



Promoting food security and enhancing Nigeria's small farmers' income through value-added processing of lesser-known and under-utilized indigenous fruits and vegetables



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ABSTRACT

In Nigeria and other African countries, there are hundreds of lesser-known indigenous crops as well as other food plants gathered from the wild that contribute to food security and play vital roles in the nutrition of the people particularly the rural populace. These native crops and wild food plants that have received little research attention or extension activities and have been largely neglected by the mainstream of international science include a wide variety of wild indigenous fruits and vegetables that enrich the diet of the rural populace and could thrive with little care and without the use of costly agricultural inputs such as fertilizers, herbicides and pesticides. Among them are numerous fruits of Nigerian trees that grow wild in the rain forest and the woodland savanna zones or are cultivated on small, compound farms. These fruits that are consumed fresh are rich sources of nutrients including ascorbic acid, provitamin A carotenoids, minerals and nutraceuticals with health-promoting benefits. There is the need to promote the cultivation and utilization of many of these indigenous fruit trees including African star apple (*Chrysophyllum albidum*), African mango (*Irvingia gabonensis*), African or native pear (*Dacryodes edulis*) and hog plum (*Spondias mombin*) that are also of considerable environmental significance and protect them from uncontrolled wood felling activities that result in deforestation. Laboratory studies have shown that good quality fruit leathers, jams, juices and other drinks can be produced from several lesser-known and under-utilized Nigerian fruits and vegetables including African star apple (*C. albidum*), African mango (*I. gabonensis*), hog plum (*S. mombin*), tamarind (*Tamarindus indica*) and roselle (*Hibiscus sabdariffa*) using simple procedures suitable for small-scale commercial production including osmotic dehydration, open-kettle jam-making process and mechanical juice extraction followed by hot water pasteurization. Removing the constraints to the development of small-scale food industries which include inadequate electricity supply, use of inappropriate technology, inadequate working capital, high interest rates, and limited access to banks and other financial institutions would facilitate commercial production of these value-added foods in rural communities thereby reducing post-harvest losses, promoting food security, enhancing small farmers' income and contributing to sustainable rural development.

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1. Introduction

Nigeria spans a total land mass of 923,768 km² with 60–70% of the 170 million population involved in farming. Poverty is pervasive in Nigeria and it is estimated that about 70% of the Nigerian population lives on less than \$1 a day (Canagarajah & Thomas, 2001; Oshewolo, 2010). Food insecurity is a major challenge in Nigeria; protein-energy malnutrition in children and micronutrient deficiencies (the hidden hunger) including Vitamin A deficiency and nutritional anemias remain important public health problems with dire consequences for productivity, maternal and infant health and intellectual development. For example, Nigeria and other West African countries have one of the highest under-5 mortality (168 per 1000) in the world (Murray, Laakso, Shibuya, Hill, & Lopez, 2007). Low food production, seasonal food shortages, high post-harvest losses, poverty, high food prices,

high unemployment, poor health facilities, low level of nutrition education and cultural factors and taboos that reduce access to food contribute to food insecurity in Nigeria (Aworh, 2010). Agricultural production is very inefficient in Nigeria and crop yields are very low compared to the developed countries. Small, resource-poor farmers, often with holdings of less than 1 ha, account for over 90% of the output of most crops grown in the country with Nigeria spending about \$8 billion annually on food importation (Aworh, 2010). Increasing productivity and improving post-harvest techniques and supply chains will increase Nigeria's smallholder farmers' income and therefore help fight poverty and secure better food and nutrition.

In Nigeria and other African countries, there are hundreds of lesser-known indigenous crops as well as other food plants gathered from the wild that contribute to food security and play vital roles in the nutrition of the people particularly the rural populace (Aworh, 2014; NRC, 1996,

2006; Stadlmayr et al., 2010). These native crops and wild food plants have received little research attention or extension activities and have been largely neglected by the mainstream of international science. Moreover, they suffer considerable post-harvest losses because of poor post-harvest handling practices, reducing their contribution to food security (Coursey, 1983; Joseph & Aworh, 1992; Olorunda & Aworh, 1983). Prominent among these native food plants are a wide variety of wild and cultivated indigenous fruits and vegetables of considerable horticultural and nutritional significance that enrich the diet of the rural populace and are available at certain critical periods of the year providing sustenance to millions of people when the more common sources are very scarce or completely unavailable (Aworh, 2014; Guarino, 1995; Okigbo, 1977; Schippers & Budd, 1997; Stadlmayr, Charrondiere, Eisenwagen, Jamnadass, & Kehlenbeck, 2013). They include green leafy vegetables such as *Amaranthus cruentus*, the most commonly grown Amaranth in Africa and other *Amaranth* species, water leaf (*Talinum triangulare*), Lagos spinach (*Celosia argentea*) and jute mallow (*Corchorus olitorius*). Other important lesser-known indigenous vegetables are the African eggplant or garden egg (*Solanum aethiopicum*, *Solanum macrocarpon*), which is widely distributed in the areas between the Guinea belt and the savanna, bitter leaf (*Vernonia amygdalina*), a perennial shrub frequently planted as a hedge or used as live fence in home gardens, fluted pumpkin (*Telfairia occidentalis*) which is commonly cultivated as an annual crop and is very popular in the diet of the Igbo, Ibibios, Efiks and other ethnic groups of south-eastern Nigeria, *Gnetum africanum*, an important non-timber forest product in Nigeria and Cameroon, and leaves of the multi-purpose baobab tree (*Adansonia digitata*) popular in northern Nigeria and the savanna zone of other African countries including the Sudan (Aworh, 2014; Gebauer, El-Siddig, & Ebert, 2002; Yazzie, Vanderjagt, Pastuzyn, Okolo, & Glew, 1994).

Prominent among fruits that grow wild in the rain forest of the humid tropics of southern Nigeria and in the woodland savanna that are consumed fresh are African star apple (*Chrysophyllum albidum*), African or native pear (*Dacryodes edulis*), African or wild mango (*Irvingia gabonensis*) and hog plum (*Spondias mombin*). *C. albidum* is a large berry, up to 6 cm long, that derives its name from the seed arrangement of its five large flattened seeds (Keay, 1989). It has an attractive fleshy pulp that varies in color from deep red through reddish or yellowish brown to light brown when ripe. The natural habitat of the African star apple is the lowland rain forest extending from Sierra Leone to East Africa (Keay, 1989). The fruits of African pear or safou (*D. edulis*) that are produced in hanging clusters on trees that may be up to 20–40 m tall are glossy in appearance and change from an initial pinkish color to bright blue and finally bluish black/black when mature (Keay, 1989; Okafor, 1981). The pulp is softened by dipping in hot water or hot ash for a few minutes before consumption. African pear is found naturally in the forest habitat extending from south-western Nigeria to Zambia and Angola, as well as in Sao Tome and Principe (Keay, 1989). In Nigeria, it is commonly planted in parts of the South-East but rarely in other parts of the country (Okafor, 1981). African or wild mango (*I. gabonensis* var. *gabonensis*), though a drupe with one large stone, is botanically unrelated to the conventional mango (*Mangifera indica*). The mature green fruits are 20.0–22.6 cm in circumference and weigh 131–184 g (Joseph & Aworh, 1991b). The ripe fruits have a fleshy, slightly fibrous, deep yellow/orange pulp with a characteristic turpentine-like aroma and a sweet taste relished by the rural populace in parts of south-western Nigeria (Joseph & Aworh, 1991b). African mango grows naturally in the forest habitat of parts of Africa extending from Senegal to Sudan and south to Angola (Keay, 1989). Regrettably, these highly perishable fruits suffer considerable post-harvest losses minimizing their contribution to food security. There is also the need to protect them from uncontrolled wood felling activities resulting in deforestation.

Numerous fruits of Nigerian trees that grow in the wild or on compound farms are not consumed in the fresh form, but rather are cooked, and together with a wide variety of wild and cultivated vegetables, form

part of main dishes or are used as condiments imparting flavor and other desirable quality attributes to soups and sauces served with starchy staple foods made from roots, tubers and grains. A variety of the African mango (*I. gabonensis* var. *excelsa*) bears fruits with bitter, very fibrous inedible pulp surrounding an endocarp that bears two large, oil-rich cotyledons that are dried, milled and used in soups as a flavoring ingredient and to impart desired consistency on account of their stringy, gum-like properties. They may also be used for the preparation of dika fat (Okafor, 1981). The seeds of the African locust bean (*Parkia biglobosa*) are fermented to produce 'dawadawa', the most important food condiment in West and Central Africa (Campbell-Platt, 1980; Odunfa, 1986), while those of African oil bean (*Pentaclethra macrophylla*) are fermented to produce 'ugba' or 'ukpaka', a delicacy usually consumed with stock fish or dried fish mainly by the Igbo ethnic group of south-eastern Nigeria (Okafor, 1987). The shea butter nut (*Vitellaria paradoxa*) is a source of edible oil and has a number of other uses (Aworh, 2014). The seeds of several lesser-known species of the family cucurbitaceae are used as ingredients in soups. For example, melon (*Citrullus lanatus*) and fluted pumpkin (*T. occidentalis*) seeds are used for the production of soup flavoring condiments known as 'ogiri' or 'ogili' (Okafor, 1987). In addition, melon seeds are also used for the preparation of 'egusi' soup and oil may be extracted from the seeds and the residue fried as 'robo' (Aworh, 2014). The seeds of *Lagenaria sicceraria* are used for the preparation of 'oseani', a very popular soup among the Igbo-speaking people of Delta State, Nigeria (Badifu & Ogunsua, 1991). Promoting the utilization of lesser-known indigenous fruits and vegetables and other food plants through value-added processing will increase their cultivation, reduce post-harvest losses and ensure that these important native crops and wild food plants that are part of Africa's rich biodiversity heritage are conserved.

2. Nutrient composition

Tables 1 and 2 present the levels of some selected nutrients in some selected lesser-known Nigerian fruits and vegetables. Most of the fresh fruits and vegetables are good sources of fiber and are rich in carbohydrates but low in fat and protein with the exception of *D. edulis* that contains over 20% fat (Eka, 1980). However their nuts and seeds may contain high levels of protein and fat (Aworh, 2014). By and large, their main contribution to the diet is as sources of valuable vitamins and minerals that are vital for good health and wellness of the rural populace. In many localities, they are the most common and relatively abundant sources of ascorbic acid, folic acid and provitamin A carotenoids as well as other nutraceuticals including antioxidant pigments such as flavonoids that have ability to sequester or bind potentially toxic constituents and act as scavengers providing considerable health benefits (Okwu, 2005). In terms of mineral composition, potassium occurs in the highest concentrations in most lesser-known Nigerian fruits (Table 1) and vegetables (Table 2). Many of them are good sources of calcium and some that are good sources of iron include *S. aethiopicum* (18 mg/100 g), *C. argentea* (13 mg/100 g), *T. occidentalis* (10 mg/100 g), *A. digitata* fruit pulp (9 mg/100 g), *A. cruentus* (6 mg/100 g) and *C. olitorius* (6 mg/100 g). *A. digitata* (baobab) fruit pulp is very rich in vitamin C reported to vary from 162 mg/100 g in one tree to 499 mg/100 g in another (Sidibe, Scheuring, Kone, Hofman, & Frigg, 1998). *Tamarindus indica* (tamarind) and *Dialium guineense* (velvet tamarind) fruit pulp are much lower in vitamin C (less than 15 mg/100 g) than *A. digitata* fruit pulp (Table 1). Other lesser-known Nigerian fruits and vegetables that are among some of the best sources of vitamin C in the Nigerian diet include *T. occidentalis* (129 mg/100 g), *C. olitorius* (78 mg/100 g), *G. africanum* (56 mg/100 g), *A. cruentus* (56 mg/100 g), *I. gabonensis* var. *gabonensis* (54 mg/100 g), *C. albidum* (48 mg/100 g), *A. digitata* leaf (47 mg/100 g) and *S. mombin* (34–56 mg/100 g). They compare favorably with conventional tropical and sub-tropical fruits such as oranges, pineapples, papaya, mangoes and guava that are generally

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