Research proposal

Conservation of wild fruit species for health and livelihoods

Submitted by
Dr. Sayma Akhter (Principal Investigator)
Email: sayma_sust@yahoo.com
Phone: 0469033235

January, 2017
1. Introduction
1.1 Background

The global population is estimated to reach 9 billion people by 2050 (Vinceti et al., 2013). With increasing climate change and biodiversity loss, the global food system may not be able to support this huge population. Therefore, there is an urgent need for collective action towards this problem to ensure global food security (Hunter and Fanzo, 2013). In recent years, there has been increasing concern to reduce malnutrition around the world (Swaminathan, 2012). Policy makers historically gave priority to energy-rich staple foods originating from cereals, starchy tubers and root vegetables, though these are often not sufficient to combat micronutrient deficiency (Swaminathan, 2012). Micronutrient deficiencies are often called ‘hidden hunger’ and can result in severe and lifelong health issues (e.g. increased mortality; physical and mental impairment). It was estimated in 2015 that over 795 million people in the world are under nourished (FAO, 2015) and over 30% of the world’s population are anaemic, many due to iron deficiency (WHO, 2016). Consumption of fruits and vegetable is a sustainable way to improve nutrient quality and diet (Slavin and Lloyd, 2012; Bharucha and Pretty, 2010).

Many traditional agricultural activities give less attention to the cultivation of fruit and vegetables (Powell et al., 2013). These nutrient-dense, non-staple foods are often harvested from wild and usually consumed by rural populations around the world (Penafiel et al., 2011; Bharucha and Pretty, 2010). Globally, an estimated 1 billion people use wild edible plants to supplement protein, vitamins and minerals and improve the palatability of staple foods. Typical wild forest foods are wild fruits and nuts, wild leaves, mushrooms, wild meat, wild roots and tubers. They are rich in proteins, fats, carbohydrates, vitamins, minerals and phyto-chemicals such as phenolics (Karjalainen et al., 2010). There is a strong negative relationship between income and malnutrition (FAO, 2012). Forests contribute to the livelihoods of more than 1.6 billion people (FAO, 2010). Forest incomes can be diverse such as income from selling these wild fruits, nuts, vegetables, medicines, firewood and timber (Powell et al., 2013). Forests in some cases provide the only cash income that makes it possible to purchase food for the local households (Powell et al., 2013). The access to wild food has diminished due to deforestation as the forest has becomes distant from settlements and the natural forests have been converted to plantation forests, which contain less diversity, there by affecting diet diversity and nutrition.

Wild biodiversity such as wild fruits and wild vegetables can contribute to the diet diversity of the local people (Frison et al., 2011). Wild fruits and vegetables contribute to food supply during lean seasons and also can be sold for income to ensure food security (Vinceti et al., 2013). Wild fruits play an important role in supplying many essential micro nutrients for human nutrition (Powell et al., 2013; Arnold et al., 2011). For example, Vitamin A deficiency causes blindness in 500,000 children every year (Kennedy et al., 2003). Wild fruits provide a ‘safety-net’ and provide emergency food during the hunger periods (Powell et al., 2010; Colfer, 2008). The contribution of wild fruits is often overlooked (Powell et al., 2013). Wild foods are especially important for the poorest communities, rural populations and women, particularly during critical food shortages. Commercialisation of wild forest products has been promoted by researchers, conservationist, development organisations and governments to achieve rural livelihood improvement in an environmentally sound way (Belcher et al., 2005). These products contribute significantly to household food security, but only if local management systems and national policies ensure their sustainable extraction and use. Wild fruits are not only an important food for poor people in developing countries in order to cope with seasonal shocks (Ræbild et al., 2011; Arnold, 2008) but also are considered as a significant storehouse of genetic resources. In order to use wild forest fruits to supplement diets in balanced ways, more knowledge is needed on the nutritional values of different types of wild forest fruits (Leakey, 2005; Leakey et al., 2003). However, due to the lack of effective regulation, over-
exploitation, climate change and habitat degradation, these wild edible resources often face rapid degradation (Karjalainen et al., 2010). The impact of losing these resources may not be immediate but could reduce the global capacity for plant breeding to produce new crop varieties needed for agricultural systems to adapt to global climate change (Frison et al., 2011). They also make a significant contribution to ecosystems (Ford-Lloyd et al., 2011). Biodiversity conservation and food security are two sides of the same coin. Conservation and sustainable use has become a priority on the international conservation agenda (Maxted et al., 2012). The value of crop wild relatives has historically been unappreciated (Jansky, 2013). It is estimated that 20% of all plant species will be in danger of extinction in the near future (Brummitt and Bachman, 2010). The World Health Organisation estimates that in many developing countries up to 80% of the population relies on biodiversity for primary health care and around 1 billion people rely on wild-harvested products for nutrition and income (Pimentel et al., 1997). Policies governing forest management, food security and health benefit are often not well coordinated. As a result, people are not aware of the benefits of the forest foods available to them and, because these resources are not valued or protected, their availability is shrinking (Bioversity International, 2006). However, wild underutilized fruits grown in forest areas without much care. There is little awareness of the nutritional value of those species among the people. These wild fruits can be a good source of micro nutrients and can be used an alternative source to combat hidden hunger such as Vitamin A and Vitamin C deficiencies (Deshmukh and Waghmode, 2011; Bioversity International, 2004). Little attention has been given so far to increase the use of wild fruits. Considering this, current study will focus on few wild underutilized fruits of Australia. Australian forest have many unique edible wild fruits including wild relatives of worldwide economically important species. However, this unique forests are vulnerable to climate change (Hennessy et al. 2007). Climate change together with weeds and habitat fragmentation is going to make this unique forest more vulnerable. For example, relative to 1990, about a 50% decrease in montane tropical rainforest area in northern Australia is predicted by 2020 (Hennessy et al. 2007). Already a good percentage of species are under threat for their genus in Queensland such as Alpinia spp., Capparis spp., Elaeocarpus spp., Davidsonia spp., Diploglottis spp., Garcinia spp., Musa spp., Myristica spp., Passiflora spp., Piper spp., Syzygium spp. Etc. (Ashmore et al. 2007, Henderson 2002). There is an urgent initiative is required to conserve them. However, prioritising conservation efforts requires information on the positive attributes of such species, which is often lacking. The information generated in this study may help to promote the conservation and popularisation of wild underutilised fruit species in Australia. Therefore, this study will investigate domestication and market prospects of selected fruit species such as Elaeocarpus angustifolius, Santalum acuminatum, Syzygium aqueum, Kunzea pomifera, Musa banksia, Musa jackeyi, Terminalia ferdinandiana, Citrus australasica by characterising their nutritional profile; antioxidant activity and potentiality for product development. Domestication and market barrier of those wild underutilised fruit will also be examined.

1.2 Aims and objectives of the study
The overall aim of this research is to assess the conservation potential of selected wild underutilised fruit species by identifying their nutritious and sustainable value added products for use in the food and health care industries. To fulfil the overall aim of the study, the following specific objectives need to be fulfilled:

Objectives:

1. To identify prospect and factors causing barriers for conservation, domestication and consumption of the selected wild underutilized fruit species
Specific questions:

Q1: What are the present uses and attractive features of the species?
Q2: What are the issues creating barriers to the conservation and consumption of the species?
Q3. Is the species is declining? If yes, why?

Wild crops can undoubtedly benefit modern agriculture, providing plant breeders with a broad pool of potentially useful genetic resources (Hajjar and Hodgkin, 2007). However, these species are now facing increasing threat from habitat destruction and climate change. To overcome this situation, widely used conservation initiative such as in vitro propagation, seed bank and gene conservation plot etc. were applied. Even with this modern technologies, conservation program often fails due to overlooking of social factors. It is equally important to know the social factors or peoples opinion about conservation of a specific species. Therefore, this present study will conducted to know the prospect and factors causing barriers for conservation, domestication and consumption of the selected wild underutilized fruit species.

2. To characterise the fruit quality in terms of morphological, nutritional and medicinal properties

Specific questions:

Q1. What are morphological features (fruit weight, pulp weight, kernel weight, fruit length and fruit width) of the selected wild fruits?
Q2. What are the nutritional (e.g. vitamin, mineral) and medicinal properties (e.g. phenolics, antioxidant)?
Q3. Is there any potential in the fruit for the production of natural products (e.g. essential oil) to enhance smallholders’ livelihoods and income?

Currently, little attention has been given to increase the use of underutilised fruits and the important contribution of fruit trees to many farmers’ livelihoods and nutrition is often not acknowledged in national reporting. Many such wild fruit species are declining and there is an urgent need to conserve them (Ashmore et al., 2007; Hamilton et al., 2011). However, prioritising conservation efforts requires information on the positive attributes of such species, which is often lacking. The development of baseline information is needed to popularise the wild fruit species. The information generated in this study may help to promote the conservation and popularisation of wild underutilised fruit in Australia.

3. To investigate the potentials of developing sustainable value added products from the selected wild fruit species for use in the food industry

Specific questions:

Q1. What products can be introduced?
Q2. How to develop the product?
Q3. Nutritional quality of the product?
Q4. What are the attitude and opinion of consumer about the product?

Local plantings, product development and market expansion are the first steps in domesticating wild fruit trees in their fields, homesteads and communal lands (Leakey et al., 2004). Domestication involves accelerated and human-induced evolution to bring species into wider cultivation through a farmer-driven and market-led process (ICRAF, 1997). However, until recently there has been little effort to improve or add value to these fruits in Australia.
Therefore, the justification of this research is to develop sustainable value added food products which will increase desire of local people to cultivate wild fruits and enhance the ways in which these species promote food and nutritional security.

2.2 Materials and method
2.1 Study area and materials
Fruit sample will be collected from different forest areas of Australia based on their availability. During fruit collection period, social survey will be also conducted.

2.2 Method (for Objective 1):
A semi-structured questionnaire will also be used to identify the factors responsible for domestication and consumption of wild underutilised fruit species. Additionally, knowledge from different local experts will be combined through participatory approaches (e.g. Focused group discussion). A reconnaissance survey and transect walk will be carried out in the selected areas. For the group discussion participants will be selected considering their knowledge about the species. Various aspects will be analyzed during Questionnaire survey and FGDs for instance, uses; attractive features (color, taste, smell, size, price); frequency of fruit consumption (once, twice, more than twice during the fruiting season) and fruit proportion size in terms number of fruit consumption (e.g. 1-15 kg, 16-30 kg and >30 kg) seasonally; seasonal income of the fruit sellers; fruit yield will be investigated to discern the prospect of the species for conservation. All the fruits from three trees for each species will be collected and yield/tree will be measured in kilogram.

The DPSIR (Driver-Pressure-State-Impact-Response) framework will also be used to know the reasons behind depletion of this species and its socio-environmental impact by FGD. Moreover constraints (farm size, planting materials) and opportunities (nurseries establishment, willingness to plant and conserve) in domestication of the species will also be discussed. Moreover a sensory analysis will be conducted to know people’s perception about the quality of the fruits. For the application of the DPSIR, we combined knowledge from different local experts through participatory approaches. For the participatory exercise, five to seven local experts will be consulted. They will be selected based on: a) their familiarity with the area and the species, and b) an adequate knowledge of the forest area. Selected experts included: local forest department officials, NGO officials, nursery staff and local people living near the forest areas. Before starting the participatory discussion, a briefing will be given about the DPSIR framework in relation to the wild fruit species conservation. In order for a consensus to be reached among the participants, they will be asked for evidence and justify their observations. A consensus will be reached among the participants when supported by the highest number of participants.

Sensory analysis will be carried out to know the attitudes towards the selected wild fruits. Samples will be evaluated for quality attributes in terms of colour, odour/smell, taste, texture and overall acceptability. A typical taste panel consisted of 15 panellists. A traditional 9-point hedonic scale will be used to evaluated the samples, where: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely.
2.3 Method (for Objective 2):

2.3.1 Sample collection, preparation and analysis

Samples of fresh and ripe fruits will be collected from different regions of Australia based on availability. The following fruit traits will be assessed: fruit length, fruit width, fruit weight, peel weight, kernel weight and pulp weight, which will be measured directly in the field using a portable electric balance and metre tape. For the nutritional analyses, after collecting the fruits, they will be refrigerated at -4°C temperature. All fruits will then be transferred to Melbourne University for further analysis. Fruits will be subsequently cleaned and separated into peel, pulp and kernel and stored in a freezer at -20°C. The frozen pulp samples will be freeze dried and stored in air-tight bags and kept in the freezer at -20°C before further analysis. These samples will be used for proximate analysis (dry matter content, moisture content, ash content, crude fat, crude fibre, crude protein, carbohydrate and energy). Apart from that, total soluble sugar (using refractometer), pH (using pH meter), Vitamin A (using HPLC-UV), Vitamin C (using HPLC-UV), macro and micro minerals (using total X-Ray fluorescence analyser), total phenolics (using folin-ciocalteu reagent), total flavonoid and anthocyanin contents, antioxidant (using DPPH) and anti-nutrient analysis. Additionally, fatty acid methyl ester will be analysed (GC-MS) for the seeds where applicable.

2.4 Method (for Objective 3):

New food items (pickle/ juice/ jam/ chocolate) will be prepared from selected underutilized fruits. For this purpose a combination of methods will be used including idea development, 1st kitchen trial, 1st sensory evaluation, modification of the product formula, 2nd kitchen trial, 2nd sensory evaluation, product specification, small scale trial, consumer testing (Street test, Expert opinion) and finally launching of the new product will be done.

3. Expected output

It is expected that the proposed research will create base line information for few wild underutilized fruit species of Australia. It is expected that, investigated wild fruits will have beneficial component for nutrition and health. It is also expected that new food products will be developed from the wild fruits which can add value to these wild species that may helpful for commercialization and popularization of these wild fruits. The barriers to conservation and domestication will be identified. It is expected that, current research will help to generate new income opportunity for people and add fruit diversity in our diet for a healthy life. Output from this multidisciplinary project will be published in good peer-reviewed journal. Press release will be made to disseminate the outcome to general public as many of them are not interested in reading scientific journal.
## 4. Tentative Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Tasks</th>
<th>Month</th>
</tr>
</thead>
</table>

### References


FAO. 2012. The state of food insecurity in the world: Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy.


