Journal of Food Composition and Analysis 19 (2006) 477–483

JOURNAL OF FOOD COMPOSITION AND ANALYSIS

www.elsevier.com/locate/jfca

Commentary

Biodiversity and nutrition: A common path toward global food security and sustainable development☆, ☆☆

Álvaro Toledo[a], Barbara Burlingame[b,*]

[a]*Secretariat of the Commission on Genetic Resources for Food and Agriculture, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome, Italy*

[b]*Senior Nutrition Officer, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome, Italy*

Abstract

Food composition provides an important link for biodiversity and nutrition. Biodiversity at three levels—ecosystems, the species they contain and the genetic diversity within species—can contribute to food security and improved nutrition. The Food and Agriculture Organization of the United Nations (FAO) and the International Plant Genetic Resources Institute (IPGRI) are leading a new international initiative on biodiversity for food and nutrition under the umbrella of the Convention of Biological Diversity. The overall aim is to promote the sustainable use of biodiversity in programmes contributing to food security and human nutrition, and to thereby raise awareness of the importance of this link for sustainable development. Further research is needed to increase the evidence base by filling our knowledge gaps with better inventories and more data on composition and consumption. If nutrient analysis and data dissemination of the various food species and intra-species diversity are systematically undertaken, national information systems for food and agriculture will be strengthened and can be used to form the basis for priority setting and national policy making. For nutrition, this will mean introducing more compositional data on biodiversity in national food composition databases and tables; developing and using dietary assessment instruments that capture food intake at the species and variety/breed level; and allowing food labelling that encourages awareness of food plant varieties and food animal subspecies. Nutrition and biodiversity feature directly the Millennium Development Goals (MDGs): halve the proportion of people who suffer from hunger; and ensure environmental sustainability. In combination, a nutrition and biodiversity initiative provides the very foundation for achieving these MDGs.

Keywords: Nutrition; Biodiversity; Millennium Development Goals; INFOODS; FAO; IPGRI

Introduction

The International Network of Food Data Systems (INFOODS, 2006),[1] through the *Journal of Food Composition and Analysis*, its standards development activities and the network of Regional Data Centres, has long promoted the importance of identifying and disseminating nutrient profiles of food plants and animals, including wild and under-utilized species, varieties and breeds. It is with great enthusiasm that the *Journal of Food Composition and Analysis* presents this special themed issue on Biodiversity, illustrating the important role of biodiversity for nutrition, and of nutrition for biodiversity.

This publication of the Food and Agriculture Organization (FAO) of the United Nations will contribute to supporting new efforts for mainstreaming biodiversity into food and agriculture, and in particular into the nutrition agenda. FAO and the International Plant Genetic Resources Institute (IPGRI) are leading a new international initiative on biodiversity for food and nutrition under the umbrella of the Convention on Biological Diversity (CBD). The overall aim of the initiative is to promote the enhanced

☆This paper expresses the views of the authors and does not necessarily reflect the policy either of the Food and Agriculture Organization of the United Nations or of its Member Countries.

☆☆This article is available in French and Spanish; kindly address all requests to the corresponding author.

*Corresponding author. Tel.: +39 06 5705 3728; fax: +39 06 5705 4593.
E-mail address: barbara.burlingame@fao.org (B. Burlingame).

[1]INFOODS is operated by the Food and Agriculture Organization (FAO, 2006a–c) in collaboration with the United Nations University (UNU, 2006).

0889-1575/$ - see front matter
doi:10.1016/j.jfca.2006.05.001

Table 1
Biodiversity and nutrition rationale

- Wild species and intraspecies biodiversity have key roles in global food security
- Different varieties have statistically different nutrient contents
- Acquiring nutrient data on existing biodiversity needs to be a prerequisite for decision making in GMO work
- Nutrient content needs to be among criteria in cultivar promotion
- Nutrient data for wild foods and cultivars need to be systematically generated, centrally compiled and widely disseminated
- Biodiversity questions and/or prompts need to be included in food consumption surveys
- Acquiring nutrient data and intake data for varieties is essential in order to understand the impact of biodiversity on food security

sustainable use of biodiversity in programmes contributing to food security and human nutrition, and, thereby, to raise awareness of the importance of biodiversity for sustainable development. Enhancing the sustainable use and conservation of biodiversity has traditionally been a core element of FAO's work to fight hunger and malnutrition since the early 1960s (Esquinas-Alcázar, 2005), so it comes as no surprise that FAO hopes to strengthen cooperation with other institutions in order to build bridges between the nutrition and biodiversity communities (see Table 1).

Food composition provides an important link for biodiversity and nutrition, which are two generally unrelated fields. Even though the terms genetic resources, ecosystems and biodiversity may not be part of the mainstream nutrition vocabulary, nutrition activities have long embraced the concepts. In the nutrition science community, biodiversity has always been about food and nutrients with a focus on wild and gathered species or varieties, and under-utilized and under-exploited food resources. Using the label biodiversity might be a little different, but conceptually it has always featured in nutrition work. In addition, it leads us logically to one of the basic principles of nutrition—dietary diversity. Similarly, the environment sector, traditionally the home of much biodiversity activity does not generally think of these resources in terms of food, nutrients and human nutrition. Food composition is therefore a useful vehicle to explore certain synergies and develop common ground between biodiversity and nutrition. Nutrition and biodiversity feature directly in the Millennium Development Goals (MDGs), in Goal 1, Target 2, "Halve the proportion of people who suffer from hunger"; and Goal 7, "Ensure environmental sustainability" (UN, 2005). In combination, a nutrition and biodiversity initiative provides the very foundation for achieving these MDGs.

Food biodiversity and trends in food security, nutrition, health and trade

Ever since human beings first began domesticating plants and animals some 12,000 years ago, agricultural biodiversity has played a pivotal role in sustaining and strengthening food, nutrition, health and livelihood security all over the world. In spite of enormous progress made in enhancing productivity through the sustainable use of genetic resources for food and agriculture, more than 800 million people remain under-nourished. The majority of them live in southern Asia and sub-Saharan Africa, areas of the globe that are rich in endemic agricultural biodiversity (Chennai Platform for Action, 2005).

Biodiversity management plays a significant role in the development of sustainable agricultural development practices and strategies against malnutrition. The integration of biodiversity into food security and anti-hunger policies is likely to generate more socio-economic benefits—including supporting poverty alleviation efforts—than in any other sector. For this to happen, our knowledge about biodiversity for food and agriculture must improve, and food composition and consumption are important dimensions. The recognition of the value of biodiversity for improved nutrition is one component of the shifting paradigm in approaches to malnutrition. New approaches stress that in order to be successful, strategies to address nutrition problems have to be systematic and multisectoral, and should be integrated into a general framework. Sustainable improvement in nutritional well-being is achieved through a combination of evidence- and community-based actions to address local causes of malnutrition; improvements in national and sectoral policies and programmes; support to civil society institutions to enable poor households to access or acquire sufficient food and utilize it most effectively; and enhancement of education and public information for dietary improvement.

These new approaches go beyond simple improvement of sufficient dietary energy provision, and—in this context—micronutrients, ecosystems, and wild or under-utilized species and varieties feature explicitly. Gathering wild foods, growing locally adapted varieties and eating from the local ecosystem are practices that continue to be part of civilizations and cultures; their potential value for food security and rural developement has been recognized.

There is also growing acknowledgment of the need to adapt nutrition and health interventions to the diversity of needs of individuals and communities. Given the enormous diversity within the human community, we need to realize that individual food requirements are not homogenous (Nabhan, 2004). Our food production and consumption need to continuously adapt to changing demands of society, and biodiversity provides the basis to confront change. Reliable data on the nutrient composition of foods is becoming critical in the formulation of appropriate therapeutic diets, and there is an increasing number of food species being evaluated for their nutritional and therapeutic properties, as is shown in one of the articles in this issue in the case of the *noni* fruit, "Diversity of fruits, nuts and their products for improving nutrient intakes" (Chan-Blanco et al., 2006).

With globalization, people and foods are increasingly moving around the world. When people, in particular those from rural areas, travel and settle down in new places, they carry with them their local food cultures. These may include a unique rice variety, a fish or a vegetable unknown for urban dwellers, or a special dish which requires certain local ingredients. Many of these products will become popular and find their way into urban menus. New national and international markets are being developed for a number of less-common food species, varieties or breeds. The absence of specific food composition data has sometimes constituted a technical barrier to trade. Most potential export markets for unique species and cultivars require or encourage nutrient composition data for food labels and point-of-purchase materials. Many countries have experienced trade problems because compositional data required by the importing countries' legislation were not provided or were considered to be incorrect. Also in the context of international trade, voluntary or mandatory safety assessment schemes have been introduced in many countries, for genetically modified organisms (GMOs) used as food. Such safety assessments usually use the concept of "substantial equivalence": the new food is compared to conventional foods to assess similarities and differences that may have a significant effect on the health of consumers. Better knowledge of the nutritional composition of conventional foods—in this case, the existing cultivars—will facilitate the conduct of safety assessments of GMOs.

Nutrition and trends in the sustainable utilization of biodiversity for food and agriculture

Biodiversity at three levels—ecosystems, the species they contain and the genetic diversity within species—can contribute to food security and improved nutrition in several ways. With population pressures rising and less land available for agriculture, global food production and yields will be forced to increase, even allowing for improvements in food distribution. Most of this productivity boost will be achieved only through the increased utilization of the genetic resource base of food species. The need for greater access to and utilization of genetic resources by farmers is therefore urgent. In pursuing global food security, it has been increasingly recognized that the wide range of existing food productions systems requires different approaches to the sustainable utilization of genetic diversity, with diverse objectives, methods and institutional arrangements being promoted to meet development goals. Nutrition considerations are increasingly important within this current trend of diversification of approaches.

This is particularly true in meeting the needs of the rural people living in vulnerable socio-economic and agro-ecological zones, who generally require greater use of genetic diversity to develop complex and dynamic farming systems (FAO, 1998). Section 1 of this special issue brings together research on biodiversity on local and traditional food systems. This compilation shows a wide range of research from all over the world, from the Artic region to the arid lands, and in mountains and island ecosystems. They reflect the tremendous efforts that local and indigenous communities are providing in the conservation and sustainable management of the biodiversity that feeds the world.

As these communities are often targeted by nutrition and livelihoods programmes, it is critical to improve local knowledge and awareness of the nutrient profiles of local food species, varieties or breeds, and thus bring about the achievement of the MDGs concerning nutritional improvement and conservation of biodiversity for food and agriculture. For example, vitamin A deficiency diseases still prevail in certain parts of the Pacific, and therefore cultivar-specific nutrient data on provitamin A carotene should be fundamental to agriculture and nutrition policies and interventions. Huang et al. (1999) reported that sweet potato cultivars in some Pacific Islands differed in their beta-carotene content by a factor of 60, yet nutrients were not considered as criteria in the promotion of varieties by agricultural extension services. In fact, recent compositional research has provided data to confirm the micronutrient superiority of some lesser-known cultivars and wild-crop relatives over some more widely utilized cultivars. The data are accumulating for dietary staples (Huang et al., 1999; Kennedy and Burlingame, 2003), fruits (Englberger et al., 2003; Englberger et al., 2006) and other foods. Sections 2 and 3, "New nutrient data to underpin the sustainable use of plant genetic resources for food and agriculture", introduces current state of the art in research on plant diversity in relation to its nutritional composition. The articles in these sections focus on a wide number of species and productions systems: key crops critical for food security (Ceballos et al., 2006); horticultural species (Deepa et al., 2006; Hanson et al., 2006); commodity species (Niemenak et al., 2006) and even on the evaluation of genetic materials for highly commercial agriculture (Jonnala et al., 2006).

Section 4, "Farm animals and fisheries diversity for human nutrition", explores current research with regard to farm animal genetic resources and fish species. Caldironia and Manes (2006) study the possibilities of farming so-called wild sources of protein in the interests of both nutrition improvement and sustainable development, for example. Although data are emerging with regard to these two components of food biodiversity (see in particular Tapura, Bhanger and Khuhawar, 2006), the quantity of compositional data on animal genetic diversity still lags behind the data that has accumulated for plant diversity. This remains a challenge for the near future, and we hope that future meetings, such as the First International Conference on Farm Animal Genetic Resources organized by FAO in Switzerland in 2007, will help to improve the linkages between animal biodiversity and human nutrition.

The section of this issue entitled, "Ecosystems and nutrition: rice-based aquatic ecosystems and dietary diversity", shows innovative ways to understand and implement nutrition strategies by considering the entire range of food biological resources available in an intensively human-managed agro-ecosystem. The Mekong River basin rice paddies and the surrounding landscape provide a striking example. The presentations in this section focus on the value of aquatic biodiversity for nutrition, raising awareness of the ecosystem approach that has been neglected in most development efforts.

Although this special issue does not include any research articles on algae and edible fungi, good examples of ongoing work can be found in previous issues of the *Journal of Food Composition and Analysis*. For example, Kuda et al. (2004, 2005) studied the nutrient composition of various marine algal products that were consumed as traditional food in certain areas of the coast of Japan (some of them being used as food only by a few fishing communities); now they are being sold as common sea vegetables. Previous articles have also examined the different nutrient elements in edible mushrooms grown in geochemically different regions (ikkarinen and Mertanen, 2004). This shows the extremely valuable research that is being carried out on all components of biodiversity for food and agriculture.

Food composition and analysis in linking biodiversity and nutrition

Many factors are known to affect the nutrient content of foods, including climate, geography and geochemistry, agricultural practices such as fertilization and the genetic composition of the food species. Up to now, as regards plants, cultivar-specific differences have received the least attention. In the past, generic food composition data were considered sufficient for most purposes, but now the usefulness of cultivar-specific composition data is increasingly being acknowledged. It should be clear that when nutrient contents are significantly different among foods of the same species, then those foods should be reported independently in food composition databases and other printed materials—including food labels—with their unique nutrient profiles. The information should also be conveyed through community health and agriculture programmes and nutrition education initiatives, and incorporated into national health and agriculture policies.

But compositional data can also provide additional information that can help us improve the management and conservation of biodiversity for food and agriculture. Data on toxicants and contaminants of food biological resources (Kuti and Konoru, 2006) provide necessary information for risk assessment (Orban et al., 2006); data on traditional preparation methods contribute to our understanding of how different forms of processing or cooking can improve or compromise the nutritional quality of a under-utilized species (Pugalenthi, Siddhuraju and Vadivel, 2006), wild relatives of food tubers (Bhandari and Kawabata, 2006) or farm animal breeds (Glew et al., 2006). Food composition can even increase our ecological knowledge of the habits of certain species involved in food production, as shown in the article on the stingless bee in Brazil (Sarmento Silva et al., 2006).

International policy developments in the field of biodiversity

Nutritionists and food experts need to be aware of the complex policy landscape governing the sustainable management of biodiversity at both national and international level, which often entangle developments in various sectors including agriculture, environment, trade, research and health. Two particular forums are now looking at ways to integrate the nutrition dimension into the priority setting related to biodiversity: the FAO of the United Nations and the CBD. The work developed at the international level is often translated into national programmes, policies or legislations that regulate the use of genetic resources.

Since its earliest days, for more than 50 years, FAO has considered the planet's genetic resources to be important to agriculture, health, the environment and trade. FAO's nutrition work has always included elements of biodiversity in its field and normative operations, and with its compilations of wild, neglected and under-utilized genetic resources used for food. During the past 25 years, formal instruments have been created that include several commissions, conventions and treaties. Most countries are party to some or all of these.

In the early 1980s, FAO members felt that the political, economic and ethical dimensions surrounding the conservation and sustainable use of genetic resources for food and agriculture needed to be tackled at the level of the UN system, beyond the technical work already being carried out by FAO and other international organizations (Esquinas-Alcázar, 2005). The FAO conference established the first intergovernmental forum specifically dealing with agricultural genetic resources: the Commission on Genetic Resources for Food and Agriculture. It now includes 166 member countries. The Commission aims to reach international consensus through negotiations on areas of global interest in relation to all components of biodiversity of relevance for food and agriculture (FAO, 2006a–c). It monitors and coordinates the development of the Global System on Plant Genetic Resources and the Global Strategy for the Management of Farm Animal Genetic Resources to ensure the safe conservation and promote the availability and sustainable use of plant and farm animal genetic resources by providing a flexible framework for sharing the benefits and burdens. In relation to nutrition, the Commission has started to discuss a draft action plan on how to better support countries to generate, compile and disseminate cultivar-specific nutrient composition and consumption data.

The Commission negotiated a new international agreement dedicated to plant genetic resources, which are so crucial in feeding the world's population. The International Treaty on Plant Genetic Resources for Food and Agriculture (FAO, 2001) was adopted by the FAO conference in November 2001 and came into force in June 2004. As of April 2006, it has been ratified by 100 countries. These genetic resources are the raw material that farmers and plant breeders use to improve the quality and productivity of crops. The future of agriculture depends on international cooperation and the open exchange of the crops and their genes that farmers all over the world have developed and shared for more than 10,000 years. No country is entirely self-sufficient; all depend on crops and the genetic diversity within these crops from other countries and regions. The treaty is vital in ensuring the continued availability of the plant genetic resources to feed the world (FAO, 2006c).

The Convention on Biological Diversity (CBD, 1992) was signed by 150 government leaders at the United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 3–14 June 1992. Currently, the contracting parties now number 188 (CBD, 2006). The CBD's conference of the parties has initiated work on a number of crosscutting issues and thematic work programmes addressing priorities for biodiversity management in different biomes, from marine to forest, from island to dry and subhumid lands or mountain biodiversity. Within the programme of work on agricultural biodiversity it has recently launched a crosscutting initiative on biodiversity for food and nutrition. The initiative will focus future work on various areas: developing and documenting knowledge; integration of biodiversity, food and nutrition issues into research and policy instruments; conserving and promoting a wider use of biodiversity for food and nutrition; and public awareness. The initiative is to be led by FAO and IPGRI.

Future challenges

Ongoing research will continue to examine the relationships between biodiversity and nutrition from different angles and at different levels. Further research is needed, first and foremost, to increase the evidence base by filling our knowledge gaps with better inventories and more data on composition and consumption. If nutrient analysis and data dissemination of the different food species and intra-species diversity is undertaken systematically, national information systems for food and agriculture can be strengthened and used to form the basis for priority setting and national policy-making. For nutrition, this will mean introducing more compositional data on biodiversity in national food composition databases and tables, developing and using dietary assessment instruments that capture food intake at the species and variety/breed level, and allowing food labelling that encourages awareness of food plant varieties and food animal subspecies and breeds. This information can then be used in community nutrition programmes, school and institutional garden projects, nutrition education initiatives and by the agro-food industry.

Researchers are developing new innovative approaches to bridge current approaches being used at local level for the management of biodiversity and to tackle malnutrition. The splendid work by Garí (2004) shows how use of local genetic diversity can expand the means and options of small farmers facing the HIV/AIDS crisis so that they can enhance their agricultural systems and cope with pressing nutritional and livelihoods needs. Enhancing the management of these resources that are locally available, affordable and versatile, enables the improvement of household nutrition even when there is shortage of productive resources, a situation commonly faced by vulnerable groups confronting complex health, food and development crisis (Garí, 2004).

For biodiversity and genetic resources, the availability of the knowledge on nutrient content of varieties will enable its introduction into the information systems of the national programmes for genetic resources for food and agriculture, and then integration in the regional and international information systems for genetic resources, all carried out consistent with national laws.

Notwithstanding the information gaps which need to be addressed, the body of existing knowledge is sufficient to warrant action to promote the use of biodiversity in food security and nutrition programmes and policy development (e.g., dietary guidelines and goals). Within current initiatives on agricultural biodiversity, nutrition can be included in participatory plant breeding programmes, community management of farm animal breeds and small-scale family poultry production, and in the development of national programmes, strategies or policies for biodiversity and genetic resources within the food security national policies or the poverty alleviation strategies.

Clearly, many wild species, varieties and animal breeds have the potential to become conventional foods of the future—useful parents in breeding programs, convenient sources of income, and the vehicles for improved nutrition and increased food supply. FAO's current efforts, together with IPGRI as an important partner, involve collecting and examining the body of existing knowledge, and identifying knowledge gaps.

The new data presented in this special issue of the Journal of Food Composition and Analysis fills some of those gaps. The journal will continue to provide an international peer reviewed forum for publishing scientific papers on nutrition and biodiversity, with particular attention to papers from developing countries.

Selected bibliography

Bhandari, M.R., Kawabata, J., 2006. Cooking effects on oxalate, phytate, trypsin and α-amylase inhibitors of wild yam tubers of Nepal. Journal of Food Composition and Analysis 19, 524–530.

Caldironi, H.A., Manes, M.E., 2006. Proximate composition, fatty acids and cholesterol content of meat cuts from tegu lizard *Tupinambis merianae*. Journal of Food Composition and Analysis 19, 711–714.

CBD, 1992. Convention on Biological Diversity, Convention Text. Retrieved 2006-03-09: http://www.biodiv.org/convention/default.shtml.

CBD, 2004. In: Seventh Meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 7), Decision VII/32, The Programme of Work of the Convention and the Millennium Development Goals. Retrieved 2006-03-13: http://www.biodiv.org/decisions/default.aspx?m = COP-07&id = 7769&lg = 0.

CBD, 2006. Convention on biological diversity. Retrieved 2006-03-09: http://www.biodiv.org/.

CGRFA/WG-PGR-3/05/Inf.9. Retrieved 2006-03-13: http://www.fao.org/waicent/FaoInfo/Agricult/AGP/AGPS/pgr/ITWG3rd/docsp1.htm.

Chan-Blanco, Y., Vaillant, F., Perez, A.M., Reynes, M., Brillouet, J.-M., Brat, P., 2006. The noni fruit (*Morinda citrifolia* L.): A review of agricultural research, nutritional and therapeutic properties. Journal of Food Composition and Analysis 19, 645–654.

Chennai Platform for Action, 2005. Agricultural biodiversity and elimination of hunger and poverty: UN millennium development goals five years later. Retrieved 2006-04-12: www.ipgri.cgiar.org/Events/IFAD-NUS/PDF/Agreement5.pdf.

Deepa, N., Kaur, C., Singh, B., Kapoor, H.C., 2006. Antioxidant activity in some red sweet pepper cultivars. Journal of Food Composition and Analysis 19, 572–578.

Englberger, L., Aalbersberg, W., Fitzgerald, M., Marks, G., Chand, K., 2003. Provitamin A carotenoid content of different cultivars of edible pandanus fruit. Journal of Food Composition and Analysis 16, 237–247.

Englberger, L., Aalbersberg, W., Schierle, J., Marks, G.C., Fitzgerald, M.H., Muller, Fred, Jekkein, A., Alfred, J., Vander, V., Nancy, 2006. Carotenoid content of different edible pandanus fruit cultivars of the Republic of the Marshall Islands. Journal of Food Composition and Analysis 19, 484–494.

Esquinas-Alcázar, J., 2005. Science and society: Protecting crop genetic diversity for food security: political, ethical and technical challenges. Nature Review Genetics 6, 946–953.

FAO, 1995. Dimensions of need: an atlas of food and agriculture. Retrieved 2006-03-09: http://www.fao.org/documents/show_cdr.asp?url_file = /docrep/U8480E/U8480E07.htm.

FAO, 1996. World food summit: food for all. Retrieved 2006-03-09: http://www.fao.org/documents/show_cdr.asp?url_file = /DOCREP/x0262e/x0262e04.htm.

FAO, 1998. The state of the world's plant genetic resources for food and agriculture. Retrieved 2006-04-01: http://www.fao.org/ag/AGP/AGPS/Pgrfa/wrlmap_e.htm.

FAO, 2001. The international treaty on plant genetic resources for food and agriculture. Retrieved 2006-03-09: ftp://ext-ftp.fao.org/ag/cgrfa/it/ITPGRe.pdf.

FAO, 2002. Major recommendations of the 20th session of the International Rice Commission, 23–26 July 2002, Bangkok, Thailand. Retrieved 2006-03-13: http://www.fao.org/ag/agp/agpc/doc/field/commrice/pages/sessions.html#01.

FAO, 2005a. Support for countries to generate, compile and disseminate cultivar–specific nutrient composition data, and the relative priority of obtaining cultivar–specific dietary consumption data. Third Session of the Intergovernmental Technical Working Group on Plant Genetic Resources for Food and Agriculture, Rome, 26–28 October 2005. CGRFA/WG-PGR-3/05/5. Retrieved 2006-03-13: http://www.fao.org/waicent/FaoInfo/Agricult/AGP/AGPS/pgr/ITWG3rd/docsp1.htm.

FAO, 2005b. Report of the Third Session of the Intergovernmental Technical Working Group on Plant Genetic Resources for Food and Agriculture, Rome, 26–28 October 2005. CGRFA/WG-PGR-3/05/REPORT. Retrieved 2006-03-13: http://www.fao.org/waicent/FaoInfo/Agricult/AGP/AGPS/pgr/ITWG3rd/docsp1.htm.

FAO, 2005c. FAO's activities in nutrition and biodiversity. Third Session of the Intergovernmental Technical Working Group on Plant Genetic Resources for Food and Agriculture. Rome, 26–28 October 2005.

FAO, 2006a. The Food and Agriculture Organization of the United Nations. Retrieved 2006-03-09: http://www.fao.org.

FAO, 2006b. Commission on Genetic Resources for Food and Agriculture. Retrieved 2006-03-09: http://www.fao.org/ag/cgrfa/#welcome.

FAO, 2006c. The International Treaty on Plant Genetic Resources for Food and Agriculture. Retrieved 2006-04-25: http://www.fao.org/ag/cgrfa/itpgr.htm.

Garí, J.A., 2004. Plant diversity, sustainable rural livelihoods and the HIV/AIDS crisis. UNDP/FAO; Bangkok (Thailand)/Rome (Italy) (published in English and Chinese). Retrieved 2006-03-29: http://www.fao.org/hivaids/publications/index_en.htm.

Glew, R.H., Herbein, J.H., Ma, I., Obadofin, M., Wark, W.A., VanderJagt, D.J., 2006. The *trans* fatty acid and conjugated linoleic acid content of Fulani butter oil in Nigeria. Journal of Food Composition and Analysis 19, 704–710.

Hanson, P.M., Yang, R.Y., Tsou, S.C.S., Ledesma, D., Engle, L., Lee, T.-C., 2006. Diversity in eggplant (*Solanum melongena*) for superoxide scavenging activity, total phenolics, and ascorbic acid. Journal of Food Composition and Analysis 19, 594–600.

Huang, A.S., Tanudjaja, L., Lum, D., 1999. Content of alpha-, beta-carotene, and dietary fiber in 18 sweetpotato varieties grown in Hawaii. Journal of Food Composition and Analysis 12, 147–151.

INFOODS, 2006. The International Network of Food Data Systems. Retrieved 2006-03-09: http://www.fao.org/infoods/.

IPGRI, 2006. The International Plant Genetics Resources Institute. Retrieved 2006-03-09: http://www.ipgri.cgiar.org/.

Jonnala, R.S., Dunford, N.T., Dashie, K.E., 2006. Tocopherol, phytosterol and phospholipid compositions of new high oleic peanut cultivars. Journal of Food Composition and Analysis 19, 601–605.

Kennedy, G., Burlingame, B., 2003. Analysis of food composition data on rice from a plant genetic resources perspective. Food Chemistry 80, 589–596.

Kennedy, G., Burlingame, B., Nguyen, V.N., 2003. Nutritional contribution of rice and impact of biotechnology and biodiversity in rice-consuming countries. In: Proceedings of the 20th Session of the International Rice Commission, Bangkok, Thailand, FAO, Rome, pp. 59–69.

Kuda, T., Taniguchi, E., Nishizawa, M., Araki, Y., 2004. Fate of water-soluble polysaccharides in dried chorda filum, a brown alga during water washing. Journal of Food Composition and Analysis 15, 3–9.

Kuda, T., Tsunekawa, M., Goto, H., Araki, Y., 2005. Antioxidant properties of four edible algae harvested in the Noto Peninsula, Japan. Journal of Food Composition and Analysis 18, 625–633.

Kuti, J.O., Konoru, H.B., 2006. Cyanogenic glycosides content in two edible leaves of tree spinach (*Cnidoscolus spp*.). Journal of Food Composition and Analysis 19, 556–561.

MESP-EA, 2001. Biological and Landscape Diversity of Slovenia, An Overview. Ministry of the Environment and Spatial Planning—Environmental Agency of the Republic of Slovenia, Ljubljana. http://www.gov.si/mop/aktualno/cbd/info/db/biological_landscape_diversity_in_slovenia.pdf.

Millennium Development Goals. Retrieved 2006-03-09: http://www.un.org/millenniumgoals/.

Nabhan, 2004. Why Some Like It Hot: Food, Genes, and Cultural Diversity. Island Press, Washington, DC.

Niemenak, N., Rohsius, C., Elwers, S., Omokolo Ndoumou, D., Lieberei, R., 2006. Comparative study of different cocoa (Theobroma cacao L.) clones in terms of their phenolics and anthocyanins contents. Journal of Food Composition and Analysis 19, 612–619.

Nikkarinen, M., Mertanen, E., 2004. Impact of geological origin on trace element composition of edible mushrooms. Journal of Food Composition and Analysis 17, 301–310.

Pugalenthi, M., Siddhuraju, P., Vadivel, V., 2006. Effect of soaking followed by cooking and the addition of α-galactosidase on oligosaccharides levels in different *Canavalia* accessions. Journal of Food Composition and Analysis 19, 512–517.

Qualset, C., Shands, H., 2005. Safeguarding the future of U.S. agriculture: the need to conserve threatened collections of crop diversity worldwide. University of California, Division of Agriculture and Natural Resources, Genetic Resources. Conservation Program, Davis, CA, USA, UN.

Sánchez, T., Ceballos, H., Chávez, A.L., Iglesias, C., Debouck, D., Mafla, G., Tohme, J., 2006. Variation in crude protein content in cassava (*Manihot esculenta* Crantz) roots. Journal of Food Composition and Analysis 19, 589–593.

Sarmento Silva, Tania Maria, Amorim Camara, Celso, da Silva Lins, Antonio Claudio, Barbosa-Filho, José Maria, Sarmento da Silva, Eva Mônica, Magalhã es Freitas, Breno, de Assis Ribeiro dos Santos, Francisco, 2006. Chemical composition and free radical scavenging activity of pollen loads from stingless bee *Melipona subnitida* Ducke. Journal of Food Composition and Analysis 19, 507–511.

Talpur, F.N., Bhanger, M.I., Khuhawar, M.Y., 2006. Comparison of fatty acids and cholesterol content in the milk of Pakistani cow breeds. Journal of Food Composition and Analysis 19, 698–703.

United Nations, 2005. UN Millennium Development Goals. Website. http://www.un.org/millenniumgoals/

UNU, 2006. The United Nations University. Retrieved 2006-03-09: http://www.unu.edu.