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Review

Potential of traditional food plants in rural household food security in Botswana

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Botswana is endowed with a variety of traditional food plants which grow annually despite erratic rainfall. The most common traditional food plants are leafy vegetables (for example, *Amaranthus*, *Cleome, Conchorus and Vigna* species) and indigenous fruits (for example*, Azanza garckeana*, *Strychnos cocculoides, Sclerocarya birrea* etc.) . They provide an important source of food for people with either low or middle income and have been consumed for years to supplement diets. They are also a source of income; thereby improve the standard of living conditions for local communities. Traditional food plants contain vital nutrients and essential vitamins important for the proper maintenance of human health, especially for children who are often vulnerable to malnutrition and diseases. Some traditional leafy vegetables are very nutritious with protein contents of up to 36%. Indigenous fruits such as *S. cocculoides* and *A. garckeana* contain more than 30% fat and about 45% crude fibre and total carbohydrates. *S. birrea* fruits and juice contain four times more vitamin C than orange juice. Traditional food plants play an important role in food security because they yield a crop even in poor rainfall years when arable crops fail. The objective of this is synthesis existing information on the status and contribution of indigenous food plants to rural household food security in Botswana.

Key words: Botswana, indigenous fruit trees, leafy vegetables, food security.

INTRODUCTION

Most rural communities in Botswana depend primarily on arable crops as their source of food. Globally, studies have shown that rural communities face food insecurity and are chronically malnourished (Tiisekwa et al., 2004) because of drought stress (Boyer, 1982; Ludlow and Muchow, 1990; Harris and Mohammed, 2003; Babu, 2000), low adoption level of improved crop production technologies (Babu, 2000), poor soils and lack of resources. These have negative effects on arable crop production and result in considerable crop yield reductions (Boyer, 1982; Ludlow and Muchow, 1990). Therefore, most rural households in Botswana depend on various natural resources to sustain their livelihoods. For example, they use natural resources based livelihood strategies as a way of escaping hunger during times of famine. Studies conducted in southern Africa have shown that indigenous food and medicinal plants play a crucial role in the livelihoods of rural communities (Godoy and Bawa, 1993; Arnold and Ruiz, 2001; Ladio and Lozada, 2004; Scherrer et al., 2005; Shackleton and Shackleton, 2004) . Their availability is significant, especially during times of famine (Akinnifesi et al., 2008a) as they provide an alternative source of nutrition, medicine (Fleurent, 1979; FAO, 1988; McGregor, 1995; Cunningham, 1997; Muok et al., 2009; Ruiz et al., 1999; Dounias et al., 2000; Shackleton et al., 2002) and cash income (Shackleton et al., 1998; Nesamvuni et al., 2001; Kadu et al., 2006; Akinnifesi et al., 2006).

However, the importance of indigenous food plants in subsistence agriculture as a source of food, a supplement for medicine and a hunger survival strategy by rural communities, especially during times of food shortage in Botswana is often overlooked. Therefore, the objective of this review was to synthesize existing information on the status and contribution of indigenous

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Table 1. Composition of edible portion of selected traditional leafy vegetables compared with some exotic vegetables.

Nutrient content (100 g fresh weight)	Protein (%)	Ca (mg)	Fe (mg)	B-carotene (mg)	Vitamin C (mg)
Traditional vegetables					
Amaranths	4.0	480	10	10.7	135
Cleome	5.1	262	19	8.7	144
Corchorus	4.5	360	7.7	6.4	131
Vigna (Cowpea)	4.7	152	39	5.7	87
Exotic vegetables					
Cabbage	1.4	44	0.8	1.2	33
Spinach	2.3	9.3	32	5.1	28
Kales	2.5	187	32	7.3	93

Sources: FAO (1990) and WHO (2000, 2001).

food plants to rural household food security in Botswana.

The role of indigenous food plants in rural households' food security

Botswana is a semi-arid country of which two third is scrub covered Kalahari sandveld. Rainfall ranges from 250 to 650 mm year $^{-1}$ and occurs mainly in the summer month (November to March) (Brinkhurst, 2010). However, the country is rich in flora despite its arid conditions. An estimated 150 edible wild and semi- wild plant species are reported used by rural communities all the time or during famine (Flyman and Afolayan, 2006). It has been estimated that one year in three consecutive years arable agriculture fail in Botswana due to lack of rainfall (Mojeremane and Tshwenyane, 2004a; Brinkhurst, 2010) and general lack of surface water (Brinkhurst, 2010). It is during these drought years that rural communities in Botswana mostly use indigenous food plants as hunger coping strategy to sustain their livelihoods (Moss, 1988; Twyman, 2001; Ohiokpehai, 2003; Mojeremane and Tshwenyane 2004b).

Botswana is endowed with a wide variety of indigenous vegetables (for example *Cleome*, *Amaranthus*, *Corchorus* and *Vigna* spp), fruit trees (for example *Azanza garckeana*, *Adansonia digitata*, *Sclerocarya birrea*, *Strychnos spinosa, Vangueria infausta, Grewia* spp) and medicinal plants used by both rural and urban communities as diet supplements, medicine and alternative source of cash income. Indigenous food plants are not cultivated but grow naturally in the wild, arable crop land and backyard gardens around homesteads. A greater variety of indigenous vegetables is often found on cultivated arable land. These are collected and consumed at a younger stage of plant development, a stage when their leaves are more palatable and nutritious (Rubaihayo, 1997; Labadarios and Steyn, 2001). Several studies conducted in Botswana (Mojeremane and Tshwenyane, 2004a, b) and elsewhere (Campbell, 1986a, b; Zinyama et al., 1990; Shackleton et al., 2000; Akinnifesi et al., 2004, 2008a; Getachew et al., 2005; Balemie and Kebebew, 2006) have shown that the importance of indigenous food plants is increased during times of food shortage and famine.

For example, Akinnifesi et al. (2004) noted that 60 to 85% of the rural people in southern Africa face food shortages for 3 to 4 months in a year and use indigenous food plants to sustain their livelihoods. Indigenous food plants also provide employment opportunities which are often lacking in rural areas. Mojeremane and Tshwenyane (2004a) noted that some indigenous food plants also provided goods and services such as medicine, building material, firewood, fodder and shade.

The nutritional role and health benefits of indigenous food plants

The nutritional role and health benefits of indigenous food plants are well documented (El and Karakaya, 2004; Ansari et al., 2005; Balemie and Kebebew, 2006; Delang, 2006; Kuhnlein et al., 2006; Shrestha and Dhillion, 2006). They are important dietary supplements and sources of trace elements, proteins, minerals and vitamins for resource poor people (Agte et al., 2000; Parvathi and Kumar, 2002; Gockowski et al., 2003; Shackleton, 2003; Agrahar-Marugkar and Pal, 2004; Redzic, 2006; Singh and Garg, 2006). Most indigenous food plants are comparable or have higher nutrient content than their domesticated or exotic counterparts (Table 1). Most are rich in iron, zinc, vitamin A, C, E (Schmidt, 1971; Chwenya, 1994), folic acid (Tuker, 1986), proteins, carbohydrates and minerals (Agte et al., 2000; Parvathi and Kumar, 2002; Gockowski et al., 2003; Shackleton, 2003; Agrahar-Marugkar and Pal, 2004; Singh and Garg, 2006). Besides indigenous vegetables, rural people in Botswana also use indigenous fruit to supplement their diet. These contain almost all known vitamins and essential minerals than their exotic counterparts (Tables 2, 3 and 4). Most indigenous fruit trees produce more fruits per unit area than some exotic fruit trees and also provide

Table 2. Nutritional values of some exotic fruit trees common in Botswana.

Fruit species	Protein (%)	Carbohydrates (%)	Fat (%)	Fibre (%)	Vitamin B_2 (mg/100 g)	Vitamin C (mg/100 g)	Ca (mg/100 g)	P (mg/100 g)	Fe (mg/100 g)	Energy (Kcal/g)
Orange	0.7	10.9	0.2	0.3	-	30	26	20	0.32	116
Mango	0.6	16.9	0.4	0.7	0.09	16	14	16	1.3	74
Grapes	0.5	16.5	0.3	2.9	-	1	20	30	0.5	71
Banana	1.2	27.2	0.3	0.4	0.08	7	17	36	0.9	116
Papaya	0.6	7.2	0.1	0.8	0.25	57	17	13	0.5	32

Source: Rathore, 2009.

Table 3. Composition (%) of fruits of selected indigenous fruit trees common in Botswana.

Fruit	Composition (%)								
	Dry matter	Ash	Crude protein	ADF	ADL	NDF	pH (25°C)	Acidity	Vitamin C
Adasonia digitata	86.0	4.6	1.3	16.2	11.3	13.1	3.06	7.85	141.3
Sclerocarya birrea	11.6	4.9	3.7	16.3	13.7	16.1	3.98	0.88	128.3
Strychnos spinosa	19.7	4.6	3.3	61.1	4.4	6.2	3.96	0.77	88.0
Vangueria infausta	23.5	3.9	3.0	39.5	35.5	39.4	3.38	1.71	67.7

ADF- Acid detergent fibre; ADL- acid detergent lignin and NDL- neutral detergent fibre. Source: Amarteifio and Mosase (2006).

a lucrative source of cash income. The ripening of indigenous fruits occurs at different seasons; hence provide fresh fruits throughout the year (Akinnifesi et al., 2004, 2006). Campbell et al. (1997) and Akinnifesi et al. (2006) noted that indigenous fruit trees contribute on average about 42% of the food basket for most rural people in southern Africa. According to WHO (2005) daily consumption of indigenous food plants in sufficient quantities can help prevent numerous diseases. Studies have shown that indigenous food plants can improve the nutrition and health of children, the elderly and boost the immune system of HIV/AIDS patients (Barany et al., 2001). Consuming cooked indigenous vegetables with a stiff porridge of maize, sorghum and millet can provide nutrients lacking in these staple food crops.

Harvesting and preserving indigenous food plants

Harvesting and collection of indigenous food plants in most developing countries is done by women and children (Ruiz-Perez et al., 1999; Ohiokpehai, 2003; Styger et al., 1999; Shackleton and Shackleton, 2004). The collection is often combined with other daily activities such as cultivation, weeding arable cropland and collection of firewood. Indigenous food plants in Botswana, particularly vegetables are plentiful in the rainy season but become scarce during the dry season or winter and available only when dried and preserved. Women often process and store indigenous vegetables for use during the dry season when they are the only alternative source of nutrition and cash income in rural areas. The principal method of extending their shelf life is to sun dry fresh or boil in salted water before drying. Various methods in harvesting and collecting indigenous fruits include climbing trees to pick fruits, hand picking from lower branches or short trees, shaking stems or branches and knocking fruits down with sticks as well as picking from the ground following abscission (Kalaba et al., 2009). Some of these fruit harvesting methods can cause fruit damage and losses. For example, Kadzere et al.

Table 4. Mineral contents of fruits of selected indigenous fruit trees common in Botswana.

Species	Ca	K	Mg	Na	P	Fe	Zn
Adasonia digitata	128	1866	121	13.3	50	0.10	0.14
Sclerocarya birrea	94	2183	158	13	69	0.07	0.13
Strychnos spinosa	56	1370	49	21.7	66	0.11	0.22
Vangueria infausta	124	1683	99	13.7	128	0.09	0.02

Source: Amarteifio and Mosase (2006).

(2006a, b) estimated that 25 to 50% of indigenous fruits are lost during and after harvesting. Losses have been attributed to lack of fruit handling and marketing skills (Kabala et al., 2009) and pest damage (Kadzere et al., 2006a, b).

Marketing of indigenous food plants

In Botswana, indigenous food plants are sold by women and children in both formal and informal markets in rural and urban areas. The markets are seasonal and very limited. In urban and peri-urban areas, sales are conducted near shopping centres and from door to door. In rural areas sale is conducted from home, door to door, at bus stops and roadside markets. The sale of indigenous food plants provides cash income (Shackleton et al., 1998; Nesamvuni et al., 2001, Kadu et al., 2006) used to buy food; pay children school fees, uniform and other household needs. However, markets in Botswana (Taylor et al., 1996) and other developing countries favour exotic food plants than their indigenous counterparts because they have been researched and developed. Domesticated or exotic food plants are widely promoted and their uses and management techniques are well known. In contrast, indigenous food plants have received little attention in terms of research, development and promotion in Botswana, despite their large market potential. Taylor et al. (1996) noted that the variety of indigenous food plants sold in formal markets is lower when compared to informal markets. They further indicated that the formalisation of markets is constrained by lack of infrastructure and products of variable quality that are always available in small quantities.

Potential for domestication of indigenous food plants in Botswana

The importance of indigenous food plants in crop production systems has received significant attention in recent years, not only in terms of increasing arable crop production and food security but also in matters related to climate change mitigation through carbon sequestration. Domestication of indigenous food plants could be used as a strategy to improve food security and cash income for people living in rural areas as well as mitigating climate change. Several indigenous fruit tree species have been selected for domestication in Botswana and other countries in southern and eastern Africa (Jaenicke et al., 2000; Akinnifesi et al., 2004, 2006, 2008b; Mateke, 2000, 2002, 2003; Teklehaimanot, 2004; Leakey, 2005; Kabala et al., 2009). It is a common practice for farmers in Botswana to leave indigenous fruit trees when they clear forests/woodlands for arable crop. People have become aware of the importance of indigenous food plants and there is evidence of indigenous fruit tree planting in homesteads and backyard gardens in both the urban and rural areas of Botswana (Taylor and Kwerepe, 1995; Taylor et al., 1996). Apart from providing food, indigenous food plants, particularly fruit trees can be managed in arable land and gardens to capture and store a significant fraction of atmospheric carbon. The planting of indigenous fruit trees may indirectly decrease pressure on indigenous forests and woodlands which are the largest sinks for terrestrial carbon (Albrecht and Kandji, 2003; Montagnini and Nair, 2004). Domestication of indigenous food plants requires gathering them from the wild and cultivation on farmland. Akinnifesi et al. (2006) noted that local planting, product development and marketing are important in the domestication of indigenous food plants.

Participatory research and development of indigenous fruits such as *S. birrea*, *S. cocculoides*, *V. infausta* and *A. garckeana* has been conducted at the Veld Products Research and Development in Botswana (Mateke, 2000, 2003). The domestication research and development involved:

i) Selection of primary indigenous fruit trees based on farmers preferences and market orientation,
ii) Identification of superior or elite trees based on established criteria by users, marketers and market preference,
iii) Development and applying efficient vegetative propagation and nursery management techniques for producing quality propagules of on-farm dissemination,
iv) Integration of improved germplasm into farming systems; and
v) Post-harvesting, processing and marketing research of fresh products from domesticated species.

The domestication research and development initiative has led to the inclusion of some indigenous fruit tree in backyard gardens and to some extent in cropping

systems in Botswana. In contrast, indigenous vegetables have not received considerable attention in terms of research and development. The planting of indigenous vegetables in Botswana is probably constrained by lack of knowledge in propagation techniques, seedling production, husbandry skills and their free availability in the wild. To improve the contribution of indigenous vegetables to the rural household livelihoods and food security, participatory domestication and research similar to the one used for indigenous fruit at Veld Products Research and Development is needed.

CONCLUSION

Food security and poverty alleviation in rural communities can be improved by diversifying the existing farming systems. Arable crops alone in dry conditions of Botswana, without incorporating alternative livelihoods such as indigenous food plants would not improve the lives of resource-poor rural households. Experiences in many African farming systems have shown that many rural communities rely on indigenous food plants for food and as source of cash income between cropping seasons. Research has shown that indigenous fruit trees have potential comparable to their domesticated counterparts in providing nutrition, food security and cash income to households. The same can be said about indigenous vegetables, though work is needed on their development, promotion and marketing. Indigenous food plants are adapted to growing in low rainfall, poor soils and have few insect and disease problems than arable crops. The predicted climate change and global warming is likely to affect arable crop production negatively in Botswana, causing food shortages. Therefore incorporating indigenous food plants into existing cropping systems may provide an alternative source of food during years with little no arable crop harvest. Research is therefore needed to screen and develop indigenous vegetables and lesser known indigenous fruits so that they can be incorporated into present cropping systems.

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