

Review

Status of conservation of the indigenous leaf vegetables and fruits of Africa

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Accepted 26 November, 2019

The diversity of indigenous leaf vegetables and fruits of Africa is being seriously eroded as a result of multiplicity of environmental, political and socio-economic factors. This paper discusses some new development-related and crises factors that have interacted in concert to amplify the spate of loss of the indigenous leaf vegetables and fruits genetic resources in Africa. The paper also suggests urgent steps that nations individually and Africa in general can take to arrest the wave of loss of plant genetic resources and therefore ensure the conservation of our remaining indigenous leaf vegetables and fruits heritage.

Key words: Conservation, indigenous vegetables and fruits, Africa, genetic erosion.

INTRODUCTION

Of the 150 food-plants commonly consumed by man, 115 are indigenous African species and the world's major regions of crop diversity include Ethiopian highlands, the Sahelian transitional zone, the delta of Niger River and the humid forest zone of west and central Africa (Kiambi and Atta-krah, 2003).

Endemism, which is the proportion of species not found anywhere else in the world, is high in Africa (Kiambi and Atta-krah, 2003). Endemism in Tropical Africa at the general level has been estimated to be 45% (Sayer et al., 1992). The Food and Agricultural Organization (FAO) (1998) reported that countries of West and Central Africa sub-regions have identified a large number of under-utilized species that are important to the livelihoods of local population. On the list are 7 cereals, 8 legumes, 4 roots and tubers, 8 oil crops, 31 fruits and nuts, 17 vegetables and spices, 4 beverages, 38 medicinal plants and 44 genera of forages.

This list is not exhaustive because Adebooye et al. (2003) reported an expanded list of twenty-four indigenous leaf vegetables that are eaten in southwest Nigeria only. Several other species have been listed by Okafor (1978, 1983) in Nigeria, Abbiw (1990) in Ghana, Chweya (1997) in Kenya, Rubaihayo (1997) in Uganda, Seck et al. (1997) in Senegal and Okigbo (1977) for the entire tropical Africa. The Plant Resources of Tropical Africa (PROTA) (2004) reported an estimated 30,000 plant species for Tropical Africa and of these only 6,376 (21%) are used by man. The PROTA called this 21% the "Basic List". The 6,376 useful indigenous African plants is made up of 1,975 medicinal plants, 820 timbers, 611 forages, 533 ornamentals, 477 fruits, 397 vegetables, 377 fibers, 240 essential oil and exudates, 220 auxiliary plants, 176 carbohydrate plants, 130 spices and condiments, 129 dyes and tannins, 104 fuel plants, 80 cereals and pulses, 54 vegetable oils and 53 stimulants. The PROTA in 2004 published the contributions of 103 authors and 46 co-authors on detailed cultivation practices for 280 African indigenous leaf vegetables. A summary of the number of useful species and endemism

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Table 1. Diversity of useful plants in 7 African countries.

Country	Size (Km ²)	Used Plants	Endemism
Cape Verde	4, 033	774	92
Gambia	11,300	974	3
Ghana	238,539	3,600	43
Guinea-Bissau	28,000	1,000	12
Liberia	111,370	2,200	Unknown
Nigeria	923, 768	4,614	205
Sierra-Leone	71, 620	2,090	74 and 1 genus

Sources: IUCN (1997), Okali and Fasheun (1997), Tuffour(1994) and Sayer et al. (1992).

in seven selected African countries is given below (Table 1).

Indigenous leaf vegetables and fruits are an integral part of agricultural systems in Africa. Unfortunately, most African countries governments have not given them priority in crop development. Adebooye et al. (2003) reported that of all mention of the status of food in Nigeria, indigenous leaf vegetables often disappear. Most studies on leaf vegetables and fruits in research institutes and universities have focused on the routinely cultivated species. Today the importance of African indigenous leaf vegetables and fruits to human nutrition, medicine and nature have been realized. Hence the United Nations in 1986 established the Institute for Natural Resources in Africa (INRA), an arm of the United Nations University in Accra Ghana, to build endogenous African capacity and strengthen national institutions to promote sustainable use of the continent's natural resources for development. The focus of INRA is research and training on conservation of African food plants diversity and soil conservation. Some other African governments have shown some form of interest in indigenous plants resources conservation, but the evaluation of their genetic variability for agronomically desirable traits is still in its infancy.

IMPORTANCE OF INDIGENOUS LEAF VEGETABLES AND FRUITS

Indigenous leaf vegetables and fruits play a key role in income generation and subsistence. For example, Adebooye (2004) reported that *Solanecio biafrae* (Olive and Heirne) C. Jeffery, an indigenous leaf vegetable in southwest Nigeria is several times more expensive than the routinely cultivated species especially during the dry season. Experience has also shown that other indigenous leaf vegetables such as *Telfairia occidentalis* f. Hook, *Celosia argentea* L., *Amaranthus cruentus* L and *Solanum macrocarpon* L. are also sold at high prices during the dry season in Southwest Nigeria. Also in Nigeria, Odiaka and Schippers (2004) reported that a fruit

of *T. occidentalis* cost as much as US\$0.70-1.00 each in the year 2002. In Kenya, the report of a survey conducted by Abukutsa-Onyago (2003) showed that indigenous leaf vegetables offer a significant opportunity for the poor people in western Kenya to earn a living because indigenous leaf vegetables production can be done with little capital investment. A direct effect of this is that these vegetables provide employment opportunities for those that are outside the formal sector.

Studies on chemical composition of indigenous leaf vegetables and fruits have shown that they contain appreciable amounts of crude protein, fat and oil, energy, vitamins and minerals (Adebooye, 1996; 2001; 2002; 2004; Adebooye and Bello, 1998; Chweya, 1997; USDA, 2002; 2003). They have also been known to make food more palatable and digestible.

In additional to serving as vegetables and fruits, some plants are also sources of traditional medicine in southwest Nigeria. Adebooye et al. (2003) documented the traditional medicinal uses of twenty-four indigenous leaf vegetables. Modern science has isolated many natural products with active principles of medicinal importance from many indigenous plants. For example, *Brassica* species have been shown to contain glucosinolates, which are highly effective against cancer and heart diseases.

The indigenous species are also adapted to many tropical conditions, pests and diseases. Therefore, they can be very good sources of genes for genetic improvement of cultivated species especially in the area of pests and diseases resistance. Also, the indigenous species can be improved by introducing desirable traits from cultivated species into them.

Despite these values, these vegetables have been neglected for many years by researchers, policy makers and funding agencies and are currently threatened with extinction. There is a great need not only to conserve their germplasm but also to improve their production (Abukutsa-Onyago, 2003).

PLACE OF PLANT CONSERVATION IN BIOTECHNOLOGY

Plant resources are basic ingredients for biotechnology research. Lewis (1985) stated that an adequate gene resource conservation programme is to genetic engineering as a library is to knowledge. Germplasm collection of indigenous leaf vegetables, fruits and spices, their wild relatives and landraces are essential if biotechnology is to move ahead (Witt, 1995). Perrino (1992) asserted that there were two reasons why biotechnologists need germplasm collections. First, they need models to synthesize genes because they cannot invent genes. Second, biotechnology will continue to depend heavily on naturally occurring genes in their experiments to influence the future. Gene banks are thus the home for gene hunters.

There is no gainsaying the fact that Africa's plant diversity, in general, is being seriously eroded as a result of multiplicity of environmental, political and socio-economic factors. Most African countries that are signatories to the Convention on Biological Diversity (CBD) of the United Nations Environment Programme (UNEP) (1994) and the Global Plan of Action (GPA) on plant genetic resources of the Food and Agricultural Organization (FAO)(FAO, 1998) have identified a singular cause of genetic erosion in crops as the replacement of local varieties by improved or exotic varieties and species. As a result of the ever-increasing human population, greater competition for natural resources and some interplay of natural factors, some other reasons can be advanced for the erosion of African indigenous plant resources. These include:

- 1.Erosion of culture and breakdown of traditional systems of plant resources management resulting in the loss of traditional varieties.
- 2.The world market has been tailored to focus on only a few crops to the extent that the industrial growth globally is dependent on continued supply of those few "elite crops" at the expense of the traditional varieties.
- 3.Deforestation, salinization, desert encroachment and erosion lead to land degradation with concomitant loss of the plant genetic resources that the land supports.
- 4.Natural disasters, including droughts, floods and pests and diseases, which have led to widespread losses of plant diversity from both farmers fields and natural habitats e.g. cassava mosaic virus attack in Uganda (Kiambi and Atta-Krah, 2003).
- 5.Climate change- this poses a threat to diversity, as many plants are unable to cope or adapt to changing temperatures and moisture gradients caused by global warming and the associated climate change (Kiambi and Atta-Krah, 2003).
- 6.Political instability, civil unrest and insurgence that have led to loss of genetic resources in fields as farmers flee from war torn areas and as *ex-situ* conservation facilities are destroyed.
- 7.The research mandates of most institutions focus on the routinely cultivated species at the expense of the indigenous species. This has resulted in the continued and ever-increasing relevance that the routinely cultivated species are enjoying.
- 8.African governments are not making adequate investment in the area of conservation of their indigenous plants heritage.

CONSERVATION PLANS FOR THE INDIGENOUS LEAF VEGETABLES AND FRUITS

Genetic erosion constitutes great threat to human survival. The extent and impact of the erosion may not be visible to the present generation. Future generations will have to pay dearly for the carelessness of the earlier

generations. In order to prevent this future disaster, the following step-wise conservation plans are suggested for the indigenous leaf vegetables and fruits of Nigeria:

Collection mission

With the realization of the threat to plant diversity in Africa the first step in the conservation effort should be a collection mission of samples of the remaining useful indigenous plants as a matter of urgency. It is imperative therefore that the diversity within the gene pools, including the wild relatives are adequately collected, conserved and used in the broadening of the genetic base in crop improvement programmes. Africa is well endowed with a wide diversity of indigenous useful plants and there is a dire need for greater investment in their conservation and sustainable utilization in order to broaden the base of agriculture and improve food security.

Seed banks

Seeds are the most convenient part of plant for storage, with the exception of a few species that have recalcitrant behavior e.g. *Telfairia occidentalis*. In storage, under good temperature and humidity regimes, seeds can be stored for several years. Therefore, following collection, reliable seed banks must be put in place for conservation of the collected samples. It must be emphasized that regular checks are carried out to test the viability of the stored seeds periodically. The seed bank will serve as a major insurance against permanent loss of any species that had been previously collected.

Crop type collection center (CTC)

This is also called "Field gene banks". Field gene banks are the most suitable for species that do not produce seeds easily and those with recalcitrant seed behavior. At the CTC, collected plant species are planted out in orderly manner – species by species, variants by variants and family by family. The CTC should be well guarded against fire as this can lead to a total loss of the conserved species. The management and maintenance of the CTC should also be accorded high priority because it is capital intensive. There must be reliable source of water especially during the dry season when water is limiting.

Conservation in natural ecosystem

The objectives of conservation in natural areas have been to protect a representative sample of each ecosystem and to establish a world network of plant

reserves in their natural ecosystem. In this way, landraces of the indigenous leaf vegetables, fruits and spices are protected in their natural habitat. This practice is as old as the beginning of time. In Nigeria among the Igbo and Yoruba there are traditional forests often called "evil forests or spirit forests" where the vegetation is left intact and tree felling is forbidden. These forests are indirectly serving plant conservation purposes. Therefore our interest as scientists should be in how many rare species we could find and collect in these forests. To ensure a successful conservation in natural ecosystem, there must be enabling laws and willing government in place to deal with illegal exploitation of the conserved species.

Cryopreservation

The best answer for long-term conservation of germplasm *in vitro* lies in cryopreservation i.e. the storage of frozen tissue cultures at very low temperatures in liquid nitrogen at -196°C , which virtually stops all biological activity. This process puts the cells in suspended animation where they can retain their viability indefinitely. This method is also the best for handling the storage of recalcitrant seeds and is also suitable for species that do not form seed and those that are propagated from bulbs and rhizomes (Perrino, 1992). *Telfairia occidentalis*, a Nigerian indigenous leaf vegetable, with recalcitrant seed behaviour is now being successfully stored using cryopreservation technique (Ajayi et al., 2004). This method of plant conservation requires a lot investment in materials and human expertise to ensure success.

CONCLUSION AND SUGGESTIONS

The advent of scientific plant breeding this century and rapid spread of high-yielding varieties characterized by narrow genetic base had caused the displacement of traditional unimproved species that had large genetic base. Narrowness of the genetic base of a crop may lead to disasters, as shown by historical examples, especially on Irish potato (National Academy of Science, 1972). In Nigeria, there is awareness about the loss of indigenous leaf vegetables as a result of neglect by research and development, fast rate of forest destruction for industrial development and environmental degradation due to pollution as in the Niger Delta region (Adebooye et al., 2003). Most African countries are signatories to the Convention on Biological Diversity (CBD) (UNEP, 1994) which calls for effective organization, management and use of biodiversity information. Articles 6, 7 and 8 of the CBD require the ratifying countries to develop national strategies, plan and programmes for the conservation and rational use of biological resources.

We are joining our voices with that of the other stakeholders in Africa to call for an urgent government,

institutional, groups and individual intervention to save what is left of our natural resources. To achieve this, the following suggestions are made:

Capacity building

Inadequate expertise in the science of plant genetic resources is at the moment posing serious problems for the ability of African countries to embark on serious plant conservation programme. For a well-organized plant conservation programme, there is the need for molecular geneticist, biochemist, horticulturist, physiologist, pathologist, entomologist, ecologist, statistician and ethno botanist. It is therefore an urgent task for African nations to strengthen the technical capacity for *in situ* and *ex situ* conservation and utilization of plant genetic resources at the sub-regional and national levels, with a special focus on human resources development and development of the necessary institutional conservation infrastructures. For conservation efforts to succeed there must be material/financial resources and human expertise. Therefore African countries, especially the West and Central Africa nations need to invest more in human resources development to be able to face the challenges of conservation of plant resources.

Facilities and infrastructure

Research in plant conservation and biotechnology is expensive. Simple form of biotechnology research, employing techniques such tissue culture to propagate a disease-free perennial, was estimated by Barker (1992) to cost a little less than US\$1.0 million in 1992 while genetic engineering or gene transfer may require US\$ 50 million-US\$500 million and it may take 10-20 years to achieve the goal! The implications of this for African countries are clear. However, with a strong will and determination to succeed, African nations through the African Union (AU) and New Partnership for Africa's Development (NEPAD), can make arrangement for development of biotechnology in Africa by having regional centers (at least two centers) one in the south and one in the north, as the starting point for biotechnological development of Africa. This type of arrangement has been made to develop vegetable research in Asia with the establishment of the Asian Vegetable Research and Development Center (AVRDC).

Respect for international agreements

Most African countries are signatories to the CBD and GPA. However, it is rather unfortunate that they are not implementing to letters the provisions of the agreements. Few experts that have knowledge of plant conservation and biotechnology are in the Universities and national

research institutes spread all over African nations. It is unfortunate that these Universities and research institutes in many African countries are not well funded and this had been a cause of repeated strike actions by lecturers and researchers in these Universities and research institutes. The irony of this is that trained hands are left idle or under-utilized because of lack of facilities. In Nigeria for example, there is the National Center for Biotechnology and the National Genetic Resources Center where no conservation research is taking place.

Application of novel technologies

Africa must be able to develop and adapt scientific procedures and technologies that can solve her problems. For example, the Geographic Information System (GIS) applications could contribute significantly to the understanding of inter-specific diversity and its spatial distribution thereby enabling scientists to develop more articulate *in situ* and *ex situ* conservation strategies (Kiambi and Atta-Krah, 2003). Other novel technologies in the public domain and from which Africa can derive maximum benefits are the application of molecular marker technology in the assessment of intra-specific diversity, germplasm characterization and evaluation, development of core collections, marker assisted selection, gene mining and functional genomics among others. The responsibility is therefore on African continents to acquire and develop the necessary human resources to make the best use of these technologies.

African governments should as a matter of urgency demonstrate seriousness by rising to protect what is left of our plant heritage. Africa's economic development will to a large extent depend on the level to which her plant genetic resources are conserved and sustainably used through a careful and deliberate effort to integrate them into both short and long-term economic development plans. To achieve this, we need development of enabling legal and policies framework, capacity and infrastructural building and reasonable financial investment to develop our plant genetic resources for the improved livelihood of our people, well being of our citizen and economic development of our continent. The world is going through a stage of conservation and biotechnological revolution and we in Africa must not be left behind.

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