

Fruit agrobiodiversity: new challenges for Africa

Today there is growing interest throughout the world in underutilized fruit-bearing species. This interest originates in several factors which combine at the same time concerns of an environmental, economic, social, medical and cultural nature. These species, however, have been generally domesticated and used by traditional agrarian societies for hundreds of years.

Beyond the simple production of knowledge on species little studied by the scientific community and the recognition of their potential or proven nutritional virtues, it is actually a question of integrating these underutilized species within new food systems. This implies implementing changes in practices on various scales and at various organization levels which will have to include: i) new cultural practices based on a rational use of the local biodiversity on the basis of ecological intensification, ii) new practices of processing to optimize and back up the nutritional qualities of the products, iii) new practices of marketing to place new foods at the disposal of rural and urban populations, and iv) new practices of consumption to improve the diet and human health.

By 1996, the plan of action of the FAO for the conservation and the sustainable use of genetic resources for farming and food, adopted by nearly 150 countries, thus identified the conservation and the use of underutilized species as one of its priorities. While 95% of the requirements in calories of the inhabitants of the planet rely on only 30 cultivated species [1], seven thousand species are actually used by humans around the world for their food requirements and other services [2]. This reduction of diversity in farming (and in consumption) has well-known causes, dependent on the intensification of farming and on the Western modes of marketing and consumption. The industrialization of production related to the development of large intensive monocultures consuming chemical inputs and fossil energy, the industrialization of the processing modes and, finally, the sanitary requirements of mass markets have indeed largely contributed to the erosion of the diversity of crop plants on a worldwide scale. The increase in exchanges and the total homogenization of consumption modes have progressed in concert, reaching

the countries of the South, overriding in many areas the traditional consumption of indigenous plants with a diet based on often imported rice or wheat. Agronomic research has largely contributed to this model, concentrating its efforts on a limited number of species or cultivars with high energy productivity.

The current challenges concerning worldwide food safety, the reduction in poverty, and the conservation of ecosystems result today in re-examining in depth this dominating paradigm and in better understanding of the opportunities offered by a farming whose balance and durability rest on the properties of a revisited agrobiodiversity. Biodiversity is recognized more and more as a key element of the sustainability of agrosystems, and agroecology is more and more essential as a central scientific discipline for the design of durable cultivation systems in the countries of the North as in those of the South. To widen the basis of agrobiodiversity constitutes one of the bases of agroecology, with a view to ensuring better functions of regulation within the agroecosystems and an increased impact strength of rural societies on the total changes. From this point of view, it is important to evaluate the capacity of insertion of the local plant species of interest in innovative productive systems.

It is recognized that the consumption of fruit and vegetables plays a determining role in human health, whether it is for the populations of the South or North. Many neglected or underutilized horticultural species have an important nutritional wealth and are consumed today in varied proportions by the rural populations among the poorest, thus contributing to the health of these populations with only very limited access to care. The development of the culture of these species in revisited systems of agroecological production, associated with the installation of adapted distribution chains and often with strong added value, constitutes a strong opportunity as regards rural development.

In Africa, more particularly, many populations have a food mode defective in vitamins and minerals; the regular consumption of fruit and vegetables could constitute an efficient way to avoid nutritional deficiencies and to prevent chronic diseases. Underutilized fruits already

play a particular part in this context, bringing into many critical rural situations as regards poverty an essential ration of minerals and vitamins in a system of gathering in which the management of the plants is more or less controlled. Often better adapted than the crop plants to environments that are degraded or threatened by biotic (resistance to bioaggressors) or abiotic (drought, soil poverty, salinity, etc.) factors, the underutilized indigenous plants deserve integration into systems managed to improve their productivity while maintaining their survival, often threatened by intensification.

This special issue of *Fruits* is dedicated to Africa, a continent particularly afflicted by malnutrition, and for which the underutilized species constitute a particular challenge. It gathers fifteen recent *Fruits* articles and constitutes the second booklet devoted by the journal to fruit-bearing agrobiodiversity and underutilized species [3]. The fifteen articles which compose this special issue approach various aspects of the research undertaken on the African continent regarding underutilized fruit trees.

Biodiversity and indigenous consumption

The first three articles of this special issue analyze the importance of the local fruit-bearing species for fruit consumption and its link with the practiced ways of managing. In West Africa, several studies revealed the wealth of fruit-bearing species in the forest and savanna zones as well as the diversity of their uses. In the first article, Atato *et al.* thus listed in the various agroecological areas of Togo the lianas with edible fruits used for human consumption; the article put forward conservation and valorization steps and noted the importance of these fruits as a food resource and source of income. The protected areas also represent an immense reserve of living resources, which the bordering populations strongly depend on. In the second article, Mbaygone *et al.* listed a total of 58 plant species in the reserve of Pama, in Burkina Faso, that is to say, more than 15% of the local flora, which provide various resources for the bordering populations, including construction equipment, medicinal herbs and food plants. Some of these species appear to be increasingly rare because of degradation of the climatic conditions, green wood abusive exploitation and the impoverishment of the soils; they require special attention.

However, fruit consumption remains a complex economic and cultural process, which is not necessarily related to the economic development of fruit-bearing sectors. Tossou *et al.* studied the volume of consumption of fruits and vegetables produced in an area of Benin, the plateau of Allada, and they evaluated the links existing between their availability, their price and their acquisition by households. In spite of a strong production of certain fruits, their consumption by agricultural households is low and remains little diversified compared with their availability; it is well below the standards recommended by the WHO. It is necessary to study the determinants of such a distortion better in order to guide the public policies better, as well as the choices of the producers and the consumers, in order to ensure a better food mode among the local populations.

Use and management of natural and cultivated stands

Eight articles are devoted to the analysis of the production of six neglected species, but whose importance is proven in West Africa for the indigenous people: the bissap (*Hibiscus sabdariffa* L.), the ditax (*Detarium senegalense* J.F. Gmel.), the black plum (*Vitex doniana*), the carapa (Meliaceae), the baobab (*Adansonia digitata*) and the tamarind (*Tamarindus indica* L.).

In their article, Cisse *et al.* sought to describe the principal elements characterizing the bissap sector in Senegal, from its production to its marketing. *Hibiscus sabdariffa* L. is an annual herbaceous plant of the Malvaceae family known under various names throughout Africa. It is cultivated today in the whole of the Senegalese area within agricultural smallholdings for which it constitutes a considerable source of income. Generally exploited by women, who gather more and more in association or in Economic Interest groupings, the plant is cultivated according to traditional practices, generally without manure contribution. Profiting from a support program of the State, the increase in the cultivated acreages and economic actors implied in the bissap production sector confers today on this crop an important place in the agricultural products marketed in Senegal.

Detarium senegalense J.F. Gmel. (ditax) is a large tree originating in tropical Africa; it is found on the wet dense

outskirts of forest, in the coastal, northern regions, and in the Sudano-Guinean zone. Indicated by the term “ditax” in Wolof, this tree is one of the most important forest fruit-bearing species in the exploitative economy in Senegal. In their article, Diop *et al.* analyze the main characteristics and uses of the edible ditax in Senegal in order to contribute to the relevant evaluation of the potential of this fruit. The fruit, characterized by its green pulp that is very rich in vitamin C (more than $1 \text{ g} \cdot 100 \text{ g}^{-1}$), has various therapeutic virtues. It is very popular and widely consumed, mainly in the form of drink, marmalade, sorbet or as a fresh product. In spite of its nutritional and organoleptic potential, the ditax remains underexploited.

In Benin, the plum tree of the savannas (*Vitex doniana*) is an indigenous fruit-bearing species important for the subsistence of the rural populations. The work of Dadjo *et al.* concerned a study of the native knowledge of the farmers concerning the use and the management of the species in the traditional systems according to various sociocultural groups. Although the use of the species varies according to local knowledge, the use as food and medicine prevailed over the other uses. There currently exists renewed national and international interest in this tree, which seems a priority species for domestication in Africa.

The trees of the *Carapa* (Meliaceae) genus are present in all the forests of tropical Africa around the equator; they constitute an important source of woody and non-woody products. In their article, Weber *et al.* analyze the production of *Carapa* and its consequences in West Africa on the regeneration of this natural resource. The West African species of *Carapa* are little or not exploited for their wood, but oil extracted from the fruits, which is polyvalent, is the most used substance resulting from the plant before the leaf, bark and root extracts. In West Africa, the oil of carapa is of traditional importance. It is very appreciated by the native populations for its especially medicinal, insecticidal and insect-repellant properties. In spite of these properties, the trade in the carapa oil is primarily local and remains a very marginal activity, although there is an increasing use of this oil as a natural insecticide, in particular in the cultivation of biological cotton or in the field of cosmetic and parapharmaceutical “biological” products. Protection

measures for the *Carapa* trees and their habitat must be taken to allow the control of long-term oil production. Its integration in cultivation systems seems to be a sustainable option for the conservation of the natural settlements of *Carapa*.

The baobab (*Adansonia digitata*) is a tree with multiple uses, adapted well to the semi-arid zones of Africa. Its fruits have today an economic importance recognized on the local scale, where they can be used for nutritional and pharmaceutical ends. A possible over-exploitation of the baobab tree was recently reinforced by the acceptance of the pulp of the baobab fruit on the EU and American markets for food, and pharmaceutical or cosmetic preparations. In her study, Sanchez analyzes the distribution of the baobab tree (*A. digitata*) in Malawi, the principal exporter of baobab fruit pulp in Africa. The baobab tree proved to be largely distributed in the south of Malawi, with variable densities. The study showed that, if certain zones with a strong density of baobab trees could be more exploited, its culture or its integration into existing cultivation systems should be favored in the zones with low density of baobab trees to mitigate a weak natural regeneration.

The tamarind (*Tamarindus indica* L.) is a tropical fruit tree with multiple functions; it originates in Africa, where it plays today an essential part in subsistence in the rural regions of West Africa; this is what Stege *et al.* underline in a study on the importance of tamarind in the traditional food of the rural communities in Benin, Mali and Senegal. The tamarind is consumed daily and throughout the year by many Africans of the rural areas; this fruit provides vitamins and minerals, as well as a traditionally appreciated acid savor to drinks and traditional dishes. The results reported by Stege *et al.* include the detailed definition of the processing of the tamarind and of the preparation of traditional dishes from its fruits, seeds, flowers and leaves. The ethnic similarities and differences in the tamarind consumption patterns stress the importance of this fruit as a subsistence food in West Africa. The importance of its local use and the strong demand as a subsistence food for the tamarind fruits and leaves should stimulate the development of its sustainable production, as well as efforts of conservation; in the future, this would then mean ensuring a continuous harvest and satisfying the high local demand for this traditional food.

For this same fruit-bearing species (*Tamarindus indica*), Fandohan *et al.* compared the viability of the tamarind populations under different human pressure severity. Their results indicate that in fact the forest gallery would be most appropriate for the *in situ* conservation of tamarind. The critical reduction of tree and young seedling numbers observed in the cultivated areas and wooded savannas could negatively influence the long-term viability of the tamarind populations. The introduction of young seedlings into the cultivation zones could be necessary to ensure the conservation of *T. indica* in agroforestry systems. In a second article, Fandohan *et al.* studied the effect of the ecological conditions on the distribution, abundance and yields of the tamarinds in three ecological areas of Benin. The tamarind's natural distribution was limited to the Sudanese and Sudano-Guinean zones, but it is necessary to note the production of larger fruits in the wetter zone.

The composition and nutritional value of fruits

The fruits of many species that are underutilized but consumed by the local populations can be rich in minerals, nutrients or vitamins and thus contribute significantly to the health of the local populations, in particular to that of groups at risk (nursing mothers, children, elderly people). Sometimes, they constitute the only source of vitamins and some can even play a particular part in scarcity periods. Nevertheless, knowledge of these fruits and of their nutritional properties remains generally partial. The last four articles presented in this special issue relate to the composition and the nutritional potential of fruits resulting from underutilized species in Africa. In certain cases, the pharmaceutical, agro-industrial or cosmetic potential could also constitute the basis for the development of an economic sector.

In Senegal, *Maerua pseudopetalosa*, a species of the Cappariaceae family, provides consumable fruits to the native populations for the scarcity period. Ayessou *et al.* show that, in spite of poor protein content, the fruit of *M. pseudopetalosa* constitutes an excellent source of nutrients and can validly fill certain deficiencies, particularly in food shortage periods.

The baobab tree (*Adansonia digitata* L.) is a tree which grows wild in Senegal; the fruit is consumed there in various forms. Although the ecology and the botany of the plant have already been the topics of some studies, work relating to fruit processing or to the impact of the processing on the quality of the products is rare. In order to evaluate the technological potential of these fruits, Cissé *et al.* sought to characterize the raw material (biochemical composition and nutritional quality), and studied fruit processing into nectar.

In Africa, the uses of the bissap (*H. sabdariffa*) are many and varied, in food as well as in traditional medicine. Cisse *et al.* propose a synthesis related to the composition and uses of the plant. Although the chalice, because of their high content of acids, vitamin C and especially anthocyanes, constitute the most involved part of the plant, the seeds of *H. sabdariffa*, because of their high content of protein, lipids and total sugars, are also very much used in food in many African countries. Lastly, the leaves constitute a good source of nutrients and are used for the preparation of sauces. As a complement to the studies on the nutritional contribution of bissap products, research on the antioxidant and therapeutic properties of the plant should be carried out.

Lastly, in the last article of this special issue, Boodraa *et al.* analyzed the fruit mineral and vitamin composition of five underexploited species in Algeria: *Celtis australis* L., *Crataegus azarolus* L., *Crataegus monogyna* Jacq., *Elaeagnus angustifolia* L. and *Zizyphus lotus* L. Their traditionally exploited fruits are sources of minerals and vitamins which could constitute a considerable raw material for food. The pulp of the five studied fruits appeared richer in vitamins (tocopherol, carotene, vitamin C, B1 thiamin) and in minerals (calcium, magnesium, potassium, iron, manganese) than certain more widely consumed fruits. In addition to their nutritional contribution, the analyzed fruits could be used in various fields: agri-foodstuffs, cosmetic and pharmaceutical.

The promotion of underutilized plant species, upon which the food balance of poor rural populations in Africa still often depends, requires a change of vision as regards agricultural development. The integration of the

underutilized plant species in sustainable food systems implies the coordination of increased multi-field research efforts associating the fields of human nutrition, botany and genetics, ecology, agroecology, and social sciences, to conceive new systems. In all cases, the taking into account of local knowledge constitutes an essential component for the design of new cultivation systems based on a sustainable valorization and management of the local biodiversity.

[1] Anon., Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture, FAO, Roma, Italy, 1996.

[2] Wilson E.O., The diversity of life, Harvard Univ. Press, MA, U.S.A., 1992, 464 p.

[3] Underutilized Fruits, hors-série *Fruits*, 2008.

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