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Medicinal and edible wild fruit plants of Botswana as emerging new crop opportunities

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There is a burgeoning need for the promotion of medicinal plants and edible fruit plants as crop in Botswana because these are re-emerging as health aid. Medicinal plants constitute one of the important overlooked areas of international development. They represent a form of biodiversity with the potential to do much good and not just in the healthcare. Indeed, the production and processing of medicinal plants offers the possibility of fundamentally upgrading the lives and well-being of peoples in rural regions. Botswana's medicinal plants are over-harvested for use as human and livestock medicines. There is therefore, a risk of depletion and extinction of the most sought after species. Initiatives should be put in place to propagate, cultivate and conserve species population through the promotion of community-based and commercial nurseries. Naturally medicinal yields from the wild are unpredictable as the supplies are at the mercy of the weather, pests and other uncontrollable variables. Farming will even out the supply, regularize trade and make available to rural areas new sources of income. In international market, the opportunities are emerging day by day for the trade of medicinal plants to fetch foreign exchange for the country. In Botswana, pilot farmer based cultivation trials for selected number of threatened and indigenous species in home gardens to supply local needs and income generation are on-going. *Hoodia gordonii* (appetite suppressant), *Harpagophytum procumbens* (anti-inflammatory) and *Artemisia afra* (anti-malaria and antioxidant), *Sclerocarya birrea* (nutritional and medicinal) are some of the plants whose domestication offers a lucrative avenue for income generation as the global demand for plants as sources of drugs and novel foods increases. Initiatives to establish nurseries and ecological medicinal centres to encourage propagation and to provide species to local communities will assist in the conservation, sustainable use and offer opportunity for economic diversification. This paper explores the possibilities of cultivating medicinal and edible wild fruit plants of Botswana as cash crops.

Key words: Botswana medicinal plants, edible wild fruits, herbal teas, domestication, economic value.

INTRODUCTION

Plants represent a constant interest as sources of novel foods and medicines. Plant derived medicines have been part of the traditional health care for many years (Cunningham, 1983). Worldwide, developing countries rely heavily on the use of traditional medicines as their primary source of health care (Hedberg and Staugard, 1989). In spite of this large dependence by native people of Botswana on plants, these plants have not been studied extensively (Motlhanka et al., 2003). Plants also play a vital role as sources of essential nutrients, vitamins and minerals necessary for the well functioning of living things. People obtain these when they consume plants as vegetable, fruits or prepared in any food formulation. Plants used as such vary from region to region depending on availability and acceptability by people in each region. Many indigenous plants of Botswana play paramount role as sources of food, medicines, firewood

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and building materials. Other plants are important sources of traditional beverages (including herbal indigenous tea plants) and livestock feed. Among these many uses of plants, this study will emphasize medicinal plants, edible fruits, herbal teas and sustainable strategies of plant exploitation. Given this growing global demand for plants as sources of novel foods and medicines, there is need to document indigenous and threatened species of economic value.

Medicinal plants

Medicinal plants constitute one of the important overlooked areas of international development. Botswana harbours a large diversity of plants that are sources of health remedifying agents (Roodt, 1998[a, b]; Motlhanka et al., 2003; Mojeremane et al., 2005). In Botswana, the most sought after medicinal plants are overharvested and there is a risk of them getting depleted and getting extinct. Depletion and extinction rate is likely to be high for slow growing and or naturally rare plant species than for fast growing and abundant species. Plant species used medicinally in Botswana are too many but amongst them include *Cassia abbriviata*, *Hoodia gordonii*, *Harpagophytum procumbens, Capparis tomentosa, Ziziphus mucronata, Bauhinia petersiana, Dichrostachys cinerea and Peltophorum africanum, Cassine transvaalensis, Ozoroa paniculosa, Clerodendrum uncinatum, Securidoca longipenduculata, Commiphora glandulosa., Colophospermum mopane, Myrothamnus flabellifolius, Elephantorhriza goetzei*. The global market and community demand for medicinal plants is so great that there is a great risk that many medicinal plants today, face either extinction or loss of genetic assortment (Lucy and DaSilva, 1999).

Although, the value of medicinal plants is widely recognized by both rural and urban dwellers in Africa, research in the strategies that may lead to the efficient utilization and management of the medicinal plants used by consumers is sluggish. There is need to intensify efforts of raising awareness of the importance of conservation of indigenous medicinal plants. In Botswana, pilot farmer based cultivation trials for a selected number of threatened indigenous species in home gardens to supply local needs and provide alternative income generation are in progress.

Indigenous wild fruit food plants and food security

The use of wild foods, of which wild fruits form a part as a component of local responses to increasing food insecurity and as one of the major coping mechanisms at times of food shortage and famine is widely documented (Abbink, 1993; Bell, 1995; Edwards, 1992; Giunand and Dechassa, 2000; Mojeremane and Tshwenyane, 2004; Motlhanka et al., 2008; Getachew et al., 2005; Redzic, 2007). Indigenous wild fruits remain one of the major options for coping with hunger and nutritional deficiency in diets and with poverty in Southern Africa. Studies have shown that harvesting fruits from the wild and also from the semi domesticated trees growing in farms can boost rural employment and generate substantial income (Leakey et al., 1999; Mithöfer and Waibel, 2004) from processing and adding value (Saka, 1994).

A host of indigenous fruits of Southern Africa have a potential as food and cash crops. Native edible wild fruits can play a crucial role in combating food insecurity, especially the so-called hidden hunger caused by micronutrient vitamin and mineral deficiencies. Dozens of tropical fruits are suitable for small scale processing into jams, juices and dried food combinations (Motlhanka et al., 2008). In Botswana, fruits of *Sclerocarya birrea* Sond are processed into an array of products such as cosmetic formulations (marula soap, marula oil), marula jam, marula chips and sweets and marula alcohol. *Mimosopus zeyheri* fruits are rich in vitamin C and are processed into a traditional dried pulp called “sesema” which has a long shelf life and serves as a delicious food during winter (Motlhanka et al., 2008). Other fruits of nutritional importance are those of *Vanguera infausta* (processed into a juice rich in Vitamin C), fruits of *Adansonia digitata* (rich in vitamin C), fruits of many *Grewia* species e.g. *Grewia flava*, *Grewia flavescens*, *Grewia bicolor* are an important source of traditional alcoholic beverages (Setshogo and Venter, 2003). Greater use of the indigenous wild fruits could do much to combat malnutrition, boost food security and contribute to income generation. In many African countries, these treasures remain untapped. The cultivation of these plants is important for their sustainable use and offers an opportunity for economic diversification.

Indigenous herbal tea plant species

Herbal teas have been used for centuries for all sorts of health reasons. There are many popular teas and herbal tea blends coming into the market place due to herbal tea benefits. Some of the herbal tea benefits include their exceptional antioxidant capacity, anti-inflammatory activity and anti-microbial activity. Herbal tea plants and plants from which essential oils can be harvested represent some of the potential market opportunities from which the quality of rural lives can be improved. Some indigenous herbal tea plants of Botswana that hold immense promise as marketable products include the leaves of *Lippia javanica*, *Lippia scaberrima, M. flabellifolius* (Motlhanka *et al.,* 2008), *Artemisia afra* (Liu *et al*., 2009) and fruits of *Combretum hereroense*.

Economic analysis has shown that herbal tea plants can considerably contribute to the economic welfare of people by generating reasonable income. The immense

economic potential of these medicinal teas calls for their domestication as cash crops.

Use and the status of plants

Edible fruits, plant species used medicinally and as herbal tea preparations are harvested from the wild. The commercialization of such products is likely to reduce the abundance of species used. This is so because as demand increases so does the rate of harvesting. Harvesting them becomes an open access or common property resource instead of a resource only used by specialists hence is driven by profit without due care to the habitat destruction (Cunningham, 1983). Harvesting of medicinal trees by ring-barking as done for *C. abbreviata, O. paniculosa* and removal of roots as done for *H. procumbens* can have detrimental effects on abundance of such species if done repeatedly. Commercialization of products from plant species that used to be done traditionally at small scale calls for careful consideration on the management of resources. It also raises consideration of alternatives to increase the supply of plant species such as domestication and cultivation. The objective of this study was therefore to document what is known and is being done concerning domestication and cultivation of plant species used in Botswana to produce medicinal, food and herbal tea products.

METHODOLOGY

A survey on inventories of different wild fruit food plants and plants used as medicinal formulations in Eastern Botswana was conducted. The data was collected by means of interviewing traditional healers, Village Community Trusts , and old people from Seolwane Village in Eastern Botswana. Some data was also collected from Botswana College of Agriculture (BCA) Forestry and Nursery and Veld Products Botanical Garden-Botswana.

RESULTS

The following medicinal plants have been cultivated either at BCA Green houses or in various local village botanical gardens. *H. procumbens* at BCA medicinal plant experimental plot. *H. gordonii* at BCA Green houses, *Moringa olifera* at BCA forestry nurseries, *S. birrea* at Veld products Botswana, *A. afra* and *L. javanica* at Thusanyo Lefatshing-Botswana. A number of indigenous wild fruit food plants are vigorously undergoing cultivation and propagation by village communities and small scale farmers across the country e.g *M. zeyheri*, *V. infausta* and *S. birrea* and *Azanza garkeana*. Some of these plant species are deliberately left to grow in arable fields and homestead to provide fruits and shade. As the global demand for plants as sources of medicines and food increases, the realization of domesticating and cultivating them as cash crops is becoming visible.

Medicinal plants of economic value

Family name: Apocynaceae
Species name: *H. gordonii*
Description: A cactus-like plant which is leafless, spiny, succulent and with smelling flowers.
Processing and mode of preparation of the medicinal part: Spines from the columnar cactus are removed, then the spineless cucumber shaped body is crushed and sun dried. The dried material is pulverized into powder and can be packaged into capsules.
Propagation / Cultivation: Vegetative and by seeds (seeds germinate in 3 - 6 days).
Economic and pharmacological value: Has an appetite suppressant effect.

Family: Pedaliaceae
Species name: *H. procumbens*
Common name: Devil's claw/grapple plant
Tswana name: Sengaparile/lengakapitsi
Description: A creeper with tendrils that radiate from an underground tuber and are about 2 m long. Leaves are shallow lobed, bluish-green above, but almost silver-grey below. Flowers are pink with a tinge of yellow in the tubular section. The fruit is oval, flattened, about 5 × 8 cm with vicious, hooked protuberances on all sides.
Processing and mode of preparation of the medicinal part: The secondary tubers are sliced and sun dried. Then they are pulverized and can be packaged into capsules or boiled and drank as tea.
Propagation / Cultivation: By seed and vegetative means. Propagation from tubers still attached to the stem has 90 - 100% success rate.
Economic and pharmacological value: Treat ailments such as intestinal disorders, diseases of the gall-bladder, kidneys, diabetes, atherosclerosis and gallstones.

Family name: Anacardiaceae
Species name: *O. paniculosa*
Tswana name: Monokane
Description: A shrub or small tree up to 6 m in height. Its leaves alternate or are in whorls being hairy on the underside while not hairy on their upper side. Has white flowers and kidney shaped fruit (Coates et al., 1987).
Processing and mode of preparation of the medicinal part: The fresh roots of an adult plant are easily sliced with a knife and sun dried. Then the material is pulverized and can be boiled in beer and drank while still warm.
Propagation / Cultivation: Seeds
Economic and pharmacological value: The plant is known to lower blood pressure and is also used by diabetic patients. It is also used for menstrual pain and alleviates

general body fatigue. Water extracts of the roots and leaves are rich in antioxidants (Motlhanka, 2008).

Family name: Celastraceae
Species name: *C. transvaalensis*
Tswana name: Monamane
Description: A small bushy tree of 4 - 5 m in height with pale grey smooth bark. Its leaves are apple-green to dull grey green and are clustered at the end of rigid short side shoots. Flowers are greenish-white while its fruits are elongate and berry-like.
Processing and mode of preparation of the medicinal part: The fresh roots of an adult plant are tough and require strong mechanical grinding. Fresh root bark ooze a red sticky sap. Ground plant material is sun dried. Then the material is pulverized and can be boiled in beer and drank while still warm. Pulverised dry material mixed with *Ozoroa paniculosa* roots is used to alleviate menstrual pains and reduce high blood pressure (Motlhanka et al., 2008).
Propagation / Cultivation: Seeds
Economic and pharmacological value: Treat ailments such as stomach-ache and fevers. Its wood is used to make crafts such as wooden utensils. Root extracts are rich in free radical scavenging compounds (Motlhanka et al., 2008).

Economic wild edible fruit plants

Family name: Rubiaceae
Species name: *V. infausta*
Tswana name: Mmilo
Description: Small tree, 3 – 7 m in height, elliptic to ovate leaves. Fruits almost spherical, 2.5 - 3.5 m in diameter, yellowish to brown when mature and edible.
Propagation / Cultivation: Seeds.
Economic value: Fruits are edible (Motlhanka et al., 2008). Fruit juice prepared from brown ripe fruits is both thirst-quenching and relaxing. The fruits are known to be rich in Vitamin C.

Family name: Sapotaceae
Species name: *M. zeyheri*
Tswana name: Mompudu
Description: Small to medium sized tree up to 15 m in height. Its leaves are thickly leathery being shiny dark green above and paler green below. Flowers are creamy-white and fruits ovoid, fleshy and yellow when mature.
Processing and mode of preparation of the ripen fruits: Yellow to pinkish fruits can be eaten fresh. Fruits contain reducing monosaccharides. Fruit pulp can be prepared into a dry pulp called “sesema” (Motlhanka et al., 2008).
Propagation / Cultivation: Seeds.
Economic value: Fruits are edible. Local communities sell both freshly cooked and preserved fruits in urban areas.

Family name: Anacardiaceae
Species name: *S. birrea*
Tswana name: Morula
Description: A deciduous tree up to 15 m in height. A walnut-sized fruit (3.5 cm) that has an edible, fleshy pulp and a very hard nut with two small kernels inside.
Processing and mode of preparation of the ripen fruits: Fruits can be processed into jam, sweets. The nut is an important source of oil. Fruit juice can be fermented into an intoxicating beverage (Motlhanka et al., 2008).
Propagation / Cultivation: Seeds.
Economic value: Fruits are edible and are used to make beer and jam. Nut from the kernels is also edible and a rich source of oil. Its wood is used to make useful items such as mortar and utensils, and canoes. Fresh leaves and yellow fruit skins are liked by livestock. The stem bark is used to treat malaria.

Family name: Malvaceae
Species name: *Azanza garckeana*
Tswana name: Morojwa
Description: Semi-deciduous shrub/tree 3 – 7 m in height with brown rough bark. Leaves are simple, alternate and lobed (3 - 5). Flowers are yellow ageing to orange-red while the fruits are almost spherical, woody capsule and yellowish to brownish-green when mature.
Propagation / Cultivation: Germinates readily without treatment.
Economic value: Fruits are edible (Braam and Piet, 1997).

Family name: Rhamnaceae
Species name: *Berchemia discolor*
Tswana name: Motsintsila
Description: A single stemmed tree up to 20 m in height. Its leaves are simple, alternate, shiny dark green above and much paler green below. Flowers are greenish-yellow while the fruits are ovoid and yellow to light orange when mature (Coates Palgrave et al., 1987).
Processing and mode of preparation of the ripen fruits: Ripen brown sweet fruits can be eaten fresh. Fruits can also be sun dried to avoid development of moulds and increase shelf life.
Propagation / Cultivation: Germinates readily without treatment but soaking with boiling water for 24 h can give better results (Roodt, 1998a).
Economic value: Fruits are edible and is of great nutritional value to animals and people. Its wood is used for building purposes, furniture and handles for various tools (Roodt, 1998b).

Economic herbal tea plants

Family name: Verbenaceae
Species name: *L. javanica*

Tswana name: Musukudu
Description: A multi-stemmed woody erect shrub up to 2 m in height. Leaves are hairy and give off a strong lemon-like smell when crushed. Flowers are small cream and arranged in dense, rounded flower heads. Fruits are rather inconspicuous, small and dry.
Processing and mode of preparation of the medicinal tea: Fresh leaves can be boiled in water (the preparation yields an aromatic scent). Leaves can also be sun dried and later boiled in water and drunk as tea.
Propagation / Cultivation: Cuttings.
Economic and pharmacological value: Its leaves are used traditionally and commercially in Botswana to make tea. Also used medicinally for treatment of coughs, colds and bronchial problems (Watt and Breyer-Brandwijk, 1962).

Family name: Verbenaceae
Species name: *L. scaberrima*
Tswana name: Musukujane
Description: An erect woody shrub, up to 0.5 m in height, with many stems arising from ground level. Has large bracts below the flowers.
Processing and mode of preparation of the medicinal tea: Fresh leaves can be boiled in water (the preparation yields an aromatic scent). Leaves can also be sun dried and drank as tea (Ben-Erik et al., 1997).
Propagation / Cultivation: Cuttings.
Economic and pharmacological value: Its leaves are used traditionally and commercially in Botswana to make tea. The tea is known to possess anti-oxidative properties (Ben-Erik et al., 1997).

Family name: Asteraceae
Species name: *A. afra*
Tswana name: Lengana
Description: A thick bushy woody shrub of up to 2 m in height. Its leaves are soft, finely divided and almost fern-like being dark green above and while below it has small white hairs. It has small yellow flowers that crowd at the tips of the branches.
Processing and mode of preparation of the medicinal tea: Fresh leaves can be boiled in water and drank as tea. Leaves can also be sun dried and drank as tea.
Propagation / Cultivation: Easy to grow plant using seeds. Needs full sun and heavy pruning in winter to encourage development of new shoots in spring.
Economic and pharmacological value: Used for brewing traditional tea. Also used medicinally to treat ailments such as coughs, colds, fever, loss of appetite and headache. Contains volatile oils with anti-oxidative properties (Hutchings and Van Staden, 1994; Liu et al., 2009)

Family name: Combretaceae
Species name: *C. hereroense*
Tswana name: Mokabi
Description: Usually a multi-stemmed shrub-like tree which on average grows up to 5 m in height but in rare cases can grow up to 15 m. Leaves are dark green to grey-green above and densely covered with brown, velvety hairs. Its flowers are very small white to creamy-yellow. Its fruits have four wings being rich russet-brown in colour (Roodt, 1998[a]).
Processing and mode of preparation of the medicinal tea: The ripened dry russet-brown fruits are boiled in water to produce strong tea.
Propagation / Cultivation: Its seeds germinate easily when removed from the exocarp and soaked in water for a few hours before planting (Roodt, 1998[a]).
Economic and pharmacological value: Its dried leaves or fruits are used to make tea. Medicinally its roots decotion can be used to treat stomach disorders.

Family name: Myrothamnaceae
Species name: *M. flabellifolius*
Tswana name: Galalatshwene
Description: Small rigid woody shrub of up to 0.4 m in height with tough branches. English name is resurrection plant (its ability to cause seemingly dead, dormant leaves to unfold and turn bright green when placed in water).
Processing and mode of preparation of the medicinal tea: Decoctions and infusions of leaves and twigs can be prepared in beer or water.
Propagation / Cultivation: Vegetative.
Economic and pharmacological value: The powdered plant material is used as medicine for hypertension, diabetes mellitus and stroke (Motlhanka et al., 2008).

DISCUSSION

Sustainable use and conservation strategies

Medicinal, edible wild fruit and herbal tea plants of Botswana represent an untapped source of therapeutic and nutritional tools. Their over exploitation and over-harvesting can however, contribute to the loss of habitat and depletion of natural resources. A balanced view is needed of the value of medicinal and food plants for their environmental role and the value of products derived from them. There is need to come up with rapid and easy to adopt cultivation and propagation techniques for these treasure troves. Tissue culture approach and other easy to transfer technologies should be exploited so that the domestication and cultivation of these plants by small scale farmers can be achieved. Domestication through propagation and good management practices may be one of the means of achieving natural resource conservation. Training villagers on harvesting, propagating and promoting community based gardens is an important conservation strategy for these hidden treasure troves. The vulnerability of medicinal herbs to

over exploitation and extinction need to be dealt with pragmatically. The concerns and issues relating to the conservation of the plants could be addressed through a variety of activities involving government and non-governmental organizations.

Cultivation of medicinal and edible wild fruit plants

The most common problem in attempting to domesticate wild medicinal and fruit plants is the lack of understanding of the best method to adopt. The most commonly used method of propagation in Botswana is from seeds. However, some plant species are entirely removed from their native habitats (e.g., *Hoodia* and *Harpagophytum procumbens*) and relocated (propagated using cuttings) to botanical or village nurseries for establishment. There is therefore, the need for understanding modern tissue culture techniques that will allow mass production.

Supply of medicinal plants

Maintaining the supply of medicinal plants is a problem mainly because most medicinal plants are harvested from the wild. Naturally medicinal yields from the wild are unpredictable as the supplies are at the mercy of the weather, pests and other uncontrollable variables. Farming will even out the supply, regularize trade and make available to rural areas new sources of income.

Trade of phyto products

The global trade value of medicinal plants and their products, currently is estimated over US $60 billion and it is expected that it will grow to 5.0 trillion by the year 2050 (Karki, 2002) due to increasing trends in their demand. Trade in medicinal plants is growing in volume and in exports. It is estimated that the global trade in medicinal plants is US $800 million per year (Aslam, 2002).

Conclusions

There is need for the development of appropriate conservation, cultivation and harvesting strategies. The participation of local community, conservers, educators and other stakeholders in the field of conservation, documentation and application of local indigenous knowledge on the use of medicinal and edible wild fruit plants should be strengthened. The conservation and sustainable use of plant habitats should be addressed through domestication of the most after sought and threatened species. Botswana with its semi-arid sub tropical climate offers a good environment for cultivating medicinal and wild fruit plants because most wild plants will do well in xerophytic habitat without any special care or maintenance. As the global demand for food and pharmaceutical drugs ever increases, medicinal and edible wild fruit plants represent new opportunities as cash crops.

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