et al*.). When guava was included as a dietary intervention for selected hypertensive patients, vitamin C intake was massively increased and a significant lowering of total cholesterol, triglycerides and blood pressure was observed and an increased HDL cholesterol, was observed over those patients not receiving guava (Singh, Rastogi *et al*. 1992; Singh, Rastogi *et al*. 1993; Singh and Rastogi 1997). A recent study in young men has shown increases in serum antioxidant status and HDL-cholesterol from guava consumption over a 4 week period (Rahmat, Abu-Bakar *et al*. 2006).

Cytoprotective

Leaf extracts have shown liver protective effects against erythromycin (Sambo, Garba *et al*. 2009), paracetamol (Priscilla and Milan ; Roy and Das ; Taju, Jayanthi *et al*.) and carbon tetrachloride (Roy and Das) induced liver damage. The extracts have reduced elevated serum levels of aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase and bilirubin, whilst also protecting tissue structure. Similarly leaf extracts have shown protective effects against kidney damage induced by arsenic (Manju and Sushovan). Administration of leaf extracts have led to significant reduction in aortic atherogenic lesion area in apoE-knock out mice (Kawakami, Hosokawa *et al*.), with ethyl gallate and quercetin were seen to be the main compounds inhibiting leucocyte-type 12-lipoxygenase and LDL oxidation *in vitro.*

Anti-diarrheal and gastro-protective

Leaf extracts have shown in vitro ability to control infectious diarrhoea, with the full scope of its antidiarrhoeal activity not due to quercetin alone (Birdi, Daswani *et al.*). Leaf extracts have shown protection to rats and mice from castor oil-induced diarrhoea, with inhibition of intestinal transit and delay of gastric emptying (Ojewole, Awe *et al*. 2008) (Shah, Begum *et al.*).

In rats with induced colitis, leaf extracts have shown decreased disease activity index, decreased macroscopic and microscopic lesion score, showing similar effects to aspirin (Sarmistha and Swarnamoni). In induced-ulcer animal models, guava leaf extracts have inhibited gastric lesions, reduced gastric secretory volume, acid secretion and increased gastric pH (Livingston Raja and Sundar).

Anti-inflammatory

Leaf extracts have shown the ability to reduce paw edema, inhibit exudate formation, inhibit weight reduction and downregulate arthritis index in a number of rat inflammation models (Dhiman, Nanda *et al*. ; Dutta and Das).

Anti-parasitic

In rats infected with Trypanosoma brucei brucei, leaf extracts have resulted in removed or lowered parasite load, extended life span, reduced serum MDA and reduce lipid peroxidation (Adeyemi, Akanji *et al*. 2009; Akanji, Adeyemi *et al*. 2009).

Immune stimulating

Guava leaf - The levels of IFN-gamma and IL-2 in the salivary juice in the patients with Norovirus diarrhoea were higher than the normal healthy patients. Guava leaf has the effect of raising the levels of IFN-gamma and IL-2 in the salivary juice on Norovirus diarrhoea patients, so it can regulate the cellular immune function and promote the T helper cell 1 immunity. (Zhou, Huang *et al*. 2008)

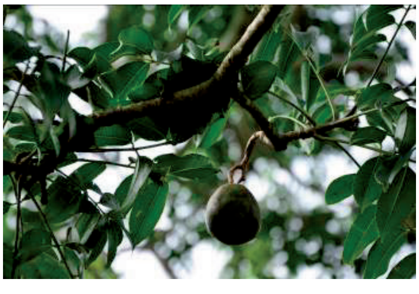
Women's health

Guava leaf inhibited spontaneous phasic rat uterine horn preparations of female rats. – this supports its use in the traditional practice of African women in treating primary dysmenorrhoea. (Chiwororo and Ojewole 2009)

Memory

Guava fruit have shown memory improving effects in mice and rats, reversing the effects of scopolamine and diazepam-induced amnesia (Milind and Ekta).

Hog Plum (*Spondias cytherea*)



Background and growing situation in Australia

Also known as Fiji Apple, Ambarella, Vi Apple or Otaheite Apple is a member of the mango and cashew family. The fruit, dark green in colour, is plum shaped sweet-sour to taste and is eaten at all stages of ripeness. The fruits have a distinct spiny seed that hardens as the fruits mature thus requiring care when the flesh is sucked from the seed. Although the fruit is native to the Pacific it is now commonly grown and eaten throughout SE Asia and Central America. The fruit is grown commercially in the NT with 890 trees representing 97.3% of total plantings. Fruit is produced from two major selections a large tree and a dwarf variety.

Nutrient and phytochemical content

Provides 12% of RDI for vitamin C (Ishak, Ismail *et al*. 2005). Total phenolic content of fruit flesh has been described (Ishak, Ismail *et al*. 2005). The structure of polysaccharide isolated from pulp has been determined (Iacomini, Serrato *et al*. 2005).

Jaboticaba (*Myrciaria cauliflora*)

Background and growing situation in Australia

Jaboticaba is native to southern Brazil. The fruit are produced directly on the main trunk and branches and are similar in appearance to a large black skinned grape. The skin of jaboticaba is relatively thick and contains a translucent flesh similar to a grape. The fruit are delicious when eaten fresh and would lend themselves to being presented in a punnet similar to temperate berries. The survey suggests there are 441 commercial trees with all of them present in north Queensland. Jaboticaba will also grow successfully in sub tropical areas such as SE Queensland.

Nutrient and phytochemical content

Jaboticaba is an excellent source of vitamin C. One hundred grams of the fruit contains 57% of the RDI for Vitamin C (Morton 1987).

Various phytochemical contents of the fruit flesh (citric acid, oxalic acid, phenolic compounds) (Abe, Lajolo *et al*. ; Trevisan, Bobbio *et al*. 1972; Einbond, Reynertson *et al*. 2004), skin (anthocyanins and phenolic compounds) (Einbond, Reynertson *et al*. 2004; Reynertson, Yang *et al*. 2008) (Abe, Lajolo *et al*.) and seed (fatty acids) have been determined (Jorge, Bertanha *et al*.).

Bioactivity and health properties

Jaboticaba leaf extracts have shown anti-bacterial activity, which may be useful in treating dental plaque (Carvalho, Macedo-Costa *et al*. 2009; Macedo-Costa, Diniz *et al*. 2009).

Freeze-dried, anthocyanin rich, peel powder has been shown to inhibit lipid oxidation in vitro and when fed to rats has increased plasma antioxidant capacity (Leite, Malta *et al*.).

Jackfruit (*Artocarpus heterophyllus*)

Background and growing situation in Australia

Jackfruit is a relative of breadfruit and mulberry and is chiefly grown for its ripe fruit that is eaten fresh or used in desserts and sweet drinks. Green fruit is also commonly used in vegetable curries and the seed of ripe fruit can be eaten after being boiled or roasted. Jackfruit is an increasingly important fruit with major plantings in The NT (7,240 trees, 78.1% of total production). The remaining 2,031 trees are grown in north Queensland. Fruit are supplied as immature green for use in curries or as whole mature fruit. The fruit also has an important profile in farmers markets in the NT. The estimated production potential of Jackfruit, at a yield of 80 kg/tree is 741 tonnes valued at $2.6M. Selected varieties of Jackfruit are assumed to have potential for the fresh cut market. This would allow the fruit to be introduced to a new market.

Nutrient and phytochemical content

Jackfruit is a good source of vitamin A (19% RDI/100g) (Chandrika, Jansz *et al*. 2005) and also contains other carotenoids including lutein, neoxanthin and violaxanthin (de Faria, de Rosso *et al*. 2009).

Recent reviews provide a good summary of the many compounds found in the jackfruit plant together with details of cultivar variation (Baliga, Shivashankara *et al*. ; Om, Rajesh *et al*. 2009).

Bioactivity and health properties

Extracts of the plant have shown a large range of effects including anti-inflammatory, anti-fungal, immunomodulatory, anti-diabetic and anti-bacterial activities (Om, Rajesh *et al*. 2009).

The fibre from jackfruit was seen to inhibit the effects of insecticide on beta-glucuronidase activity (a weak marker of colon cancer) in the gut of rats (Serji and Devi 1993).

Cycloheterophyllin and artronin A and artonin B have shown *in vitro* inhibition of LDL oxidation and lipid peroxidation in rat brain homogenate (Baliga, Shivashankara *et al*.).

Artocarpesin, norartocarpesin, oxyresveratrol from leaves have shown in vitro antiinflammatory activity with artocarpesin being heralded as potentially beneficial in treating inflammatory disorders (Fang, Hsu *et al*. 2008). A bark extract has shown anti-inflammatory activity in carrageenan-induced inflammatory rat model (Sandhya, Roopam *et al*.).

Leaf extracts have shown the ability to improve glucose tolerance in diabetic patients (Fernando, Wickramasinghe *et al*. 1991). In diabetic rats leaf extracts have lowered blood glucose, cholesterol and triglyceride levels, in a similar fashion to clinically used drug glibenclamide (Chackrewarthy, Thabrew *et al*.), as well as decreasing lipid peroxides, glycosylated hemoglobin, triglycerides, total cholesterol, LDL and VLDL, but increasing HDL levels (with the high flavonoid content thought to be responsible for the effects) (Omar, El-Beshbishy *et al*.). A fruit extract showed similar improvements to blood glucose and blood lipid profiles in diabetic rats (Sanjay, Rajani *et al*.). Both plant seed powder and bark extract have also significantly lowered blood glucose in diabetic rats (Osmani, Sekar *et al*. 2009), with the bark extract also seen to reduce serum cholesterol and restore body weight (Priya, Gothandam *et al*.).

Various parts of the plant have shown promise as sources of anti-cancer compounds with a range of compounds showing *in vitro* antitumor activity, including dihydromorin, steppogenin, norartocarpetin, artocarpanone, artocarpesin albanin A and 3-prenyl luteolin, being extracted from twigs, wood and tegmen (Zheng, Chen *et al*. 2009) (Arung, Shimizu *et al*. ; Arung, Shimizu *et al*. ; Arung, Yoshikawa *et al*.). Jacalin, a lectin from latex, has been shown to inhibit colon cancer cell proliferation (Ajayi).

Jacalin and ArtinM (another lectin) have shown adjuvant and immune stimulating activities against several parasites (Cardoso, Mota *et al*.).

Glycoproteins isolated from latex have shown in vitro anti-thrombotic activity (Siritapetawee and Thammasirirak ; Siritapetawee, Thumanu *et al*.).

Longan (*Dimocarpus longan*)

Nutrient and phytochemical content

Longans are an excellent source of vitamin C with one hundred grams of the fruit containing over 2 times the RDI (USDA).

Several recent review articles have compiled excellent summaries of the compounds identified and quantified in pericarp, seed and fruit flesh of longan with detailed cultivar comparisons (Wang, Liang *et al*. ; Yang, Jiang *et al*. 2011). Interestingly the aim of elevated polysaccharide content has become the target of Chinese breeding programs (Zheng, Jiang *et al*. 2008).

Bioactivity and health properties

Polysaccharides from pericarp have shown neuroprotective ability in rats with ischemia/reperfusion injury, with polysaccharide administration reducing the neurological score, infarct volume, brain water content, and a range of oxidative stress and inflammatory response markers (Chen, Chen *et al*. ; Chen, Sun *et al*.).

Longan flower extracts have shown *in vitro* delay of LDL oxidation with epicatechin and proanthocyanidin A2 thought to be mediate the effect (Hsieh, Shen *et al*. 2008).

Longan seed powder has shown antifungal activity, which was superior to that of pulp and whole fruit, being heralded as a suitable antifungal agent in mouthwash products (Rangkadilok, Tongchusak *et al*.).

Fruit extracts and polysaccharide-protein complexes from pulp have shown immune stimulating effects in both in vitro systems (Yang, Sen Tai *et al*.) and immunosuppressed mice (Kui, Qiang *et al*.) (Yi, Liao *et al*.) (Su, Zhang *et al*.).

Polysaccarhides from pulp have shown *in vitro* inhibition of tyrosinase activity, which may be suggestive of potential benefits in skin cancer therapy (Yang *et al*, FRI 2011) as well as antitumor effects in mice (Kui, Qiang *et al*.). Longan flower extract has also showed *in vitro* chemoprotective activity against colon cancer cell lines (Chih-Ping, Ying-Hsi *et al*.).

In rodents, extracts of fruit peel have ameliorated the effects of kainic acid (which induces seizures) with increased survival rate and latency of convulsion onset, as well as decreased seizure scores and weight loss (Jo, Eun *et al.*). Both seed and fruit extracts have shown memory enhancing effects in mice (Park, Park *et al.* ; Losuwannarak, Pasadhika *et al.* 2009).

Polyphenol-rich longan seed extract, polysaccarhides from pulp, and twig extract have all showed *in vitro* anticancer activity against cancer cell lines (Chung, Lin *et al.* ; Wang, Tang *et al.* ; Yang, Jiang *et al.* 2011).

Polysaccarhides have also shown in vitro anti-glycation activity, which may indicate potential benefits for diabetics (Yang *et al*, FRI 2011).

In hypercaloric rat models longan flower water extracts have shown the ability to decrease body weight, size of epididymal fat, serum triglyceride level, atherogenic index, hepatic lipids, insulin resistance, systolic blood pressure, and improved liver function and tissue structure (Deng-Jye, Yuan-Yen *et al.* ; Liu, Yang *et al.* ; Tsai, Wu *et al.* 2008).

Seed extracts have shown anti-fatigue properties in mice with extended swimming time, increased hepatic glycogen, reduced blood urea nitrogen and decreased lactic acid observed (Zheng, Jiang *et al.*).

Mamey sapote (*Pouteria sapota*)

Nutrient and phytochemical content

Mamey Sapote is a good source of fibre (10% RDI/100g) and niacin (20% RDI/100g), and an excellent source of vitamin C (60% RDI/100g) (Morton 1987).

The phenolic (Torres-Rodríguez, Salinas-Moreno *et al.* ; Ma, Yang *et al.* 2004; Li, Xie *et al.* 2008), carotenoid (Murillo, McLean *et al.* ; Yahia, Gutierrez-Orozco *et al.* ; Alia-Tejacal, Villanueva-Arce *et al.* 2007) and vitamin E (Yahia, Gutierrez-Orozco *et al.*) Composition of the fruit flesh have all been examined recently.

Mangosteen (*Garcinia mangostana*)

Background and growing situation in Australia

Mangosteen is considered the “Queen” of tropical fruit. The thick purple skin surrounds a number of white fleshed citrus like segments which may contain one or two seeds. Mangosteen is primarily grown in north Queensland (11,606 trees or 98.6% of total plantings). The remaining 163 trees are recorded in the NT. This is not unexpected given that mangosteen is not ideally suited to the monsoonal tropics. The production potential of mangosteen, at a modest yield of 15 kg per tree is 176 tonnes valued at $1.77M. Mangosteen production is dependent on ideal environmental conditions. Hence yearly production is highly variable.

Nutrient and phytochemical content

A range of studies have isolated, identified and quantified a variety of phytochemicals in various parts of the plant, including pericarp procyanidins (Zhou, Lin *et al.*), phenolic acids in flesh and pericarp (Zadernowski, Czaplicki *et al*. 2009), anthocyanins in pericarp (Zarena and Udaya Sankar), and xanthones and benzophones present in fruit and pericarp (Jiang, Quan *et al.* ; Wittenauer, Falk *et al.*).

Bioactivity and health properties

In rats fed 5% powdered mangosteen together with 1% cholesterol rats showed significantly lower total cholesterol, LDL-cholesterol and triglycerides, than 1% cholesterol rats without mangosteen (Leontowicz, Leontowicz *et al*. 2006; Leontowicz, Leontowicz *et al*. 2007).

The various bioactivities of the pericarp extracts have created much interest with several review articles examining the effects of extracts and isolated compounds (Lobb ; Shan, Ma *et al.* ; Akao, Nakagawa *et al*. 2008; Chin and Kinghorn 2008; Obolskiy, Pischel *et al*. 2009).

Anticancer

Whole extracts of pericarp as well as the isolated xanthones, alpha- and gamma-mangostin, have shown anti-cancer activity in a range of human cancer cell lines, including breast (Balunas, Su *et al.* 2008), colon (Zhou, Huang *et al.*), colo-rectal (Ramida, Faongchat *et al.*), leukemia (Ong, Ling *et al.* 2009), melanoma (Han, Kim *et al*. 2009), brain (Hui-Fang, Wen-Tsung *et al.*), prostate (Johnson, Petiwala *et al.*), mammary carcinoma (Shibata, Iinuma *et al.*) and gastric adenocarcinoma (Kikuchi, Ohtsuki *et al.*). Stem bark extracts have also shown cytotoxicity to colon cancer cells (Han, Kim *et al.* 2009).

Studies in animal models have also shown promising results. Intratumoral administration of xanthones in mice has repressed, reduced size and caused disappearance of tumors of implanted human colorectal adenocarcinoma cells (Ramida, Faongchat *et al.*). In mouse models of mammary cancer, alpha-mangostin administration has significantly increased survival rate, reduced tumor volume and suppressed lymph node metastases multiplication (Shibata, Iinuma *et al.*), and panaxanthone (80% alpha-mangostin and 20% gamma-mangostin) significantly suppressed tumor volumes (Doi, Shibata *et al*. 2009). Alpha-mangostin administration in mice implanted with pancreatic cancer cells also caused a significant reduction in tumor volume (Johnson, Petiwala *et al.*).

Cytoprotective/anti-oxidative stress

Xanthones have shown in vitro inhibition of lipid peroxidation (Zarena and Sankar 2009). Alpha-mangostin has shown in vitro attenuation of neurotoxicity induced by amyloid oligomers in rat cortical neurons (Wang, Xia *et al.*). As Alzheimer's Disease is associated with accumulation of these oligomers, the authors proposed that alpha-mangostin may be a candidate for treatment. Pretreatment of mice with xanthone fraction has shown protection from doxorubicin-induced central nervous system toxicity (Tangpong, Miriyala *et al.*). Pretreatment with alpha-mangostin showed protective effects against isoproterenol-induced myocardial necrosis in rats (Cui, Hu *et al.*). Alpha-mangostin has shown the ability to ameliorate the harmful effects of cisplatin (apoptotic cell death and oxidative stress) to the kidneys of rats (Sanchez-Perez, Morales-Barcenas *et al*. 2010).

Alpha and gamma-mangostin have also showed potent in vitro ability to inhibit hepatic stellate cells, which may indicate a possible role in the treatment of liver fibrosis (Chin, Shin *et al.* ; Akao, Nakagawa *et al*. 2008).

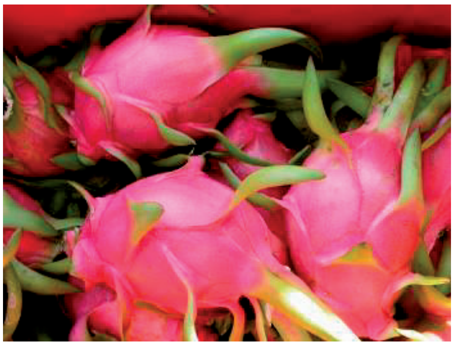
Anti-bacterial

Pericarp extracts have shown in vitro activity against bacteria that cause acne (Propionibacterium acnes and Staphylococcus epidermidis), with alpha-mangostin a major active component (Pothitirat, Chomnawang *et al*.). When formulated into a gel system the extract had better activity than commercial clindamycin phosphate gel (Bhaskar, Arshia *et al*. 2009). A gel formulation containing pericarp extract has also shown promise as a topical anti-bacterial assisting in periodontal treatment (Rassameemasmaung, Sirikulsathean *et al*. 2008).

Pericarp extracts and isolated alpha and gamma-mangostin have shown in vitro ability to reduce inflammation including insulin resistance in adipocytes (Bumrungpert, Kalpravidh *et al*. 2009), allergic responses in mast cells (Hee-Sung, Sei-Ryang *et al*.) and basophils (Itoh, Ohguchi *et al*. 2008), and nitric oxide and prostaglandin E-2 release from macrophages (Tewtrakul, Wattanapiromsakul *et al*. 2009). Furthermore, in animal studies, extracts as well as the individual compounds have exhibited pain relieving effects (Cui, Hu *et al*.) and inhibited carrageenan-induced paw edema (Chen, Yang *et al*. 2008). In obese patients mangosteen juice has shown the ability to reduced elevated high-sensitivity C-reactive protein levels (Udani, Singh *et al*. 2009). However there was no change in other markers of inflammation or lipid peroxidation. Similarly in a study in healthy adults, participants receiving mangosteen juice had decreased serum C-reactice protein levels (Tang, Li *et al*. 2009). This was accompanied by increased concentrations of various markers of immune function.

Leaf extract has shown in vitro ability to enhance tyrosinase activity, which indicates a potential use is self-tanning cosmetic products (Hamid, Sarmidi *et al*.).

Pitaya (*Hylocereus undatus, Hylocereus polyrhizus, Selenicereus megalanthus*)



Background and growing situation in Australia

Pitaya is also known as dragon fruit. There are normally grown and marketed as *Hylocersus undatus* (red skin white flesh), *Hylocerus polyrhizus* (red skin red flesh) and *Selenicereus megalanthus* (yellow skin with white flesh). The fruits are members of the cactus family. They are popular among immigrants of Vietnamese decent. The fruit are an attractive addition to a fruit platter. Some consider the flesh bland. The red fleshed species lends itself to be used as a base for exotic spiced or sweet sauces. Dragon fruit is currently the most prolific species recorded in the survey with 50,100 planting sites. The bulk of the plantings are in the NT (34,150 sites or 62.2% of total plantings). The survey did not distinguish between the three species but experience suggests that the bulk of the plantings in the NT are based on *Hylocerus undatus* while Queensland produces a high proportion of Hylocerus polyrhizus. The third species (S. megalanthus) is usually grown in small quantities. The farmgate value of the pitaya industry, based on the survey data, is $2.25M from a production of 750 tonnes.

Nutrient and phytochemical content

Pitaya is an excellent source of vitamin C, with a 100 gram serving of the white and red fleshed fruits containing 33% and 140%, respectively, of the RDI (Mahattanatawee, Manthey *et al*. 2006).

The betalain (Wybraniec and Mizrahi 2002; Yi-Zhong, Jie *et al*. 2006; Wybraniec, Nowak-Wydra *et al*. 2007) (Jamilah, Shu *et al*. ; Phebe, Chew *et al*. 2009) and phenolic content (Vaillant, Perez *et al*. 2005; Mahattanatawee, Manthey *et al*. 2006; Wu, Hsu *et al*. 2006; Esquivel, Stintzing *et al*. 2007) of both flesh and peels has been determined, as well as the structures of the oligosaccarhides in the flesh (Wichienchot, Jatupornpipat *et al*.). Identification of major flavanoids (Yi, Zhang *et al*.) and new glycosides, termed undatusides (Wu, Wang *et al*.), in flowers of Hylocereus undatus, as well as seed composition (Adnan, Osman *et al*. ; Chemah, Aminah *et al*. ; Villalobos-Gutierrez, Schweiggert *et al*.) have also been undertaken.

Bioactivity and health properties

The fruit pulp when applied topically showed wound healing ability in diabetic rats (Perez, Vargas *et al*. 2005). There was decreased edema, increased collagen and tensile strength of the wound site, a shortened period of epithelialisation, and increased hexosamine, total proteins and DNA.

Extracts of fruit have shown in vitro inhibition of breast cancer cells (Jayakumar and Kanthimathi), while peel extracts had greater inhibitory activity on melanoma cancer cell growth than flesh (Dembitsky, Poovarodom *et al*. 2011).

Both peel (Nurmahani, Osman *et al*.) and flesh (Tenore, Novellino *et al*.) fractions have shown antibacterial properties *in vitro*.

When fed to hypercholesterolemia rats, fresh pitaya reduced total and LDL cholesterol and blood glucose but increased serum antioxidant activity (Omidizadeh, Yusof *et al*.). Similarly in diabetic rats fruit pulp reduced fasting blood glucose, as well as reducing systolic blood pressure, malondialdehyde levels and aortic stiffness but increased superoxide dismutase and total antioxidant capacity (Anand Swarup, Sattar *et al*.).

Oligosaccharides from both white and red fleshed fruit have shown in vitro stimulation of the growth of lactobacilli and bifidobacteria (Wichienchot, Jatupornpipat *et al*.).

Oral administration of fruit extract to male rats has shown increased sperm count, sperm viability and sperm production, with histology of the testis showing a high density of sperm in seminiferous tubules (Aziz and Noor).

Pomelo (*Citrus grandis*)

Background and growing situation in Australia

This citrus best suited to the hot humid tropics, is the largest of the citrus fruits with specimens recorded up to 6 kg in weight. Pomelos are round or pear shaped depending on cultivar and tend to have relatively thick rind. Skin colour is generally light green, yellow or light pink. The flesh varies in colour from pale yellow to pink. The juice sacks are large and lightly crunchy containing a mildly sweet acidic juice. The fruit is a favourite among Chinese people, particularly during festivals such as Chinese New Year and the Moon Festival. Pomelo is grown widely in tropical north Australia with major plantings in the NT (4,100 trees or 76.7% of total). The fruit are growing in acceptability in the market and are being increasingly utilised by high-end restaurants in fusion style salads. The estimated production potential of pomelo, at a yield of 60 kg/tree is 321 tonnes valued at $0.96M.

Nutrient and phytochemical content

Pomelo is an excellent source of vitamin C with one hundred grams of the fruit containing 1.5 times the RDI (UDSA).

A range of studies have identified and examined the carotenoids (Tao, Gao *et al.* ; Xu, Fraser *et al.* 2006; Wang, Chuang *et al.* 2008), limonoids (Tian, Dai *et al.* 2000), polysaccharides (Mokbel 2005), furocoumarins (Girennavar, Jayaprakasha *et al.* 2008), flavonoids (Wang, Chuang *et al.* 2008), and essential oil (Neng-Guo and Yue-Jin) content of different parts of the fruit including flesh, juice, peel and seeds. Several studies have examined cultivar variation in limonin and naringin (Zhang, Duan *et al.*; Dan, Sheng *et al.* 2008; Pichaiyongvongdee and Haruenkit 2009), total phenolic content (Ramful, Tarnus *et al.*), total flavonoid content (Ramful, Tarnus *et al.*) and ascorbic acid content (Ramful, Tarnus *et al.*).

Bioactivity and health properties

The juice affects the pharmacokinetics of certain prescription drugs (Lin, Chao *et al.* ; Grenier, Fradette *et al.* 2006; Guo, Chen *et al.* 2007; Farkas and Greenblatt 2008).

Peel extracts have shown in vitro antimicrobial activity (Neng-Guo and Yue-Jin).

Leaf extracts have shown a range of *in vitro* activities including anti-inflammatory effects (Yang, Kang *et al.* 2008; Yang, Kang *et al.* 2008; Yang, Lee *et al.* 2009), cytoprotective effects to induced oxidative stress (Lim, Yoo *et al.* 2006; Kim, Cho *et al.* 2008), anti-cancer properties with antiproliferative effects on human prostate cancer cells (Chiang, Kim *et al.*) and apoptotic inducing effects on human cervical carcinoma cells (extract was identified as rich in polymethoxylated flavones) (Kim, Moon *et al.*), as well as insulin-like activity of two isolated compounds, rhoifolin and cosmosiin (Rao, Lee *et al.*). Further anticancer activity has been shown by peel (Jae-Seok, Sung-Myung *et al.* 2009) and fruit (Lim, Moon *et al.* 2009) extracts, mediating in vitro apoptosis of human cancer cells.

Flavanone extracts have shown *in vitro* inhibitory effects on the activity of intestinal alpha-glucosidase and pancreatic alpha-amylase inhibition, which may indicate a role for these compounds in controlling blood glucose level in diabetics (Gyo-Nam, Jung-Geun *et al*. 2009).

Rambutan (*Nephelium lappaceum*)

Background and growing situation in Australia

This fruit has been the main stay of the tropical exotic fruit industry. The fruit is the "tropical" cousin of lychee and longan. The attractive soft spined exterior skin surrounds the sweet translucent to white flesh containing one seed. Rambutan's are best eaten as a fresh fruit. The majority of trees are located in north Queensland (approx 20,000 or 79.7% of total plantings) with approximately 5000 trees recorded in the NT. The production potential of rambutan, at a modest yield of 25 kg per tree, is 627 tonnes valued at $3.76M. Rambutan production is dependent on ideal environmental conditions. Hence yearly production is highly variable.

Nutrient and phytochemical content

Rambutan is an excellent source of vitamin C with one hundred grams of the fruit containing 75% of the RDI (Morton 1987).

Total phenolic content (Gorinstein, Zemser *et al*. 1999) and major phenolic compounds of flesh (Thitilertdecha and Rakariyatham ; Thitilertdecha, Teerawutgulrag *et al.* ; Gorinstein, Zemser *et al*. 1999) and pericarp (Liping, Huilin *et al*.) have been recorded including anthocyanins (Jian, Hongxiang *et al*.).

Bioactivity and health properties

Pericarp extracts have shown a range of activities in vitro including antimicarobial activity (Nont, Aphiwat *et al*. 2008), cytoprotective activity (Ling, Saito *et al*.) and fatty synthase inhibition (Zhao, Liang *et al*.), as well as inhibition of alpha-glucosidase, alpha amylase, aldol reducatse and prevention of advanced glycation end product formation, which may translate to benefits for diabetic patients (Palanisamy, Thamilvaani *et al*.). The high content of phenolic compounds in rind extracts, in particular ellagic acid, corilagin and geraniin, have been identified as the key compounds in mediating many of these effects (Dembitsky, Poovarodom *et al*. 2011).

Rollinia (*Rollinia deliciosa*)

Background and growing situation in Australia

Also known as Biriba, this fruit is a relative of custard apple native to tropical central America and south America. The fruit is a yellow and heart shaped with a bumpy surface of soft leathery spines. The soft white tasty flesh is interspersed with black seeds which are not eaten. The tree is commonly propagated by seed and no varieties exist in commercial production. The fruit is challenging to move when ripe but a number of specialist growers are managing to get the fruit to southern markets. Fruit are best eaten fresh or can be used in cooking (cheese cakes and ice creams). The survey suggests that 100% of the crop is grown in far north Queensland (1330 trees). The tree bears early and prolifically.

Nutrient and phytochemical content

Rollinia is an excellent source of vitamin C with one hundred grams of the fruit containing 82% of the RDI (Morton 1987).

Lignan content has been studied (Queiroz Paulo, Kaplan *et al*. 1991) as well as the leaf essential oil profile (Ito, Cordeiro *et al*.).

Bioactivity and health properties

Leaf extracts have shown antimicrobial activity *in vitro* (Ito, Cordeiro *et al*.) as well as inducing anxiolytic-like actions in rodents with motor coordination impairment seen at high doses (Estrada-Reyes, Lopez-Rubalcava *et al*.). In vitro binding studies in mouse brain has shown significant interactions with the GABA/benzodiazepine receptor complex, which is the probable mechanism for central nervous system depressant effects (Estrada-Reyes, Lopez-Rubalcava *et al*.).

Sapodilla (*Manilkara zapota*)

Background and growing situation in Australia

Sapodilla or chico is native to Mexico and central America. The fruits aromatic and sweet "brown sugar" like flesh has led to its cultivation throughout tropical regions of the world. It is particularly popular in India and latex from the trees was extracted as the base for chewing gum prior to the development of synthetic gum base. The survey suggests there are 1076 trees with 79.6% (856 trees) in north Queensland and 220 trees in the NT. The tree is ideal for back yard production. The fruit lends itself to fresh eating and the flesh can be stirred into creams, ice creams and mousse.

Nutrient and phytochemical content

A typical sapodilla (170g) is an excellent source of fibre (30% RDI) and vitamin C (62% RDI) (USDA).

Polyphenols in the ripe fruit (Ma, Luo *et al*. 2003), proanthocyanidins in the unripe fruit (Hongyu, Tingting *et al*.) and the leaf content, including fatty acid profile and major phenolic compounds (Fayek, Monem *et al*.), have all been described.

Bioactivity and health properties

Leaf extracts have shown antimicrobial (Nair and Chanda 2008), antihyperglycemic (Fayek, Monem *et al*.) and hypocholesterolemic (Fayek, Monem *et al*.) activity in vitro. Proanthocyanidins from unripe fruit have shown the ability to inhibit alpha-amylase and alpha-glucosidase in vitro (Hongyu, Tingting *et al*.).

Fruit flesh extracts have shown in vitro inhibition of breast cancer cell proliferation and significant nitric oxide scavenging ability (Jayakumar and Kanthimathi). Intraperitoneal administration of a stem bark extract has lengthened survival time, reduced Ehrlich ascites carcinoma cells and improved haematology in mice (Osman, Rashid *et al*.).

Soursop (*Annona muricata*)

Background and growing situation in Australia

Soursop or guanabana is a relative of the better known custard apple and native to central and South America. The fruit flesh is ideal for use in tropical flavoured ice-creams and juices. The bulk of soursop is grown in north Queensland (2440 trees or 97.6% of total plantings). There are reported to be 60 trees in the NT. The estimated production potential of soursop, at a yield of 20 kg/tree is 50 tonnes valued at $0.30M. Opportunities exist for industry expansion if the fruit can be successfully introduced to the specialist food service market.

Nutrient and phytochemical content

Soursop is an excellent source of vitamin C with one hundred grams of the fruit containing 51% of the RDI (USDA).

Acetogenins in the pulp (Melot, Fall *et al*. 2009), seeds (Badrie, Schauss *et al*.) and leaves (Badrie, Schauss *et al*.) have been described. Alkaloids from leaves have also been isolated (Matsushige, Kotake *et al*.).

Bioactivity and health properties

Acetogenins from seeds and leaves have shown cytotoxicity in vitro to a range of human cancer cell lines including lung carcinoma (Badrie, Schauss *et al*.), breast carcinoma (Ko, Wu *et al*.), colon adenocarcinoma (Badrie, Schauss *et al*.), colon adenocarcinoma (Badrie, Schauss *et al*.), pancreatic carcinoma (Torres, Rachagani *et al*.), and prostate carcinoma (Badrie, Schauss *et al*.). Administration of annonacin (one of the acetogenins) has decreased cell survival, induced cell growth arrest, increased apoptosis and reduced tumour size in mice with xenografts of human breast cancer cells (Ko, Wu *et al*.).

Leaf extracts have shown significant effects in diabetic rats with lowered blood glucose (Adewole and Ojewole 2009; Adeyemi, Komolafe *et al*. 2009), restored body weight (Adeyemi, Komolafe *et al*. 2009), lowered total cholesterol, triglyceride and LDL cholesterol (Adewole and Ojewole 2009), increased insulin levels (Adewole and Ojewole 2009), as well as pancreatic beta-cell regeneration (Adeyemi, Komolafe *et al*.). In one human study, when leaf extract was administered together with glibenclamide to diabetic patients there was better glycaemic control reported than with glibenclamide alone (Arroyo, Martinez *et al*. 2009).

Leaf extracts have shown anti-inflammatory (reduced paw edema, exudate volume and leukocyte migration) and pain relieving effects in several animal models (de Sousa, Vieira *et al*. ; Roslida, Tay *et al*.). A stem bark extract has also shown wound healing ability in rats (Paarakh, Chansouria *et al*. 2009).

Star Apple (*Chrysophyllum cainito*)

Background and growing situation in Australia

Star Apple is an attractive fruit native to South America but well known through Asia with a particular following in the Philippines. Trees are grown throughout northern Australia where they are often planted for their attractive foliage. The survey data suggests there are a total of 1,717 trees with the bulk (68.3%) grown in the NT. There are purple skinned (cv. Grimal and Haitian) and green skinned (cv. Philippine Gold) fruit with green skinned fruit generally receiving a higher market price.

Nutrient and phytochemical content

Star Apple is considered to be a good source of vitamin C (20% RDI/100g) (Morton 1987).

Phytochemical content including phenolic acids (Fukuji, Tonin *et al*.) have been described in several studies (Luo, Basile *et al*. 2002; Einbond, Reynertson *et al*. 2004; Li, Xie *et al*. 2008).

Discussion

In general the nutrient compositional data of tropical exotic fruits still lacks the scope of that of temperate fruits. Vitamin C content is consistently high across the fruits. Some of the fruits also have notable amounts of vitamin A, B-vitamins and fibre.

There is a rich diversity of phytochemicals present in the fruit flesh, seeds, skins, bark and wood of the tropical exotics studied. Specific fruit consumption benefits have been shown for durian, guava, mangosteen and pitaya in animal and/or human feeding trials. Further research is required to more fully investigate the benefits of consumption.

There was no recent nutrient data found for Australian grown fruit, which was reflected by the fact that only three fruits were present in the NUTTAB database. There is scope to develop proposals for discussion with FSANZ to investigate how data can be generated and/or compiled to enable for more fruits to be in the database. This information may be valuable to consumers interested in these fruits.

Despite this there is a developing interest by local research groups in investigating the compositional and bioactivity of tropical exotic fruits in Australia. To date this has focussed on more main stream tropical fruits with work being undertaken by PhD students on the phytochemicals and bioactivity from different varieties of Australian grown mango flesh and peel (Daud, Aung *et al.* ; Wilkinson, Monteith *et al.* 2008; Monteith, Wilkinson *et al.* 2009), and more recently papaya. The University of Queensland research group who have undertaken this work on mangos have recently published a review on the compounds and bioactivities in tropical fruits (Pierson, Dietzgen *et al.*). These positive outputs, following on from the 2008 Tropical fruits in human nutrition and health conference, need to be maintained by keeping the relevant researchers connected to coordinate and stimulate further research. It is anticipated that research will continue through relatively small student projects and approaches for recruiting good students are needed.

As Australian varieties/cultivars are based on imported seed stock, and Australian breeding programs have been very limited, there were no specific advantages identified between the varieties/cultivars grown in Australia and those grown overseas. In fact it appears that there are more nutrient and phytochemical rich cultivars existing in overseas countries due to much larger germplasm resources, analytical work identifying cultivar differences (for example (Ashraf, Maah *et al.* ; Englberger, Alfred *et al.* 2007)), and in some cases specific breeding programs targeting elevation of nutrient and phytochemical contents (Zheng, Jiang *et al.* 2008).

In general, due to the large differences in practices employed across the Australian industry and little comparative information on horticultural practices, there is no evidence suggesting that growing practices and/or supply chain handling are markedly different for Australia and fruit grown overseas. There is no evidence suggesting that Australian approaches improve nutrient or phytochemical content.

Opportunities for use of extracts of these fruits for food use is highly limited in Australia due to the relatively small amount of fruit, geographical dispersion of production, lack of processing waste stream, and much higher production costs than countries from which products are (or could be) imported. The use of certain fibres (for example carambola) to carry nutrients/phytochemicals in food systems may be worth evaluating if there are marketable differences from other fibre sources, which can be protected by process or technology IP, and if Australian fruit production is large enough to support production. The most promising opportunity is for the use of achachairu in processed food applications. This fruit is grown in significant amounts in a single location and there is no current threat of imported product. Identification of functional and marketable characteristics of processed products should be undertaken to evaluate potential.

There is evidence that the use of certain fruit/plant extracts can be utilised in a nutraceutical or pharmaceutical fashion to mediate a variety of health benefits. The best opportunities for utilisation of Australian grown fruit are listed below.

- Achachairu: As mentioned previously the significant amount of fruit grown in a single location and lack of large commercial plantings overseas are key factors for potential commercial viability of extracts. The recent reports highlighting the potential of seed extracts and/or purified compound guttiferone to mediate pain relieving and cholesterol lowering effects should be investigated using Australian material.

- Durian: polysaccharide extracts from husk may have applications in cosmetic formulations. However consideration of local fruit production volumes, geographical dispersion of production and competition with overseas production must be firstly considered to determine if there is any economic validity for such a proposal.

- Guava: there is a large evidence base for the use of leaf extracts, particularly in controlling diabetes and metabolic syndrome. There are commercial products available internationally and consideration must firstly be given to whether Australian grown and made product could compete with imported product. Consideration to minimum production volume requirements, possible processing locations and import competition must be made to determine preliminary viability.

- Jackfruit: the potential for leaf extracts that help control diabetes and metabolic syndrome could be explored. However consideration of local fruit production volumes, geographical dispersion of production and competition with overseas production must be firstly considered to determine if there is any economic validity for such a proposal.

- Longan: the potential for polysaccharide extracts could be explored. There is intense Chinese research into sourcing starting material with elevated levels of the phytochemical(s) of interest, developing optimised extraction procedures and technologies and the health properties of the extracts. There are commercial products available internationally and consideration must firstly be given to whether Australian grown and made product could compete with imported product.

- Mangosteen: there is a reasonably large evidence base for the use of pericarp extracts, particularly in animal models of cancer. However there is potential to explore the suitability of pericarp extracts in acne treatments. There are a range of mangosteen products available internationally and consideration must firstly be given to whether Australian grown and made product could compete with imported product.

- Soursop: there is some evidence supporting the use of leaves for their anti-cancer properties however much more work is required to validate effectiveness and safety of such products. There are commercial products available internationally and consideration must firstly be given to whether Australian grown and made product could compete with imported product.

Implications

- The information in this report detailing the nutrient and health benefits of tropical exotic fruit consumption could be developed into promotional and/or educational materials.

- Waste fruit (including seeds, peel etc) may be able to be utilised in food and nutraceutical extracts. Achachairu has the most potential due to its relatively high fruit volume, single growing location and lack of international competition.

Recommendations

- Undertake work to put the nutritional and health benefit information for these fruits into suitable formats (web based etc) for promotional and/of educational purposes.
- Develop and present a proposal to FSANZ to develop NUTTAB records for the fruits that do not currently have one.
- Develop a suitable forum to keep a connected and coordinated approach for further research in Australia, and stimulate student interest in research projects, following on from the 2008 Tropical fruits in human nutrition and health conference.
- Develop a plan to investigate opportunities for utilisation of retail-rejected Achachairu fruit as flesh/peel/seed products/extracts for food and nutraceutical uses.

References

(2008). Queensland tropical fruit - The healthy flavours of North Queensland, Queensland Government.

Abe, L. T., F. M. Lajolo, *et al*. "Potential dietary sources of ellagic acid and other antioxidants among fruits consumed in Brazil: Jabuticaba (Myrciaria jaboticaba (Vell.) Berg)." Journal of the Science of Food and Agriculture **92**(8): 1679-1687.

Adebayo, S. A., E. Brown-Myrie, *et al*. (2008). "Comparative disintegrant activities of breadfruit starch and official corn starch." Powder Technology **181**(2): 98-103.

Adepeju, A. B., S. O. Gbadamosi, *et al*. "Functional and pasting characteristics of breadfruit (Artocarpus altilis) flours." African Journal of Food Science **5**(9): 529-535.

Adewole, S. O. and J. A. O. Ojewole (2009). "PROTECTIVE EFFECTS OF ANNONA MURICATA LINN. (ANNONACEAE) LEAF AQUEOUS EXTRACT ON SERUM LIPID PROFILES AND OXIDATIVE STRESS IN HEPATOCYTES OF STREPTOZOTOCIN-TREATED DIABETIC RATS." African Journal of Traditional Complementary and Alternative Medicines **6**(1): 30-41.

Adeyemi, D. O., O. A. Komolafe, *et al*. (2009). "ANTI HYPERGLYCEMIC ACTIVITIES OF ANNONA MURICATA (LINN)." African Journal of Traditional Complementary and Alternative Medicines **6**(1): 62-69.

Adeyemi, D. O., O. A. Komolafe, *et al*. "Histomorphological and morphometric studies of the pancreatic islet cells of diabetic rats treated with extracts of Annona muricata." Folia Morphologica **69**(2): 92-100.

Adeyemi, O. S., M. A. Akanji, *et al*. (2009). "Ethanolic leaf extract of Psidium guajava: Phyto-chemical and trypanocidal activity in rats infected with Trypanosoma brucei brucei." Journal of Medicinal Plants Research **3**(5): 420-423.

Adnan, L., A. Osman, *et al*. "ANTIOXIDANT ACTIVITY OF DIFFERENT EXTRACTS OF RED PITAYA (HYLOCEREUS POLYRHIZUS) SEED." International Journal of Food Properties **14**(6): 1171-1181.

Ajayi, I. A. "Chapter 79 - Use of Jackfruit (Artocarpus heterophyllus) Seeds in Health." Nuts and Seeds in Health and Disease Prevention: 677-683.

Akanji, M. A., O. S. Adeyemi, *et al*. (2009). "PSIDIUM GUAJAVA EXTRACT REDUCES TRYPANOSOMOSIS ASSOCIATED LIPID PEROXIDATION AND RAISES GLUTATHIONE CONCENTRATIONS IN INFECTED ANIMALS." Excli Journal **8**: 148-154.

Akao, Y., Y. Nakagawa, *et al*. (2008). "Anti-cancer effects of xanthones from pericarps of mangosteen." International Journal of Molecular Sciences **9**(3): 355-370.

Alia-Tejacal, I., R. Villanueva-Arce, *et al*. (2007). "Postharvest physiology and technology of sapote mamey fruit (Pouteria sapota (Jacq.) H.E. Moore & Stearn)." Postharvest Biology and Technology: 45 (3) 285-297 **45**(3): 285-297.

Amarasinghe, N. R., L. Jayasinghe, *et al*. (2008). "Chemical constituents of the fruits of Artocarpus altilis." Biochemical Systematics and Ecology **36**(4): 323-325.

Anand Swarup, K. R. L., M. A. Sattar, *et al*. "Effect of dragon fruit extract on oxidative stress and aortic stiffness in streptozotocin-induced diabetes in rats." Pharmacognosy research **2**(1): 31-5.

Andersson, C. and U. B. Sundh (2004). "Starfruit - a risk for dialysis patients." Var Foda **56**(1): 18-21.

ANZFS (2008). Australia New Zealand Food Standards Code, Food Standards Australia and New Zealand.

Appiah, F., I. Oduro, *et al*. "Predicting the digestibility of nutrients and energy values of 4 breadfruit varieties based on chemical analysis." Pakistan Journal of Nutrition **11**(4): 401-405.

Ardon, A. and T. Nakano (1973). "Triterpenes from the bark of Pouteria caimito." Planta Medica **23**(4): 348-352.

Arellano-Gomez, L. A., C. Saucedo-Veloz, *et al*. (2005). "Biochemical and physiological changes during ripening of black sapote fruit (Diospyros digyna Jacq.)." Agrociencia (Montecillo) **39**(2): 173-181.

Arroyo, J., J. Martinez, *et al*. (2009). "Coadjuvant hypoglycemiant effect of Annona muricata L (guanabana) leaves ethanolic extract in patients with type 2 diabetes mellitus receiving glibenclamide treatment." Anales de la Facultad de Medecina **70**(3): 163-167.

Arung, E. T., K. Shimizu, *et al*. "3-Prenyl luteolin, a new prenylated flavone with melanin biosynthesis inhibitory activity from wood of Artocarpus heterophyllus." Fitoterapia **81**(6): 640-643.

Arung, E. T., K. Shimizu, *et al*. "Melanin Biosynthesis Inhibitors from Wood of Artocarpus heterophyllus: The Effect of Isoprenoid Substituent of Flavone with 4-Substituted Resorcinol Moiety at B Ring." Letters in Drug Design & Discovery **7**(8): 602-605.

Arung, E. T., B. D. Wicaksono, *et al*. (2009). "Anti-Cancer Properties of Diethylether Extract of Wood from Sukun (Artocarpus altilis) in Human Breast Cancer (T47D) Cells." Tropical Journal of Pharmaceutical Research **8**(4): 317-324.

Arung, E. T., K. Yoshikawa, *et al*. "Isoprenoid-substituted flavonoids from wood of Artocarpus heterophyllus on B16 melanoma cells: Cytotoxicity and structural criteria." Fitoterapia **81**(2): 120-123.

Ashraf, M. A., M. J. Maah, *et al*. "Estimation of antioxidant phytochemicals in four different varities of durian (Durio zibethinus Murray) fruit." Middle East Journal of Scientific Research **6**(5): 465-471.

Ashraf, M. A., M. J. Maah, *et al*. "Study of Antioxidant Potential of Tropical Fruit Durian." Asian Journal of Chemistry **23**(8): 3357-3361.

Ayub, M. Y., M. N. Norazmir, *et al*. "Anti-hypertensive effect of pink guava (Psidium guajava) puree on spontaneous hypertensive rats." International Food Research Journal **17**(1): 89-96.

Azeem, A. K., M. Mathew, *et al*. "Hepatoprotective effect of Averrhoea carambola fruit extract on carbon tetrachloride induced hepatotoxicity in mice." Asian Pacific Journal of Tropical Medicine **3**(8): 610-613.

Aziz, F. A. and M. M. Noor "Ethanol extract of dragon fruit and its effects on sperm quality and histology of the testes in mice." Biomedical Research-India **21**(2): 126-130.

Badrie, N., J. Broomes, *et al*. Chapter 33 - Beneficial uses of Breadfruit (Artocarpus altilis): Nutritional, Medicinal and Other Uses. Bioactive Foods in Promoting Health. San Diego, Academic Press**:** 491-505.

Badrie, N., A. G. Schauss, *et al*. Chapter 39 - Soursop (Annona muricata L.): Composition, Nutritional Value, Medicinal Uses, and Toxicology. Bioactive Foods in Promoting Health. San Diego, Academic Press**:** 621-643.

Baliga, M. S., A. R. Shivashankara, *et al*. "Phytochemistry, nutritional and pharmacological properties of Artocarpus heterophyllus Lam (jackfruit): A review (vol 44, pg 1800, 2011)." Food Research International **44**(9): 3123-3123.

Balunas, M. J., B. Su, *et al*. (2008). "Xanthones from the botanical dietary supplement mangosteen (Garcinia mangostana) with aromatase inhibitory activity." Journal of Natural Products **71**(7): 1161-1166.

Bhaskar, G., S. Arshia, *et al*. (2009). "Formulation and evaluation of topical polyherbal antiacne gels containing Garcinia mangostana and Aloe vera." Pharmacognosy Magazine **5**(19): 93-99.

Birdi, T., P. Daswani, *et al*. "Newer insights into the mechanism of action of Psidium guajava L. leaves in infectious diarrhoea." BMC complementary and alternative medicine **10**: 33.

Bontempo, P., A. Doto, *et al*. "Psidium guajava L. anti-neoplastic effects: induction of apoptosis and cell differentiation." Cell Proliferation **45**(1): 22-31.

Bumrungpert, A., R. W. Kalpravidh, *et al*. (2009). "Xanthones from Mangosteen Prevent Lipopolysaccharide-Mediated Inflammation and Insulin Resistance in Primary Cultures of Human Adipocytes." Journal of Nutrition **139**(6): 1185-1191.

Cabrini, D. A., H. H. Moresco, *et al*. "Analysis of the Potential Topical Anti-Inflammatory Activity of Averrhoa carambola L. in Mice." Evidence-Based Complementary and Alternative Medicine: 1-7.

Cardoso, M. R. D., C. M. Mota, *et al*. "ArtinM, a d-mannose-binding lectin from Artocarpus integrifolia, plays a potent adjuvant and immunostimulatory role in immunization against Neospora caninum." Vaccine **29**(49): 9183-9193.

Carvalho, C. M., M. R. Macedo-Costa, *et al*. (2009). "In vitro antimicrobial effect of jabuticaba [Myrciaria cauliflora (Mart.)O.Berg] extract on Streptococcus from the oral cavity." Revista Brasileira de Plantas Medicinais **11**(1): 79-83.

Cassinotto, C., M. Mejdoubi, *et al*. (2008). "[MRI findings in star-fruit intoxication.]." J Neuroradiol: aheadofprint.

Cazarolli, L. H., P. Folador, *et al*. (2009). "Stimulatory effect of apigenin-6-C-Î²-l-fucopyranoside on insulin secretion and glycogen synthesis." European Journal of Medicinal Chemistry **44**(11): 4668-4673.

Chackrewarthy, S., M. I. Thabrew, *et al*. "Evaluation of the hypoglycemic and hypolipidemic effects of an ethylacetate fraction of Artocarpus heterophyllus (jak) leaves in streptozotocin-induced diabetic rats." Pharmacognosy Magazine **6**(23): 186-190.

Chakthong, S., C. Chiraphan, *et al*. "Alkyl phenols from the wood of Averrhoa carambola." Chinese Chemical Letters **21**(9): 1094-1096.

Chandrika, U. G., K. S. S. P. Fernando, *et al*. (2009). "Carotenoid content and in vitro bioaccessibility of lycopene from guava (Psidium guajava) and watermelon (Citrullus lanatus) by high-performance liquid chromatography diode array detection." International Journal of Food Sciences and Nutrition **60**(7): 558-566.

Chandrika, U. G., E. R. Jansz, *et al*. (2005). "Analysis of carotenoids in ripe jackfruit (Artocarpus heterophyllus) kernel and study of their bioconversion in rats." Journal of the Science of Food and Agriculture **85**(2): 186-190.

Chang, C. H. and J. H. Yeh (2004). "Non-convulsive status epilepticus and consciousness disturbance after star fruit (Averrhoa carambola) ingestion in a dialysis patient." Nephrology (Carlton) **9**(6): 362-5.

Chang, C. T., Y. C. Chen, *et al*. (2002). "Star fruit (Averrhoa carambola) intoxication: an important cause of consciousness disturbance in patients with renal failure." Ren Fail **24**(3): 379-82.

Chang, J. M., S. J. Hwang, *et al*. (2000). "Fatal outcome after ingestion of star fruit (Averrhoa carambola) in uremic patients." Am J Kidney Dis **35**(2): 189-93.

Chansiripornchai, P. and S. Pongsamart (2008). "Treatment of Infected Open Wounds on Two Dogs Using a Film Dressing of Polysaccharide Extracted from the Hulls of Durian (Durio zibethinus Murr.): case report." Thai Journal of Veterinary Medicine **38**(3): 55-61.

Chau, C. and C. Chen (2006). "Effects of two pomace insoluble fibres on the activities of faecal bacterial enzymes and intestinal health." European Food Research and Technology **222**(5/6): 681-685.

Chau, C., P. Chien, *et al*. (2005). "Influence of insoluble fiber fractions from carambola and carrot on intestinal enzymes and fecal bacterial enzymes in hamsters." Nutrition Research **25**(10): 947-957.

Chemah, T. C., A. Aminah, *et al*. "Determination of pitaya seeds as a natural antioxidant and source of essential fatty acids." International Food Research Journal **17**(4): 1003-1010.

Chen, C. L., K. J. Chou, *et al*. (2002). "Neurotoxic effects of carambola in rats: the role of oxalate." J Formos Med Assoc **101**(5): 337-41.

Chen, C. L., H. C. Fang, *et al*. (2001). "Acute oxalate nephropathy after ingestion of star fruit." Am J Kidney Dis **37**(2): 418-22.

Chen, J., X. Chen, *et al*. "Effects of polysaccharides of the Euphoria Longan (Lour.) Steud on focal cerebral ischemia/reperfusion injury and its underlying mechanism." Brain Injury **25**(3): 292-299.

Chen, J., X.-d. Sun, *et al*. "Effect of polysaccharides of the Euphoria longan (Lour.) Steud on inflammatory response induced by focal cerebral schemia/reperfusion injury in rats." Food and Agricultural Immunology **21**(3): 219-225.

Chen, K.-C., C.-C. Peng, *et al*. "Action Mechanism and Signal Pathways of Psidium guajava L. Aqueous Extract in Killing Prostate Cancer LNCaP Cells." Nutrition and Cancer-an International Journal **62**(2): 260-270.

Chen, L.-G., L.-L. Yang, *et al*. (2008). "Anti-inflammatory activity of mangostins from Garcinia mangostana." Food and Chemical Toxicology **46**(2): 688-693.

Chen, L. L., J. T. Fang, *et al*. (2005). "Chronic renal disease patients with severe star fruit poisoning: hemoperfusion may be an effective alternative therapy." Clin Toxicol (Phila) **43**(3): 197-9.

Cheng, F.-C., S.-C. Shen, *et al*. (2009). "Effect of Guava (Psidium guajava L.) Leaf Extract on Glucose Uptake in Rat Hepatocytes." Journal of Food Science **74**(5): H132-H138.

Chiang, S. Y., S.-M. Kim, *et al*. "Antiproliferative Effects of Dangyuja (Citrus grandis Osbeck) Leaves Through Suppression of Constitutive Signal Transducer and Activator of Transcription 3 Activation in Human Prostate Carcinoma DU145 Cells." Journal of Medicinal Food **15**(2): 152-160.

Chih-Ping, H., L. Ying-Hsi, *et al*. "Longan flower extract inhibits the growth of colorectal carcinoma." Nutrition and Cancer **62**(2): 229-236.

Chin, Y.-W. and A. D. Kinghorn (2008). "Structural Characterization, Biological Effects, and Synthetic Studies on Xanthones from Mangosteen (Garcinia mangostana), a Popular Botanical Dietary Supplement." Mini-Reviews in Organic Chemistry **5**(4): 355-364.

Chin, Y.-W., E. Shin, *et al*. "Antifibrotic Constituents from Garcinia mangostana." Natural Product Communications **6**(9): 1267-1268.

Chiwororo, W. D. H. and J. A. O. Ojewole (2009). "Spasmolytic effect of Psidium guajava Linn. (Myrtaceae) leaf aqueous extract on rat isolated uterine horns." Journal of smooth muscle research = Nihon Heikatsukin Gakkai kikanshi **45**(1): 31-38.

Chua, Y. A., H. Nurhaslina, *et al*. (2008). "Hyperthermic Effects of Durio zibethinus and Its Interaction with Paracetamol." Methods and Findings in Experimental and Clinical Pharmacology **30**(10): 739-743.

Chuang, P.-T., S.-C. Shen, *et al*. (2008). "Anti-peroxidation effect of guava (Psidium guajava Linn.) leaf soluble solids in vitro and in streptozotocin/nicotinamide-induced diabetic rats." Journal of the Science of Food and Agriculture **88**(12): 2173-2179.

Chung, Y.-C., C.-C. Lin, *et al*. "The effect of Longan seed polyphenols on colorectal carcinoma cells." European Journal of Clinical Investigation **40**(8): 713-721.

Contreras-Calderon, J., L. Calderon-Jaimes, *et al*. (2011). "Antioxidant capacity, phenolic content and vitamin C in pulp, peel and seed from 24 exotic fruits from Colombia." Food Research International **44**(7): 2047-2053.

Cui, J., W. Hu, *et al*. "New medicinal properties of mangostins: Analgesic activity and pharmacological characterization of active ingredients from the fruit hull of Garcinia mangostana L." Pharmacology Biochemistry and Behavior **95**(2): 166-172.

Dal Molin, M. M., S. Silva, *et al*. "Phytochemical analysis and antinociceptive properties of the seeds of Garcinia achachairu." Archives of pharmacal research **35**(4): 623-31.

Dan, J., X. Sheng, *et al*. (2008). "Determination of antioxidant compounds in five kinds of pummelo juices and their antioxidant capacities." Food Science, China **29**(7): 90-93.

Daud, N. H., C. S. Aung, *et al*. "Mango Extracts and the Mango Component Mangiferin Promote Endothelial Cell Migration." Journal of Agricultural and Food Chemistry **58**(8): 5181-5186.

de Faria, A. F., V. V. de Rosso, *et al*. (2009). "Carotenoid Composition of Jackfruit (Artocarpus heterophyllus), Determined by HPLC-PDA-MS/MS." Plant Foods for Human Nutrition **64**(2): 108-115.

de Sousa, O. V., G. D.-V. Vieira, *et al*. "Antinociceptive and Anti-Inflammatory Activities of the Ethanol Extract of Annona muricata L. Leaves in Animal Models." International Journal of Molecular Sciences **11**(5): 2067-2078.

Deguchi, Y. and K. Miyazaki "Anti-hyperglycemic and anti-hyperlipidemic effects of guava leaf extract." Nutrition & Metabolism **7**.

Dembitsky, V. M., S. Poovarodom, *et al*. (2011). "The multiple nutrition properties of some exotic fruits: Biological activity and active metabolites." Food Research International **44**(7): 1671-1701.

Deng-Jye, Y., C. Yuan-Yen, *et al*. "Antiobesity and hypolipidemic effects of polyphenol-rich longan (Dimocarpus longans Lour.) flower water extract in hypercaloric-dietary rats." Journal of Agricultural and Food Chemistry **58**(3): 2020-2027.

Dhiman, A., A. Nanda, *et al*. "Metal analysis in citrus sinensis fruit peel and psidium guajava leaf." Toxicology international **18**(2): 163-167.

Diczbalis, Y. (2010). Tropical exotic fruit industry - strategic direction setting 2010-2012, RIRDC.

Doi, H., M.-A. Shibata, *et al*. (2009). "Panaxanthone Isolated from Pericarp of Garcinia mangostana L. Suppresses Tumor Growth and Metastasis of a Mouse Model of Mammary Cancer." Anticancer Research **29**(7): 2485-2495.

Dutta, S. and S. Das "A study of the anti-inflammatory effect of the leaves of Psidium guajava Linn. on experimental animal models." Pharmacognosy research **2**(5): 313-7.

Einbond, L. S., K. A. Reynertson, *et al*. (2004). "Anthocyanin antioxidants from edible fruits." Food Chemistry **84**(1): 23-28.

Einbond, L. S., K. A. Reynertson, *et al*. (2004). "Anthocyanin antioxidants from edible fruits." Food Chemistry: 84 (1) 23-28 **84**(1): 23-28.

El Sohafy, S. M., A. M. Metwalli, *et al*. (2009). "Quantification of flavonoids of Psidium guajava L. preparations by Planar Chromatography (HPTLC)." Pharmacognosy Magazine **5**(17): 61-66.

Englberger, L., J. Alfred, *et al*. (2007). Screening of selected breadfruit cultivars for carotenoids and related health benefits in Micronesia. Acta Horticulturae. D. T. M. B. Ragone**:** 193-199.

Esquivel, P., F. C. Stintzing, *et al*. (2007). "Phenolic compound profiles and their corresponding antioxidant capacity of purple pitaya (Hylocereus sp.) genotypes." Zeitschrift fur Naturforschung. Section C, Biosciences **62**(9/10): 636-644.

Estrada-Reyes, R., C. Lopez-Rubalcava, *et al*. "Anxiolytic-like and sedative actions of Rollinia mucosa: Possible involvement of the GABA/benzodiazepine receptor complex." Pharmaceutical Biology **48**(1): 70-75.

Fang, H. C., C. L. Chen, *et al*. (2007). "The role of oxalate in star fruit neurotoxicity of five-sixths nephrectomized rats." Food Chem Toxicol **45**(9): 1764-9.

Fang, H. C., C. L. Chen, *et al*. (2001). "Acute oxalate nephropathy induced by star fruit in rats." Am J Kidney Dis **38**(4): 876-80.

Fang, H. C., P. T. Lee, *et al*. (2008). "Mechanisms of star fruit-induced acute renal failure." Food Chem Toxicol **46**(5): 1744-52.

Fang, S.-C., C.-L. Hsu, *et al*. (2008). "Anti-inflammatory effects of phenolic compounds isolated from the fruits of Artocarpus heterophyllus." Journal of Agricultural and Food Chemistry **56**(12): 4463-4468.

Fanning, K., D. Murray, *et al*. (2009). "The health benefits of tropical fruit grown in Queensland, Australia." Proceedings of the tropical fruits in human nutrition and health conference 2008, Couran Cove Island Resort, Gold Coast, Australia, 8-11 November 2008: 202-214.

Farkas, D. and D. J. Greenblatt (2008). "Influence of fruit juices on drug disposition: Discrepancies between in vitro and clinical studies." Expert Opinion on Drug Metabolism and Toxicology **4**(4): 381-393.

Fayek, N. M., A. R. A. Monem, *et al*. "Chemical and biological study of Manilkara zapota (L.) Van Royen leaves (Sapotaceae) cultivated in Egypt." Pharmacognosy research **4**(2): 85-91.

Fernando, M. R., N. Wickramasinghe, *et al*. (1991). "Effect of Artocarpus heterophyllus and Asteracanthus longifolia on glucose tolerance in normal human subjects and in maturity-onset diabetic patients." Journal of Ethnopharmacology **31**(3): 277-82.

Ferreira, E. B., L. C. Fernandes, *et al*. (2008). "Hypoglycemic effect of the hydroalcoholic extract of leaves of Averrhoa carambola L. (Oxalidaceae)." Revista Brasileira De Farmacognosia-Brazilian Journal of Pharmacognosy **18**(3): 339-343.

Fu, H., Y. Luo, *et al*. (2009). "[Studies on chemical constituents of leaves of Psidium guajava]." Zhongguo Zhong yao za zhi = Zhongguo zhongyao zazhi = China journal of Chinese materia medica **34**(5): 577-579.

Fukuji, T. S., F. G. Tonin, *et al*. "Optimization of a method for determination of phenolic acids in exotic fruits by capillary electrophoresis." Journal of Pharmaceutical and Biomedical Analysis **51**(2): 430-438.

Futrakul, B., M. Kanlayavattanakul, *et al*. "Biophysic evaluation of polysaccharide gel from durian's fruit hulls for skin moisturizer." International journal of cosmetic science **32**(3): 211-5.

Girennavar, B., G. K. Jayaprakasha, *et al*. (2008). "Variation of bioactive furocoumarins and flavonoids in different varieties of grapefruits and pummelo." European Food Research and Technology **226**(6): 1269-1275.

Gorinstein, S., M. Zemser, *et al*. (1999). "Comparative content of total polyphenols and dietary fiber in tropical fruits and persimmon." Journal of Nutritional Biochemistry: 10 (6) 367-371 **10**(6): 367-371.

Grenier, J., C. Fradette, *et al*. (2006). "Pomelo juice, but not cranberry juice, affects the pharmacokinetics of cyclosporine in humans." Clinical Pharmacology & Therapeutics **79**(3): 255-262.

Guo, L. Q., Q. Y. Chen, *et al*. (2007). "Different roles of pummelo furanocoumarin and cytochrome P450 3A5*3 polymorphism in the fate and action of felodipine." Current Drug Metabolism **8**(6): 623-630.

Gupta, G. K., C. Jagbir, *et al*. "Psidium guajava Linn: current research and future prospects." Journal of Pharmacy Research **4**(1): 42-46.

Gutiérrez, R. M. P., S. Mitchell, *et al*. (2008). "Psidium guajava: a review of its traditional uses, phytochemistry and pharmacology." Journal of Ethnopharmacology **117**(1): 1-27.

Gyo-Nam, K., S. Jung-Geun, *et al*. (2009). "Antioxidant and antidiabetic activity of Dangyuja (Citrus grandis Osbeck) extract treated with Aspergillus saitoi." Food Chemistry **117**(1): 35-41.

Hamid, M. A., M. R. Sarmidi, *et al*. "Mangosteen leaf extract increases melanogenesis in B16F1 melanoma cells by stimulating tyrosinase activity in vitro and by up-regulating tyrosinase gene expression." International Journal of Molecular Medicine **29**(2): 209-217.

Han, A.-R., J.-A. Kim, *et al*. (2009). "Cytotoxic Xanthone Constituents of the Stem Bark of Garcinia mangostana (Mangosteen)." Journal of Natural Products **72**(11): 2028-2031.

Haruenkit, R., S. Poovarodom, *et al*. (2007). "Comparative study of health properties and nutritional value of durian, mangosteen, and snake fruit: experiments in vitro and in vivo." Journal of Agricultural and Food Chemistry **55**(14): 5842-5849.

Hee-Sung, C., O. Sei-Ryang, *et al*. "Mangosteen xanthones, alpha-and gamma-mangostins, inhibit allergic mediators in bone marrow-derived mast cell." Food Chemistry **134**(1): 397-400.

Herath, K., H. Jayasuriya, *et al*. (2005). "Guttiferone I, a new prenylated benzophenone from Garcinia humilis as a liver X receptor ligand." Journal of Natural Products **68**(4): 617-619.

Hidaka, M., K. Fujita, *et al*. (2004). "Potent inhibition by star fruit of human cytochrome P450 3A (CYP3A) activity." Drug Metab Dispos **32**(6): 581-3.

Hongyu, W., L. Tingting, *et al*. "Profiles and alpha-amylase inhibition activity of proanthocyanidins in unripe Manilkara zapota (chiku)." Journal of Agricultural and Food Chemistry **60**(12): 3098-3104.

Hosoi, S., E. Shimizu, *et al*. (2008). "Analysis of CYP3A inhibitory components of star fruit (Averrhoa carambola L.) using liquid chromatography-mass spectrometry." Nat Med (Tokyo) **62**(3): 345-8.

Hsieh, M.-C., Y.-J. Shen, *et al*. (2008). "Antioxidative activity and active components of longan (Dimocarpus longan Lour.) flower extracts." Journal of Agricultural and Food Chemistry **56**(16): 7010-7016.

Hsu, C.-L., M.-H. Shyu, *et al*. "Cytotoxic effects of geranyl flavonoid derivatives from the fruit of Artocarpus communis in SK-Hep-1 human hepatocellular carcinoma cells." Food Chemistry **127**(1): 127-134.

Hsu, P.-K., K.-M. Lin, *et al*. (2009). "Esterification of insoluble fibres using high-pressure homogenisation and their potential vitamin carrying and releasing abilities." Food Chemistry **113**(4): 1015-1019.

Huang, C.-S., M.-C. Yin, *et al*. "Antihyperglycemic and antioxidative potential of Psidium guajava fruit in streptozotocin-induced diabetic rats." Food and Chemical Toxicology **49**(9): 2189-2195.

Hui-Fang, C., H. Wen-Tsung, *et al*. "Apoptotic effects of gamma-mangostin from the fruit hull of Garcinia mangostana on human malignant glioma cells." Molecules **15**(12): 8953-8966.

Iacomini, M., R. V. Serrato, *et al*. (2005). "Isolation and partial characterization of a pectic polysaccharide from the fruit pulp of Spondias cytherea and its effect on peritoneal macrophage activation." Fitoterapia **76**(7â€“8): 676-683.

Isabelle, M., B. L. Lee, *et al*. "Antioxidant activity and profiles of common fruits in Singapore." Food Chemistry **123**(1): 77-84.

Ishak, S. A., N. Ismail, *et al*. (2005). "Some physical and chemical properties of ambarella (Spondias cytherea Sonn.) at three different stages of maturity." Journal of Food Composition and Analysis **18**(8): 819-827.

Ito, R. K., I. Cordeiro, *et al*. "Chemical Composition and Antimicrobial Activity of the Essential Oil from Rollinia sericea (REFr.) REFr. (Annonaceae) Leaves." Journal of Essential Oil Research **22**(5): 419-421.

Itoh, T., K. Ohguchi, *et al*. (2008). "Inhibitory effect of xanthones isolated from the pericarp of Garcinia mangostana L. on rat basophilic leukemia RBL-2H3 cell degranulation." Bioorganic & Medicinal Chemistry **16**(8): 4500-4508.

Jae-Seok, H., K. Sung-Myung, *et al*. (2009). "Induction of apoptosis by Citrus grandis Osbeck peel (CGP) extract in HL60 cells." Journal of the Korean Society of Food Science and Nutrition **38**(10): 1317-1323.

Jamilah, B., C. E. Shu, *et al*. "Physico-chemical characteristics of red pitaya (Hylocereus polyrhizus) peel." International Food Research Journal **18**(1): 279-286.

Jayakumar, R. and M. S. Kanthimathi "Inhibitory effects of fruit extracts on nitric oxide-induced proliferation in MCF-7 cells." Food Chemistry **126**(3): 956-960.

Jian, S., P. Hongxiang, *et al*. "Anthocyanins extracted from rambutan (Nephelium lappaceum L.) pericarp tissues as potential natural antioxidants." Journal of Food Biochemistry **35**(5): 1461-1467.

Jiang, H. Z., X. F. Quan, *et al*. "Fatty acid synthase inhibitors of phenolic constituents isolated from Garcinia mangostana." Bioorganic & Medicinal Chemistry Letters **20**(20): 6045-6047.

Jo, Y., J. Eun, *et al*. "Protection by methanol extract of longan (Dimocarpus longan Lour.) peel against kainic acid-induced seizure." Natural Product Sciences **16**(2): 99-106.

Johnson, J. J., S. M. Petiwala, *et al*. "alpha-Mangostin, a xanthone from mangosteen fruit, promotes cell cycle arrest in prostate cancer and decreases xenograft tumor growth." Carcinogenesis **33**(2): 413-419.

Jones, A. M. P., D. Ragone, *et al*. "Nutritional and morphological diversity of breadfruit (Artocarpus, Moraceae): Identification of elite cultivars for food security." Journal of Food Composition and Analysis **24**(8): 1091-1102.

Jorge, N., B. J. Bertanha, *et al*. "Antioxidant activity and profile fatty acids of jabuticaba seeds (Myrciaria cauliflora Berg)." Acta Biologica Colombiana **16**(2): 75-82.

Kawakami, Y., T. Hosokawa, *et al*. "Antiatherogenic effect of guava leaf extracts inhibiting leucocyte-type 12-lipoxygenase activity." Food Chemistry **131**(4): 1069-1075.

Kikuchi, H., T. Ohtsuki, *et al*. "Activity of Mangosteen Xanthones and Teleocidin A-2 in Death Receptor Expression Enhancement and Tumor Necrosis Factor Related Apoptosis-Inducing Ligand Assays." Journal of Natural Products **73**(3): 452-455.

Kim, H., J. Y. Moon, *et al*. "Induction of apoptosis in human cervical carcinoma HeLa cells by polymethoxylated flavone-rich Citrus grandis Osbeck (Dangyuja) leaf extract." Food and Chemical Toxicology **48**(8â€“9): 2435-2442.

Kim, Y., M. Cho, *et al*. (2008). "In vitro Antioxidant and Cytoprotective Activities of the Extract of Dangyuja (Citrus grandis Osbeck) Leaves." Food Science and Biotechnology **17**(5): 1086-1091.

Ko, Y.-M., T.-Y. Wu, *et al*. "Annonacin induces cell cycle-dependent growth arrest and apoptosis in estrogen receptor-Î±-related pathways in MCF-7 cells." Journal of Ethnopharmacology **137**(3): 1283-1290.

Kuan-Chou, C., H. Chiu-Lan, *et al*. (2009). "Anticancer activity of rhamnoallosan against DU-145 cells is kinetically complementary to coexisting polyphenolics in Psidium guajava budding leaves." Journal of Agricultural and Food Chemistry **57**(14): 6114-6122.

Kui, Z., W. Qiang, *et al*. "Evaluation of radicals scavenging, immunity-modulatory and antitumor activities of longan polysaccharides with ultrasonic extraction on in S180 tumor mice models." International Journal of Biological Macromolecules **47**(3): 356-360.

Lee, S.-B. and H.-R. Park "Anticancer activity of guava (Psidium guajava L.) branch extracts against HT-29 human colon cancer cells." Journal of Medicinal Plants Research **4**(10): 891-896.

Leite, A. V., L. G. Malta, *et al*. "Antioxidant Potential of Rat Plasma by Administration of Freeze-Dried Jaboticaba Peel (Myrciaria jaboticaba Vell Berg)." Journal of Agricultural and Food Chemistry **59**(6): 2277-2283.

Leontowicz, H., M. Leontowicz, *et al*. (2006). "Bioactive properties of Snake fruit (Salacca edulis Reinw) and Mangosteen (Garcinia mangostana) and their influence on plasma lipid profile and antioxidant activity in rats fed cholesterol." European Food Research and Technology **223**(5): 697-703.

Leontowicz, H., M. Leontowicz, *et al*. (2008). "Durian (Durio zibethinus Murr.) cultivars as nutritional supplementation to rat's diets." Food and Chemical Toxicology **46**(2): 581-589.

Leontowicz, H., M. Leontowicz, *et al*. (2008). "Durian (Durio zibethinus Murr.) cultivars as nutritional supplementation to rat's diets." Food and Chemical Toxicology **46**(2): 581-589.

Leontowicz, H., M. Leontowicz, *et al*. "Positive effects of durian fruit at different stages of ripening on the hearts and livers of rats fed diets high in cholesterol." European Journal of Integrative Medicine **3**(3): e169-e181.

Leontowicz, M., H. Leontowicz, *et al*. (2007). "Two exotic fruits positively affect rat's plasma composition." Food Chemistry: 102 (1) 192-200 **102**(1): 192-200.

Leontowicz, M., H. Leontowicz, *et al*. (2007). "The nutritional and metabolic indices in rats fed cholesterol-containing diets supplemented with durian at different stages of ripening." BioFactors **29**(2-3): 123-136.

Levy, A. S. and S. Carley "Cytotoxic activity of hexane extracts of Psidium guajava L (Myrtaceae) and Cassia alata L (Caesalpineaceae) in Kasumi-1 and OV2008 cancer cell lines." Tropical Journal of Pharmaceutical Research **11**(2): 201-207.

Li, A., B. Xie, *et al*. (2008). "Comparative antioxidant activities of Manilkara zapodilla, Chrysophyllum cainto and Pouteria sapota." Acta Horticulturae Sinica **35**(2): 175-180.

Lim, H.-K., J. Y. Moon, *et al*. (2009). "Induction of apoptosis in U937 human leukaemia cells by the hexane fraction of an extract of immature Citrus grandis Osbeck fruits." Food Chemistry **114**(4): 1245-1250.

Lim, H. K., E. S. Yoo, *et al*. (2006). "Antioxidant activity of extracts from Dangyuja (Citrus grandis Osbeck) fruits produced in Jeju Island." Food Science and Biotechnology **15**(2): 312-316.

Lin, S.-P., P.-D. L. Chao, *et al*. "Citrus grandis Peel Increases the Bioavailability of Cyclosporine and Tacrolimus, Two Important Immunosuppressants, in Rats." Journal of Medicinal Food **14**(11): 1463-1468.

Ling, L. T., Y. Saito, *et al*. "Cytoprotective effects of geraniin against peroxynitrite- and peroxyl radical-induced cell death via free radical scavenging activity." Food Chemistry **132**(4): 1899-1907.

Liping, S., Z. Huilin, *et al*. "Preparation of free, soluble conjugate, and insoluble-bound phenolic compounds from peels of rambutan (Nephelium lappaceum) and evaluation of antioxidant activities in vitro." Journal of Food Science **77**(2): C198-C204.

Liu, C.-W., D.-J. Yang, *et al*. "Polyphenol-rich longan (Dimocarpus longan Lour.)-flower-water-extract attenuates nonalcoholic fatty liver via decreasing lipid peroxidation and downregulating matrix metalloproteinases-2 and -9." Food Research International **45**(1): 444-449.

Liu, C., C. Peng, *et al*. "Polyphenolics-rich Psidium guajava budding leaf extract canreverse diabetes-induced functional impairment of cavernosal smooth muscle relaxation in rats." Research Journal of Medical Sciences **4**(1): 25-32.

Liu, Y., X. Zhang, *et al*. (2009). "Extraction and purification of flavonoids in Carambola." Journal of Shenyang Agricultural University **40**(4): 491-493.

Livingston Raja, N. R. and K. Sundar "Psidium guajava Linn confers gastro protective effects on rats." European review for medical and pharmacological sciences **16**(2): 151-6.

Lobb, A. L. "Science in liquid dietary supplement promotion: the misleading case of mangosteen juice." Hawai'i journal of medicine & public health : a journal of Asia Pacific Medicine & Public Health **71**(2): 46-8.

Losuwannarak, N., C. Pasadhika, *et al*. (2009). "Effects of longan seed extract on scopolamine-induced learning and memory deficit in mice." The Thai Journal of Pharmaceutical Sciences **33**(1): 33-38.

Luo, X. D., M. J. Basile, *et al*. (2002). "Polyphenolic antioxidants from the fruits of Chrysophyllum cainito L. (star apple)." Journal of Agricultural and Food Chemistry **50**(6): 1379-1382.

Ma, J., X. D. Luo, *et al*. (2003). "Bioactive novel polyphenols from the fruit of Manilkara zapota (Sapodilla)." Journal of Natural Products **66**(7): 983-986.

Ma, J., H. Yang, *et al*. (2004). "Analysis of polyphenolic antioxidants from the fruits of three pouteria species by selected ion monitoring liquid chromatography-mass spectrometry." J Agric Food Chem **52**(19): 5873-8.

Macedo-Costa, M. R., D. N. Diniz, *et al*. (2009). ""Effectiveness of the Myrciaria cauliflora (Mart.) O. Berg. extract on oral bacteria"." Revista Brasileira De Farmacognosia-Brazilian Journal of Pharmacognosy **19**(2B): 565-571.

Mahattanatawee, K., J. A. Manthey, *et al*. (2006). "Total antioxidant activity and fiber content of select Florida-grown tropical fruits." Journal of Agricultural and Food Chemistry **54**(19): 7355-7363.

Maia, J. G. S., E. H. A. Andrade, *et al*. (2003). "Volatiles from fruits of Pouteria pariry (Ducke) Baehni and P. caimito (Ruiz and Pavon.) Rdlkl." Journal of Essential Oil-Bearing Plants **6**(2): 127-129.

Manju, R. and R. Sushovan "Ameliorative potential of Psidium guajava in induced arsenic toxicity in Wistar rats." Veterinary World **4**(2): 82-83.

Marin-Restrepo, L. and D. Rosselli (2008). "[Intoxication with Averrhoa carambola in a patient on chronic dialysis]." Nefrologia **28**(1): 117-8.

Matsushige, A., Y. Kotake, *et al*. "Annonamine, a New Aporphine Alkaloid from the Leaves of Annona muricata." Chemical & Pharmaceutical Bulletin **60**(2): 257-259.

Melot, A., D. Fall, *et al*. (2009). "Apolar Annonaceous Acetogenins from the Fruit Pulp of Annona muricata." Molecules **14**(11): 4387-4395.

Metwally, A. M., A. A. Omar, *et al*. "Monograph of Psidium guajava L. leaves." Pharmacognosy Journal **3**(21): 89-104.

Milind, P. and B. Ekta "Guava: a promising memory enhancer in rodents." International Journal of Plant Sciences (Muzaffarnagar) **5**(1): 297-301.

Milind, P. and B. Ekta "Psidium guajava: an affordable tasty medicine." International Journal of Plant Sciences (Muzaffarnagar) **5**(1): 385-392.

Mokbel, M. S. (2005). "Antioxidant activities of water-soluble polysaccharides from buntan (Citrus grandis Osbeck) fruit flavedo tissues." Pakistan Journal of Biological Sciences **8**(10): 1472-1477.

Monteith, G. R., A. S. Wilkinson, *et al*. (2009). "Discovery of bioactives in tropical fruits." Proceedings of the tropical fruits in human nutrition and health conference 2008, Couran Cove Island Resort, Gold Coast, Australia, 8-11 November 2008: 189-194.

Moresco, H. H., G. S. Queiroz, *et al*. "Chemical constituents and evaluation of the toxic and antioxidant activities of Averrhoa carambola leaves." Revista Brasileira De Farmacognosia-Brazilian Journal of Pharmacognosy **22**(2): 319-324.

Morton, J. F. (1987). Biriba. Fruits of warm climates. Miami, FL**:** 88-90.

Morton, J. F. (1987). Black Sapote. Fruits of warm climates. Miami, FL**:** 416-18.

Morton, J. F. (1987). Fruits of warm climates. Miami, FL.

Morton, J. F. (1987). Jaboticaba. Fruits of warm climates. Miami, FL**:** 371-4.

Morton, J. F. (1987). Mamey Sapote. Fruits of warm climates. Miami, FL**:** 398-402.

Morton, J. F. (1987). Rambutan. Fruits of warm climates. Miami, FL**:** 262-265.

Morton, J. F. (1987). Star Apple. Fruits of warm climates. Miami, FL**:** 408-410.

Murillo, E., R. McLean, *et al*. "Sapotexanthin, an A-Provitamin Carotenoid from Red Mamey (Pouteria sapota)." Journal of Natural Products **74**(2): 283-285.

Nair, R. and S. Chanda (2008). "Antimicrobial Activity of Terminalia catappa, Manilkara zapota and Piper betel Leaf Extract." Indian Journal of Pharmaceutical Sciences **70**(3): 390-U21.

Neng-Guo, T. and L. Yue-Jin "Chemical composition and antimicrobial activity of the essential oil from the peel of Shatian pummelo (Citrus grandis Osbeck)." International Journal of Food Properties **15**(3): 709-716.

Neto, M. M., J. A. da Costa, *et al*. (2003). "Intoxication by star fruit (Averrhoa carambola) in 32 uraemic patients: treatment and outcome." Nephrol Dial Transplant **18**(1): 120-5.

Neto, M. M., F. Robl, *et al*. (1998). "Intoxication by star fruit (Averrhoa carambola) in six dialysis patients? (Preliminary report)." Nephrol Dial Transplant **13**(3): 570-2.

Niticharoenpong, K., P. Chalermsanyakorn, *et al*. (2006). "Acute deterioration of renal function induced by star fruit ingestion in a patient with chronic kidney disease." J Nephrol **19**(5): 682-6.

Nont, T., T. Aphiwat, *et al*. (2008). "Antioxidant and antibacterial activities of Nephelium lappaceum L. extracts." LWT -- Food Science and Technology **41**(10): 2029-2035.

Nurmahani, M. M., A. Osman, *et al*. "Antibacterial property of Hylocereus polyrhizus and Hylocereus undatus peel extracts." International Food Research Journal **19**(1): 77-84.

Nwokocha, L. M. and P. A. Williams "Comparative study of physicochemical properties of breadfruit (Artocarpus altilis) and white yam starches." Carbohydrate Polymers **85**(2): 294-302.

Obolskiy, D., I. Pischel, *et al*. (2009). "Garcinia mangostana L.: A Phytochemical and Pharmacological Review." Phytotherapy Research **23**(8): 1047-1065.

Ojewole, J. A. O., E. O. Awe, *et al*. (2008). "Antidiarrhoeal activity of Psidium guajava Linn. (Myrtaceae) leaf aqueous extract in rodents." Journal of smooth muscle research = Nihon Heikatsukin Gakkai kikanshi **44**(6): 195-207.

Oliveira, A. L. d., E. d. Almeida, *et al*. (2006). "Elemental contents in exotic Brazilian tropical fruits evaluated by Energy Dispersive X-ray Fluorescence." Scientia Agricola **63**(1): 82-84.

Oliveira, D. D. S., A. L. Lobato, *et al*. "Carotenoids and Vitamin C during Handling and Distribution of Guava (Psidium guajava L.), Mango (Mangifera indica L.), and Papaya (Carica papaya L.) at Commercial Restaurants." Journal of Agricultural and Food Chemistry **58**(10): 6166-6172.

Oloyede, O. I. Antimicrobial properties and chemical constituents of Psidium guajava leaf.

Om, P., K. Rajesh, *et al*. (2009). "Artocarpus heterophyllus (Jackfruit): an overview." Pharmacognosy Reviews **3**(6): 353-358.

Omar, H. S., H. A. El-Beshbishy, *et al*. "Antioxidant activity of Artocarpus heterophyllus Lam. (Jack Fruit) leaf extracts: remarkable attenuations of hyperglycemia and hyperlipidemia in streptozotocin-diabetic rats." TheScientificWorldJournal **11**: 788-800.

Omidizadeh, A., R. M. Yusof, *et al*. "Cardioprotective compounds of red pitaya (Hylocereus polyrhizus) fruit." Journal of Food Agriculture & Environment **9**(3-4): 152-156.

Ong, C. Y., S. K. Ling, *et al*. (2009). "Systematic analysis of in vitro photo-cytotoxic activity in extracts from terrestrial plants in Peninsula Malaysia for photodynamic therapy." Journal of Photochemistry and Photobiology B: Biology **96**(3): 216-222.

Osman, M. A., M. M. Rashid, *et al*. "Inhibition of Ehrlich ascites carcinoma by Manilkara zapota L. stem bark in Swiss albino mice." Asian Pacific Journal of Tropical Biomedicine **1**(6): 448-451.

Osmani, O. H., D. S. Sekar, *et al*. (2009). "In vivo antidiabetic potential of Artocarpus heterophyllus plant seeds in streptozotocin-induced-diabetic rats." Biomedical & Pharmacology Journal **2**(2): 339-343.

Owen, P. L., L. C. Martineau, *et al*. (2008). "Consumption of guava (Psidium guajava L) and noni (Morinda citrifolia L) may protect betel quid-chewing Papua New Guineans against diabetes." Asia Pacific Journal of Clinical Nutrition **17**(4): 635-643.

Paarakh, P. M., J. P. N. Chansouria, *et al*. (2009). "Wound healing activity of Annona muricata extract." Journal of Pharmacy Research **2**(3): 404-406.

Padhy, I. P., M. Yedukondalu, *et al*. (2008). "Effect of fruits of Averrhoa carambola against CCl 4-induced hepatotoxicity." Indian Journal of Natural Products **24**(3): 17-21.

Palanisamy, U., M. Thamilvaani, *et al*. "Rambutan rind in the management of hyperglycemia." Food Research International **44**(7): 2278-2282.

Park, S. J., D. H. Park, *et al*. "The memory-enhancing effects of Euphoria longan fruit extract in mice." Journal of Ethnopharmacology **128**(1): 160-165.

Paulsi, S. and P. Dhasarathan "Screening of antioxidant properties in Durio zibethinus using rodent models." Journal of Pharmacy Research **4**(7): 2300-2302.

Payal, M., G. Vikas, *et al*. "Phytochemistry and pharmacological activities of Psidium guajava: a review." International Journal of Pharmaceutical Sciences and Research (IJPSR) **1**(9 Suppl.): 9-19.

Peng, C.-C., C.-H. Peng, *et al*. "The Aqueous Soluble Polyphenolic Fraction of Psidium guajava Leaves Exhibits Potent Anti-Angiogenesis and Anti-Migration." Evidence-Based Complementary and Alternative Medicine **2011**: 1-8.

Perez, G. R., S. R. Vargas, *et al*. (2005). "Wound healing properties of Hylocereus undatus on diabetic rats." Phytother Res **19**(8): 665-8.

Phebe, D., M. K. Chew, *et al*. (2009). "Red-fleshed pitaya (Hylocereus polyrhizus) fruit colour and betacyanin content depend on maturity." International Food Research Journal **16**(2): 233-242.

Pholdaeng, K. and S. Pongsamart "Studies on the immunomodulatory effect of polysaccharide gel extracted from Durio zibethinus in Penaeus monodon shrimp against Vibrio harveyi and WSSV." Fish & Shellfish Immunology **28**(4): 555-561.

Pichaiyongvongdee, S. and R. Haruenkit (2009). "Comparative studies of limonin and naringin distribution in different parts of pummelo [Citrus grandis (L.) Osbeck] cultivars grown in Thailand." Kasetsart Journal, Natural Sciences **43**(1): 28-36.

Pierson, J. T., R. G. Dietzgen, *et al*. "Major Australian tropical fruits biodiversity: Bioactive compounds and their bioactivities." Molecular Nutrition & Food Research **56**(3): 357-387.

Pierson, J. T., R. G. Dietzgen, *et al*. "Major Australian tropical fruits biodiversity: bioactive compounds and their bioactivities." Molecular Nutrition and Food Research **56**(3): 357-387.

Pothitirat, W., M. T. Chomnawang, *et al*. "Free radical scavenging and anti-acne activities of mangosteen fruit rind extracts prepared by different extraction methods." Pharmaceutical Biology **48**(2): 182-186.

Prasad, S. K., K. Alka, *et al*. (2008). "Antidiabetic potential of Psidium guajava in streptozotocin induced diabetic albino rats." Biochemical and Cellular Archives **8**(1): 151-154.

Prasad, S. K., T. N. Qureshi, *et al*. (2008). "Effect of Psidium guajava bark extract in neurotransmitter induced hyperglycemic albino rats." Journal of Experimental Zoology, India **11**(1): 45-47.

Priscilla, D. M. and R. Milan "Hepatoprotective activity of Psidium guajava extract and its phospholipid complex in paracetamol induced hepatic damage in rats." International Journal of Phytomedicine **2**(1): 85-93.

Priya, E. M., K. M. Gothandam, *et al*. "Antidiabetic activity of Feronia limonia and Artocarpus heterophyllus in streptozotocin induced diabetic rats." American Journal of Food Technology **7**(1): 43-49.

Queiroz Paulo, M. d., M. A. C. Kaplan, *et al*. (1991). "Lignans and other non-alkaloidal constituents from Rollinia mucosa." Fitoterapia **62**(2): 150-152.

Rahmat, A., M. F. Abu-Bakar, *et al*. (2006). "The effects of guava (Psidium guajava) consumption on total antioxidant and lipid profile in normal male youth." African Journal of Food, Agriculture, Nutrition and Development: 6 (2) 12pp. **6**(2): 12pp.

Rai, P. K., D. Jaiswal, *et al*. (2009). "Anti-hyperglycaemic potential of Psidium guajava raw fruit peel." The Indian journal of medical research **129**(5): 561-565.

Rai, P. K., S. Mehta, *et al*. "Hypolipidaemic & hepatoprotective effects of Psidium guajava raw fruit peel in experimental diabetes." Indian Journal of Medical Research **131**(6): 820-824.

Ramful, D., E. Tarnus, *et al*. "Polyphenol composition, vitamin C content and antioxidant capacity of Mauritian citrus fruit pulps." Food Research International **44**(7): 2088-2099.

Ramida, W., J. Faongchat, *et al*. "Potential of xanthones from tropical fruit mangosteen as anti-cancer agents: caspase-dependent apoptosis induction in vitro and in mice." Applied Biochemistry and Biotechnology **162**(4): 1080-1094.

Rangkadilok, N., S. Tongchusak, *et al*. "In vitro antifungal activities of longan (Dimocarpus longan Lour.) seed extract." Fitoterapia **83**(3): 545-553.

Rao, Y. K., M.-J. Lee, *et al*. "Insulin-Mimetic Action of Rhoifolin and Cosmosiin Isolated from Citrus grandis (L.) Osbeck Leaves: Enhanced Adiponectin Secretion and Insulin Receptor Phosphorylation in 3T3-L1 Cells." Evidence-Based Complementary and Alternative Medicine: 1-9.

Rassameemasmaung, S., A. Sirikulsathean, *et al*. (2008). "Topical application of Garcinia mangostana L. pericarp gel as an adjunct to periodontal treatment." Complementary Therapies in Medicine **16**(5): 262-267.

Reynertson, K. A., H. Yang, *et al*. (2008). "Quantitative analysis of antiradical phenolic constituents from fourteen edible Myrtaceae fruits." Food Chemistry **109**(4): 883-890.

Roslida, A. H., C. E. Tay, *et al*. "Anti-inflammatory and anti-nociceptive activities of the ethanolic extract of Annona muricata leaf." Journal of Natural Remedies **10**(2): 97-104.

Roy, C. K. and A. K. Das "COMPARATIVE EVALUATION OF DIFFERENT EXTRACTS OF LEAVES OF PSIDIUM GUAJAVA LINN. FOR HEPATOPROTECTIVE ACTIVITY." Pakistan Journal of Pharmaceutical Sciences **23**(1): 15-20.

Ryu, N. H., K.-R. Park, *et al*. "A Hexane Fraction of Guava Leaves (Psidium guajava L.) Induces Anticancer Activity by Suppressing AKT/Mammalian Target of Rapamycin/Ribosomal p70 S6 Kinase in Human Prostate Cancer Cells." Journal of Medicinal Food **15**(3): 231-241.

Saewan, N., J. D. Sutherland, *et al*. (2006). "Antimalarial tetranortriterpenoids from the seeds of Lansium domesticum Corr." Phytochemistry **67**(20): 2288-2293.

Sambo, N., S. H. Garba, *et al*. (2009). "Effect of the aqueous extract of Psidium guajava on erythromycin-induced liver damage in rats." Nigerian journal of physiological sciences : official publication of the Physiological Society of Nigeria **24**(2): 171-6.

Sanchez-Perez, Y., R. Morales-Barcenas, *et al*. (2010). "The alpha-mangostin prevention on cisplatin-induced apoptotic death in LLC-PK1 cells is associated to an inhibition of ROS production and p53 induction." Chemico-Biological Interactions **188**(1): 144-150.

Sanda, K. A., H. A. Grema, *et al*. "Pharmacological Aspects of Psidium guajava: An Update." International Journal of Pharmacology **7**(3): 316-324.

Sandhya, L., D. Roopam, *et al*. "Anti-inflammatory activity of Artocarpus heterophyllus bark." Der Pharmacia Sinica **2**(2): 127-130.

Sanjay, J., S. Rajani, *et al*. "Effect of fruit extract of Artocarpus heterophyllus in alloxan induced diabetic rats." International Journal of Pharmaceutical Sciences and Research (IJPSR) **1**(11): 59-64.

Sarmistha, D. and D. Swarnamoni "Effect of the leaves of Psidium guajava Linn. on experimentally induced colitis in animal models." International Journal of Green Pharmacy **5**(1): 55-60.

Serji, K. and K. S. Devi (1993). "Dietary fiber from Musa paradisiaca and Artocarpus heterophyllus on intestinal mucosal and bacterial beta-glucuronidase activity in hexachlorocyclohexane-treated rats." Bull Environ Contam Toxicol **50**(2): 293-9.

Shah, A. J., S. Begum, *et al*. "Pharmacological basis for the medicinal use of Psidium guajava leave in hyperactive gut disorders." Bangladesh Journal of Pharmacology **6**(2): 100-105.

Shan, T., Q. Ma, *et al*. "Xanthones from Mangosteen Extracts as Natural Chemopreventive Agents: Potential Anticancer Drugs." Current Molecular Medicine **11**(8): 666-677.

Shejuty, S., B. Joyanta, *et al*. "Antihyperglycemic activities of leaves of three edible fruit plants (Averrhoa carambola, Ficus hispida and Syzygium samarangense) of Bangladesh." African Journal of Traditional, Complementary and Alternative Medicines **9**(2): 287-291.

Shen, S.-C., F.-C. Cheng, *et al*. (2008). "Effect of guava (Psidium guajava Linn.) leaf soluble solids on glucose metabolism in type 2 diabetic rats." Phytotherapy research : PTR **22**(11): 1458-1464.

Shibata, M.-A., M. Iinuma, *et al*. "alpha-Mangostin extracted from the pericarp of the mangosteen (Garcinia mangostana Linn) reduces tumor growth and lymph node metastasis in an immunocompetent xenograft model of metastatic mammary cancer carrying a p53 mutation." Bmc Medicine **9**.

Siddesha, J. M., N. Angaswamy, *et al*. "Phytochemical screening and evaluation of in vitro angiotensin-converting enzyme inhibitory activity of Artocarpus altilis leaf." Natural Product Research **25**(20): 1931-1940.

Singh, R. B. and S. S. Rastogi (1997). "Effects on plasma ascorbic acid and coronary risk." Journal of Nutritional & Environmental Medicine **7**(1): 5.

Singh, R. B., S. S. Rastogi, *et al*. (1993). "Can Guava Fruit Intake Decrease Blood-Pressure and Blood-Lipids." Journal of Human Hypertension **7**(1): 33-38.

Singh, R. B., S. S. Rastogi, *et al*. (1992). "Effects of Guava Intake on Serum Total and High-Density-Lipoprotein Cholesterol Levels and on Systemic Blood-Pressure." American Journal of Cardiology **70**(15): 1287-1291.

Siritapetawee, J. and S. Thammasirirak "Purification and characterization of a heteromultimeric glycoprotein from Artocarpus heterophyllus latex with an inhibitory effect on human blood coagulation." Acta Biochimica Polonica **58**(4): 521-528.

Siritapetawee, J., K. Thumanu, *et al*. "A novel serine protease with human fibrino(geno)lytic activities from Artocarpus heterophyllus latex." Biochimica et Biophysica Acta (BBA) - Proteins and Proteomics **In Press, Uncorrected Proof**.

Soman, S., C. Rajamanickam, *et al*. "Beneficial effects of Psidium guajava leaf extract on diabetic myocardium." Experimental and Toxicologic Pathology(0).

Soman, S., A. A. Rauf, *et al*. "Antioxidant and Antiglycative Potential of Ethyl Acetate Fraction of Psidium guajava Leaf Extract in Streptozotocin-Induced Diabetic Rats." Plant Foods for Human Nutrition **65**(4): 386-391.

Soncini, R., M. B. Santiago, *et al*. "Hypotensive effect of aqueous extract of Averrhoa carambola L. (Oxalidaceae) in rats: An in vivo and in vitro approach." Journal of Ethnopharmacology **133**(2): 353-357.

Su, D., M. Zhang, *et al*. "Effects of water soluble extracts from longan on immune regulation in normal mice." Scientia Agricultura Sinica **43**(9): 1919-1925.

Taju, G., M. Jayanthi, *et al*. "Hepatoprotective effect of Indian medicinal plant Psidium guajava Linn. leaf extract on paracetamol induced liver toxicity in Albino rats." Journal of Pharmacy Research **3**(8): 1759-1763.

Tang, Y.-P., P.-G. Li, *et al*. (2009). "Effect of a Mangosteen Dietary Supplement on Human Immune Function: A Randomized, Double-Blind, Placebo-Controlled Trial." Journal of Medicinal Food **12**(4): 755-763.

Tangpong, J., S. Miriyala, *et al*. "Doxorubicin-induced central nervous system toxicity and protection by xanthone derivative of Garcinia Mangostana." Neuroscience **175**(0): 292-299.

Tao, N., Y. Gao, *et al*. "Carotenoids from the peel of Shatian pummelo (Citrus grandis Osbeck) and its antimicrobial activity." American-Eurasian Journal of Agricultural and Environmental Science **7**(1): 110-115.

Tenore, G. C., E. Novellino, *et al*. "Nutraceutical potential and antioxidant benefits of red pitaya (Hylocereus polyrhizus) extracts." Journal of Functional Foods **4**(1): 129-136.

Tewtrakul, S., C. Wattanapiromsakul, *et al*. (2009). "Effects of compounds from Garcinia mangostana on inflammatory mediators in RAW264.7 macrophage cells." Journal of Ethnopharmacology **121**(3): 379-382.

Thitilertdecha, N. and N. Rakariyatham "Phenolic content and free radical scavenging activities in rambutan during fruit maturation." Scientia Horticulturae **129**(2): 247-252.

Thitilertdecha, N., A. Teerawutgulrag, *et al*. "Identification of Major Phenolic Compounds from Nephelium lappaceum L. and Their Antioxidant Activities." Molecules **15**(3): 1453-1465.

Thuaytong, W. and P. Anprung "Bioactive Compounds and Prebiotic Activity in Thailand-Grown Red and White Guava Fruit (Psidium guajava L.)." Food Science and Technology International **17**(3): 205-212.

Tian, Q. G., J. Dai, *et al*. (2000). "[Screening for limonoid glucosides in Citrus grandis L. Osbeck by high performance liquid chromatography-electrospray ionization/mass spectrometry]." Se Pu **18**(4): 291-4.

Toledo, F., P. Arancibia-Avila, *et al*. (2008). "Screening of the antioxidant and nutritional properties, phenolic contents and proteins of five durian cultivars." International Journal of Food Sciences and Nutrition **59**(5): 415-427.

Toledo, F., P. Arancibia-Avila, *et al*. (2008). "Screening of the antioxidant and nutritional properties, phenolic contents and proteins of five durian cultivars." Int J Food Sci Nutr **59**(5): 415-427.

Torres-Rodríguez, A., Y. Salinas-Moreno, *et al*. "Soluble phenols and antioxidant activity in mamey sapote (Pouteria sapota) fruits in postharvest." Food Research International **44**(7): 1956-1961.

Torres, M. a. P., S. Rachagani, *et al*. "Graviola: A novel promising natural-derived drug that inhibits tumorigenicity and metastasis of pancreatic cancer cells in vitro and in vivo through altering cell metabolism." Cancer Letters(0).

Trevisan, L. M., F. O. Bobbio, *et al*. (1972). "Carbohydrates, organic acids and anthocyanins of Myrciaria jaboticaba, Berg." Journal of Food Science **37**(6): 818-819.

Tsai, H.-Y., L.-Y. Wu, *et al*. (2008). "Effect of a Proanthocyanidin-Rich Extract from Longan Flower on Markers of Metabolic Syndrome in Fructose-Fed Rats." Journal of Agricultural and Food Chemistry **56**(22): 11018-11024.

Tsai, M. H., W. N. Chang, *et al*. (2005). "Status epilepticus induced by star fruit intoxication in patients with chronic renal disease." Seizure **14**(7): 521-5.

Tse, K. C., P. S. Yip, *et al*. (2003). "Star fruit intoxication in uraemic patients: case series and review of the literature." Intern Med J **33**(7): 314-6.

Udani, J. K., B. B. Singh, *et al*. (2009). "Evaluation of Mangosteen juice blend on biomarkers of inflammation in obese subjects: a pilot, dose finding study." Nutrition Journal **8**.

Vaillant, F., A. Perez, *et al*. (2005). "Colorant and antioxidant properties of red-purple pitahaya (Hylocereus sp.)." Fruits (Paris) **60**(1): 3-12.

Vasconcelos, C. M. L., A. N. S. Gondim, *et al*. (2008). "Aqueous leaf extract of Averrhoa carambola L. (Oxalidaceae) reduces both the inotropic effect of BAY K 8644 on the guinea pig atrium and the calcium current on GH(3) cells." Revista Brasileira De Farmacognosia-Brazilian Journal of Pharmacognosy **18**(4): 539-543.

Villalobos-Gutierrez, M. G., R. M. Schweiggert, *et al*. "Chemical characterization of Central American pitaya (Hylocereus sp.) seeds and seed oil." Cyta-Journal of Food **10**(1): 78-83.

Viyoch, J., S. Buranajaree, *et al*. "Evaluation of the effect of Thai breadfruit's heartwood extract on the biological functions of fibroblasts from wrinkles." Journal of Cosmetic Science **61**(4): 311-324.

Wang, B.-S., C.-H. Tang, *et al*. "Inhibitory effects of water extract from longan twigs on mutation and nitric oxide production." Food Chemistry(0).

Wang, H., Y.-J. Du, *et al*. "alpha-Glucosidase and alpha-amylase inhibitory activities of guava leaves." Food Chemistry **123**(1): 6-13.

Wang, K., Y. Liang, *et al*. Chapter 83 - Antioxidant Activity of Longan (Dimocarpus Longan L.) Seed Extract. Nuts and Seeds in Health and Disease Prevention. San Diego, Academic Press**:** 705-710.

Wang, Y.-C., Y.-C. Chuang, *et al*. (2008). "The flavonoid, carotenoid and pectin content in peels of citrus cultivated in Taiwan." Food Chemistry **106**(1): 277-284.

Wang, Y., Z. Xia, *et al*. "Î±-Mangostin, a polyphenolic xanthone derivative from mangosteen, attenuates Î²-amyloid oligomers-induced neurotoxicity by inhibiting amyloid aggregation." Neuropharmacology **62**(2): 871-881.

Wang, Y., K. Xu, *et al*. (2007). "Geranyl flavonoids from the leaves of Artocarpus altilis." Phytochemistry **68**(9): 1300-1306.

Wang, Y. C., B. M. Liu, *et al*. (2006). "Management of star fruit-induced neurotoxicity and seizures in a patient with chronic renal failure." Pharmacotherapy **26**(1): 143-6.

Wichienchot, S., M. Jatupornpipat, *et al*. "Oligosaccharides of pitaya (dragon fruit) flesh and their prebiotic properties." Food Chemistry **120**(3): 850-857.

Wilkinson, A. S., G. R. Monteith, *et al*. (2008). "Effects of the mango components mangiferin and quercetin and the putative mangiferin metabolite norathyriol on the transactivation of peroxisome proliferator-activated receptor isoforms." Journal of Agricultural and Food Chemistry **56**(9): 3037-3042.

Witayapan, N., Y. Songwut, *et al*. "Factors influencing antioxidant activities and total phenolic content of guava leaf extract." LWT -- Food Science and Technology **43**(7): 1095-1103.

Wittenauer, J., S. Falk, *et al*. "Characterisation and quantification of xanthones from the aril and pericarp of mangosteens (Garcinia mangostana L.) and a mangosteen containing functional beverage by HPLC-DAD-MS n." Food Chemistry **134**(1): 445-452.

Wu, L. C., H. W. Hsu, *et al*. (2006). "Antioxidant and antiproliferative activities of red pitaya." Food Chemistry **95**(2): 319-327.

Wu, M.-z., G. Xie, *et al*. "[Cough-relieving, analgesic and antibiotic effects of durian shell extracts: a study in mice]." Nan fang yi ke da xue xue bao = Journal of Southern Medical University **30**(4): 793-7.

Wu, X., Y. Wang, *et al*. "Three new glycosides from Hylocereus undatus." Journal of Asian natural products research **13**(8): 728-733.

Wybraniec, S. and Y. Mizrahi (2002). "Fruit flesh betacyanin pigments in hylocereus cacti." J Agric Food Chem **50**(21): 6086-9.

Wybraniec, S., B. Nowak-Wydra, *et al*. (2007). "Minor betalains in fruits of Hylocereus species." Phytochemistry **68**(2): 251-9.

Xu, C. J., P. D. Fraser, *et al*. (2006). "Differences in the carotenoid content of ordinary citrus and lycopene-accumulating mutants." J Agric Food Chem **54**(15): 5474-81.

Yahia, E. M., F. Gutierrez-Orozco, *et al*. "Phytochemical and antioxidant characterization of the fruit of black sapote (Diospyros digyna Jacq.)." Food Research International **44**(7): 2210-2216.
Yahia, E. M., F. Gutierrez-Orozco, *et al*. "Phytochemical and antioxidant characterization of the fruit of black sapote (Diospyros digyna Jacq.)." Food Research International **44**(7): 2210-2216.
Yang, B., Y. Jiang, *et al*. (2011). "Extraction and pharmacological properties of bioactive compounds from longan (Dimocarpus longan Lour.) fruit - A review." Food Research International **44**(7): 1837-1842.

Yang, E.-J., G.-J. Kang, *et al*. (2008). "368 Anti-inflammatory effect of Citrus grandis Osbeck (dangyuja) leaves in LPS-stimulated raw 2764.7 cells." Cytokine **43**(3): 330.

Yang, E.-J., G.-J. Kang, *et al*. (2008). "Anti-inflammatory effect of Citrus grandis Osbeck (dangyuja) leaves in LPS-stimulated raw 2764.7 cells." Cytokine **43**(3): 330-330.

Yang, E.-J., H.-J. Lee, *et al*. (2009). "Anti-inflammatory Effect of Dangyuja (Citrus grandis Osbeck) Leaves in LPS-stimulated RAW 264.7 Cells." Food Science and Biotechnology **18**(5): 1063-1070.

Yang, X., K. Hsieh, *et al*. (2008). "Diguajadial: a dimer of the meroterpenoid from the leaves of Psidium guajava (Guava)." Chinese Journal of Natural Medicines **6**(5): 333-335.

Yang, Y., L. Sen Tai, *et al*. "Physicochemical characteristics and immunomodulatory activities of three polysaccharide-protein complexes of longan pulp." Molecules **16**(7): 6148-6164.

Yap, C. F., C. W. Ho, *et al*. (2009). "Optimization of Extraction Conditions of Total Phenolic Compounds from Star Fruit (Averrhoa carambola L.) Residues." Sains Malaysiana **38**(4): 511-520.

Yapp, D. T. T. and S. Y. Yap (2003). "Lansium domesticum: skin and leaf extracts of this fruit tree interrupt the lifecycle of Plasmodium falciparum, and are active towards a chloroquine-resistant strain of the parasite (T9) in vitro." Journal of Ethnopharmacology **85**(1): 145-150.

Yi-Zhong, C., X. Jie, *et al*. (2006). "Rapid identification of betacyanins from Amaranthus tricolor, Gomphrena globosa, and Hylocereus polyrhizus by matrix-assisted laser desorption/ionization quadrupole ion trap time-of-flight mass spectrometry (MALDI-QIT-TOF MS)." Journal of Agricultural and Food Chemistry: 54 (18) 6520-6526 **54**(18): 6520-6526.

Yi, Y., S.-T. Liao, *et al*. "Immunomodulatory Activity of Polysaccharide-Protein Complex of Longan (Dimocarpus longan Lour.) Pulp." Molecules **16**(12): 10324-10336.

Yi, Y., Q.-W. Zhang, *et al*. "Simultaneous quantification of major flavonoids in â€œBawanghuaâ€□, the edible flower of Hylocereus undatus using pressurized liquid extraction and high performance liquid chromatography." Food Chemistry(0).

Zadernowski, R., S. Czaplicki, *et al*. (2009). "Phenolic acid profiles of mangosteen fruits (Garcinia mangostana)." Food Chemistry **112**(3): 685-689.

Zarena, A. S. and K. U. Sankar (2009). "Screening of xanthone from mangosteen (Garcinia mangostana L.) peels and their effect on cytochrome c reductase and phosphomolybdenum activity." Journal of Natural Products (India) **2**: 23-30.

Zarena, A. S. and K. Udaya Sankar "Isolation and identification of pelargonidin 3-glucoside in mangosteen pericarp." Food Chemistry **130**(3): 665-670.

Zhang, M., C. Duan, *et al*. "The flavonoid composition of flavedo and juice from the pummelo cultivar (Citrus grandis (L.) Osbeck) and the grapefruit cultivar (Citrus paradisi) from China." Food Chemistry **129**(4): 1530-1536.

Zhao, Y.-X., W.-J. Liang, *et al*. "Fatty acid synthase inhibitors from the hulls of Nephelium lappaceum L." Carbohydrate Research **346**(11): 1302-1306.

Zheng, S., F. Jiang, *et al*. (2008). "Breeding high polysaccharide content of longan cv. Gaobao." Fujian Journal of Agricultural Sciences **23**(4): 387-391.

Zheng, S. Q., F. Jiang, *et al*. "Preliminary Observations on the Antifatigue Effects of Longan (Dimocarpus longan Lour.) Seed Polysaccharides." Phytotherapy Research **24**(4): 622-624.

Zheng, Z.-P., S. Chen, *et al*. (2009). "Chemical components and tyrosinase inhibitors from the twigs of Artocarpus heterophyllus." Journal of Agricultural and Food Chemistry **57**(15): 6649-6655.

Zhou, H.-C., Y.-M. Lin, *et al*. "Structural diversity and antioxidant activity of condensed tannins fractionated from mangosteen pericarp." Food Chemistry **129**(4): 1710-1720.

Zhou, X., R. Huang, *et al*. "Two New Prenylated Xanthones from the Pericarp of Garcinia mangostana (Mangosteen)." Helvetica Chimica Acta **94**(11): 2092-2098.

Zhou, Y., H. Huang, *et al*. (2008). "Effect of guava leaf on IFN-gamma and IL-2 in salivary of children patients with noroviruses diarrhea." Chinese Journal of Information on Traditional Chinese Medicine **15**(2): 7-9.

Collation of Health Literature for Tropical Fruits and Extracts

By Kent Fanning and Yan Diczbalis

Pub. No. 13/014

This report collates data on the nutrient and phytochemical content of tropical exotic fruits, the evidence for health effects from consumption of these fruit and the use of extracts from edible and non-edible parts of these plants. The knowledge of Australian fruit compared with that grown overseas is presented together with opportunities for future work by Australian researchers. Opportunities for developing commercial extracts for use as food or nutraceutical uses are also presented.

The report is targetted at tropical exotic fruit growers and marketers and researchers involved and/or interested in tropical exotics research.

RIRDC is a partnership between government and industry to invest in R&D for more productive and sustainable rural industries. We invest in new and emerging rural industries, a suite of established rural industries and national rural issues.

Most of the information we produce can be downloaded for free or purchased from our website <www.rirdc.gov.au>.

RIRDC books can also be purchased by phoning 1300 634 313 for a local call fee.

RURAL INDUSTRIES
Research & Development Corporation

Phone: 02 6271 4100

Fax: 02 6271 4199

Bookshop: 1300 634 313

Email: rirdc@rirdc.gov.au

Postal Address: PO Box 4776,
Kingston ACT 2604

Street Address: Level 2, 15 National Circuit,
Barton ACT 2600

www.rirdc.gov.au