BIODIVERSITY AND NUTRITION A COMMON PATH

NUTRITION AND CONSUMER PROTECTION DIVISION

BIODIVERSITY AND NUTRITION: A COMMON PATH

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A COMMON PATH

The Food and Agriculture Organization of the United Nations (FAO) is actively promoting the conservation and sustainable use of biodiversity for food and nutrition. Biodiversity on three levels—genetic diversity, species diversity and ecosystem diversity—contributes to improved nutrition. Nutrition and biodiversity converge as one common path leading to food and nutrition security and sustainable development. They feature directly in the Millennium Development Goals, to halve the proportion of people who suffer from hunger (Goal 1) and to ensure environmental sustainability (Goal 7). In combination, nutrition and biodiversity will provide the foundation for achieving these Goals.

Since agriculture began some 12,000 years ago, approximately 7,000 plant species and several thousand animal species have been used for human food. Today, however, the worldwide trend is towards dietary simplification, with consequent negative impacts on food security, nutrition and health. Comparing the number of rice varieties cultivated today with the past highlights this dramatic loss of biodiversity. In most Asian countries, the number of rice varieties being grown has dropped from thousands to just a few dozen; for example, in Thailand the number of varieties cultivated has fallen from more than 16,000 to only 37, and 50% of the area cultivated with rice uses only two varieties.

Globalization, industrial development, population increase and urbanization have changed patterns of food production and consumption in ways that profoundly affect ecosystems and human diets. High-input industrial agriculture and long-distance transport increase the availability and affordability of refined carbohydrates and fats, leading to an overall simplification of diets and reliance on a limited number of energy-rich foods. Diets low in variety but high in energy contribute to the escalating problems of obesity and chronic disease which are increasingly found alongside micronutrient deficiencies and undernourishment. The causes and consequences of the dramatic reduction of food diversity and the simplification of diets are complex and are not limited to specific cultures. The overall health of the population, agricultural practices, market conditions and the situation of the environment within a given country are factors contributing to this complexity. However, the potential role that agricultural biodiversity can play in moderating nutritional problems is being increasingly acknowledged. The food systems of indigenous peoples show the important role of a diversified diet based on local plant and animal species and traditional food for health and well-being. In most cases, the increase of processed and commercial food items over time results in a decrease in the quality of the diet.

Countries, communities or cultures that maintain their own traditional food systems are better able to conserve local food specialties with a corresponding diversity of crops and animal breeds. They are also more likely to show a lower prevalence of diet-related diseases.

Documenting nutritional value

Biodiversity plays a key role in ensuring dietary diversity because nutrient composition between foods and among varieties/cultivars/breeds of the same food can differ dramatically. For example, sweet potato cultivars can differ in their carotenoid content by a factor of 200 or more; protein content of rice varieties can range from 5 percent to 14 percent by weight; provitamin-A carotenoid content of bananas can be less than 1 µg/100 g for some cultivars to as high as 8,500 µg/100 g for other cultivars.

Intake of one variety rather than another can make the difference between micronutrient deficiency and micronutrient adequacy. Data on nutrient content is useful for plant breeders assessing genetic materials for improving nutrient values of crop cultivars.

Diversity in aquatic animal species, along with that in crops and livestock, makes a substantial contribution to nutrition by securing high-quality protein and fatty acid intakes for populations relying on wild or farmed fish or other animals that live in aquatic ecosystems. The calcium and vitamin A from small indigenous freshwater fish species can contribute from one-third to one half of the total recommended intakes of these nutrients. New market niches are being developed for a number of less-common food species, varieties and breeds. Indeed, food biodiversity, with its greater or unique nutritional properties, provides products with added value which appeal to consumers and thus provide income sources for many rural people.

FAO is promoting a series of activities towards "sustainable diets" linking local food products, biodiversity, nutrition and sustainability. The development of sustainable diet guidelines will serve to counteract the simplification of diets as well as to promote the consumption of local and traditional foods, as available sustainable sources of quality nutrition.

Key points

- Wild species and intraspecific biodiversity play key roles in global nutrition security.
- Different varieties of the same species have statistically different nutrient contents.
- Acquiring nutrient data on existing biodiversity needs to be a prerequisite for decision-making in work on genetically modified organisms (GMOs).
- Nutrient content needs to be among criteria in cultivar promotion.
- Nutrient data for wild foods and cultivars must be systematically generated, centrally compiled and widely disseminated.
- Biodiversity questions and/or prompts should be included in food consumption surveys.
- Nutrient and intake data for different varieties must be collected and analysed in order to understand the impact of biodiversity on food and nutrition security.

THE CROSS-CUTTING INITIATIVE ON BIODIVERSITY FOR FOOD AND NUTRITION

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The Cross-cutting Initiative on Biodiversity for Food and Nutrition is being jointly developed by the CBD and its partners, the Food and Agriculture Organization of the United Nations (FAO) and Bioversity International. This Initiative was established by decision VIII/23 A of the Conference of the Parties, in Curitiba, Brazil, held from 9 to 31 March 2006. The overall aim of the Initiative is to promote and improve the sustainable use of biodiversity in programmes contributing to food security and human nutrition, as a contribution to the achievement of Millennium Development Goal 1, Goal 7 and related goals and targets and, thereby, to raise awareness of the importance of biodiversity, its conservation and sustainable use. The Initiative's framework is built around four elements:1: Developing and documenting knowledge; 2: Integration of biodiversity, food and nutrition issues into research and policy instruments; 3: Conserving and promoting wider use of biodiversity for food and nutrition; 4: Public awareness and supporting activities. The framework of the Cross-cutting Initiative on Biodiversity for Food and Nutrition identifies the contribution of agricultural biodiversity as a priority for improving nutrition and health of the rural and urban poor. It addresses major global health issues and trends such as micronutrient deficiencies, the decline of dietary diversity and the concomitant rise in chronic diseases that are affecting developing countries, particularly among the poor. The Initiative promotes the use of local biodiversity, including traditional foods of indigenous and local ecosystems with their many sources of nutritionally-rich species and varieties as readily-accessible, locally-empowering and sustainable sources of quality nutrition. Furthermore, the Cross-cutting Initiative recognizes that, in an increasingly global, urban and commercial environment, fulfilment of the potential of local resources must successfully integrate production, marketing, consumption and the health of rural and urban dwellers alike as components of sustainable food systems.

FOOD COMPOSITION AND BIODIVERSITY

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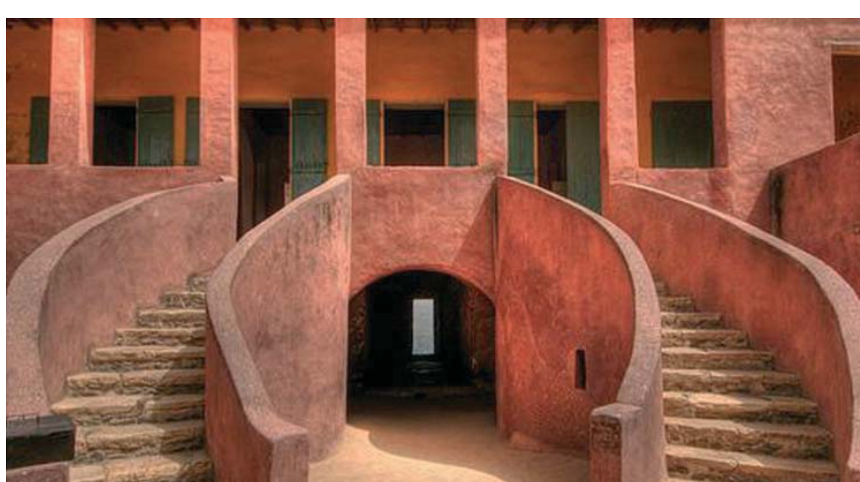
Achieving a worldwide system of compatible food composition databases lies at the heart of the INFOODS (International Network of Food Data Systems) programme. Established in 1984, it operates under the auspices of FAO and UNU (United Nations University). Its goal is to stimulate and coordinate efforts to improve the quality and availability of food analysis data worldwide and to ensure that anyone, anywhere, will be able to obtain adequate and reliable food composition data. It has established a framework for the development of standards and guidelines for the collection, compilation and reporting of food component data.

Ever since human beings first began domesticating plants and animals, agricultural biodiversity has played a pivotal role in sustaining and strengthening food, nutrition, health and livelihood security all over the world. In the past, biodiversity was valued and utilized, and traditional knowledge and practices ensured the conservation and sustainable use of food biodiversity within healthy ecosystems. Agriculture, diets and nutrition have changed so dramatically in recent decades that now the main efforts must be concentrated in returning to local crops and traditional food systems.

AFROFOODS Call for Action from the Door of Return for a Food Renaissance in Africa - December 2009

During the 5th AFROFOODS Meeting held in Dakar in December 2009, the delegates noted that the degradation of ecosystems and the loss of food biodiversity are contributing greatly to the increases in poverty and malnutrition in Africa; recognized that returning to local crops and traditional food systems is a prerequisite for conservation and sustainable use of biodiversity for food and nutrition; acknowledged that local foods are the basis for African sustainable diets; urged that food composition data be emphasized as the fundamental information underpinning almost all activities in the field of nutrition; and issued a call for action for a renewed commitment to an African food renaissance, with biodiversity at its core.



Tables are presented here with some examples of the range in quantity of nutrients among different varieties of the same plant (Table 1); and a particular example of the extremely wide differences in nutrient composition among varieties of one plant (sweet potato; Table 2).

Table1. Nutrient composition ranges among varieties of the same species (per 100 g edible portion, raw)

	Protein, g	Fibre, g	Iron, mg	Vitamin C, mg	Beta-carotene, mcg
Rice	5.6–14.6		0.7–6.4		
Cassava	0.7–6.4	0.9–1.5	0.9–2.5	25–34	< 5–790
Potato	1.4–2.9	1–2.29	0.3–2.7	6.4–36.9	1–7.7
Sweet potato	1.3–2.1	0.7–3.9	0.6–14	2.4–35	100–23100
Taro	1.1–3	2.1–3.8	0.6–3.6	0–15	5–2040
Breadfruit	0.7–3.8	0.9	0.29–1.4	21–34.4	8–940
Eggplant		9–19		50–129	
Mango	0.3–1.0	1.3–3.8	0.4–2.8	22–110	20–4320
Banana			0.1–1.6	2.5–17.5	< 1–8500
Pandanus			0.4	5–10	14–902
Gac					6180–13720
Apricot	0.8–1.4	1.7–2.5	0.3–0.85	3.5–16.5	200–6939 (beta-carotene equivalent)

Source: Burlingame et al., 2009, Journal of Food Composition and Analysis, vol. 22, No. 5, pp. 361-365.

Table 2. Sweet potato *(Ipomoea batatas)* varieties: α–and β-carotene, mg/100g fresh wt (SD)

Variety	%Moisture	β-carotene	α-carotene
Orange Fleshed			
Excel	77.8 (0.8)	12.8 (0.1)	< 0.1
Kona B #	77.8 (0.6)	6.7 (0.2)	1.5 (0.2)
Regal	77.2 (2.1)	13.1 (0.7)	< 0.1
UH 71-5 #	70.3 (1.1)	8.0 (0.1)	< 0.1
Yellow/White Fleshed			
Hoolehua Red #	70.4 (2.7)	0.2 (0.1)	< 0.1
Satsuma #	68.3 (0.2)	0.6 (0.1)	< 0.1

 # Varieties are recommended by the University of Hawaii Extension Service for good yield and disease resistance.

Source: A. S. Huang, L. Tanudjaja, D. Lum., 1999, Journal of Food Composition and Analysis, Vol. 12, No. 2, pp. 147-151.

Bangkok Declaration - 8th International Food Data Conference, Bangkok, Thailand - 3 October 2009

The delegates participating in the 8th International Food Data Conference, in recognizing the importance of food composition data to nearly all activities in nutrition and food quality and safety, as well as the continuing need for quality food composition data for public health, for agriculture, for the environment and for food trade, agreed to promote the science of food composition in multiple and diverse forums, including national, regional and international conferences; to undertake advocacy in the context of policy and programme development; to insure the integration of food composition principles in relevant activities; and to support in various ways the continuing development, maintenance and updating of food composition databases within sustainable infrastructures.

Because nutrient composition can differ enormously among different varieties/cultivars/breeds of the same species, carrying out food composition analyses provides an important link for biodiversity and nutrition.

In the past, generic food composition data were considered sufficient for most purposes. Today, there is more awareness about the need for carrying out food composition studies that take biodiversity into account, but compositional data at the variety/cultivar/breed level are not yet widely generated or disseminated. Farmers and consumers, for example, are often not aware of the higher nutrient values of certain plant cultivars compared with others, and do not grow or consume these fruits or vegetables. Introducing more compositional data on biodiversity in food composition databases will improve the quality of nutrient intake estimates and of dietary adequacy/inadequacy, especially for micronutrients. It is possible that wrong decisions have been made in nutrition and health programmes because the micronutrient values in a national food composition database did not reflect the composition of the varieties actually consumed by that country's population.

With respect to rice varieties, the International Rice Commission, at its 20th Session held in Thailand in July 2002 and its 21st Session held in Peru in May 2006, recommended the following:

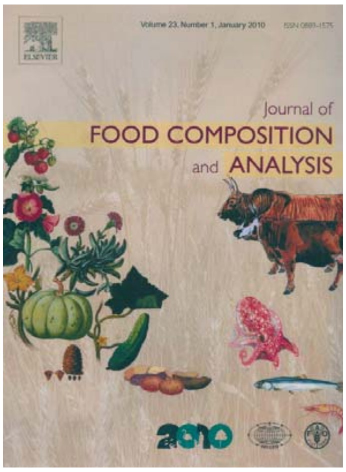
- Existing biodiversity of rice varieties and their nutritional composition need to be explored before committing to transgenic varieties of rice.
- Nutrient content needs to be among the criteria in cultivar promotion.
- Cultivar-specific nutrient analysis and data dissemination should be systematically undertaken.
- The evaluation of the composition and consumption of rice cultivars should continue for the development of food biodiversity indicators to guide agro-biodiversity conservation and human nutrition.

rice is life

INTERNATIONAL YEAR OF RICE 2004

www.rice2004.org

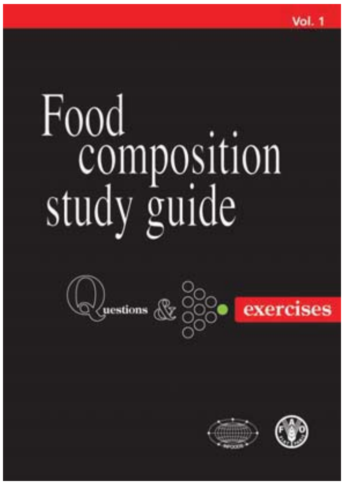
The FAO/INFOODS "Journal of Food Composition and Analysis" publishes scientific articles concerning data on chemical composition of human foods and it gives increasing emphasis on bioactive non-nutrient and anti-nutrient components. The Journal regularly reports findings on the nutrition composition of non-cultivated, non-commercial foods from various regions around the world, preferably below species level.

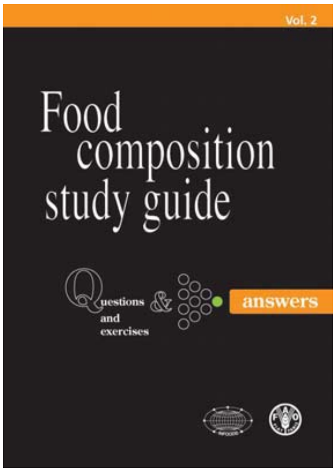


TRAINING IN FOOD COMPOSITION AND BIODIVERSITY

FAO's support to member countries is based on a recognized link between biodiversity, food and nutrition along with the need for enhancing sustainable use of food biodiversity to combat hunger and malnutrition.
Classroom-based food composition training courses have been held in Europe, Africa, Asia, Latin America, the Near East and Oceania. The courses comprise lectures, group work, practical sessions and field trips. Each course covers all relevant aspects of food composition, and targets professionals in food composition data generation, compilation and use—usually from fields such as nutrition science, food science, public health and analytical chemistry. These courses contribute to capacity-building and strengthening of food composition activities at national and regional levels. They also aim to improve the availability, comparability, quality and use of food composition data, and the training of trainers, which ultimately leads to improved quality and quantity of compositional data and results in better dietary assessments, policy decisions, food labels and consumer choice.

In many cases, former participants have taken up key positions in their countries and regions in the implementation of food composition programmes and have become trainers in subsequent courses. The number of sectors requiring food composition data is expanding to areas such as biodiversity, plant breeding, dietary diversity, food industry and food regulation. In line with the current trend whereby continuing education is no longer restricted to the classroom and professionals learning on the job using distance and e-learning tools, FAO and INFOODS have developed the Food Composition Study Guide, a self-study version of the classroom course. The Food Composition Study Guide is one of the several initiatives of FAO aimed at encouraging and promoting continuing education in food composition activities with a significant cost-reduction with respect to the organization of on-site seminars and courses. An entire module of the Study Guide is devoted to biodiversity and meets the growing need for knowledge of the composition of foods based on varieties/cultivars/breeds.





www.fao.org/infoods/training_en.stm

Analysis of food composition data on rice from a plant genetic resources perspective

Authors Gina Kennedy, ESNA Consultant
gina.kennedy@fao.org
Barbara Burlingame, Senior Officer, ESNA
barbara.burlingame@fao.org

1 Abstract

Rice accounts for 21, 14 and 2 % of global energy, protein and fat supply respectively. There are thousands of different rice varieties; some have been in the diet for centuries, while others are new genetic hybrids promoted for qualities such as high yield and drought and disease resistance.

Little is known about the nutrient composition of many of the world's rice varieties. This paper addresses the question of whether there are measurable differences in the nutrient composition of rice by variety, and highlights practical applications for rice genetic resources.

2 Introduction

This paper presents the nutrient composition of rice by variety, and sets out a preliminary basis for assessing the significance of differences among rice varieties using nutrient content as one marker for genetic diversity in rice. While many post harvest factors, such as milling, preparation and cooking can influence nutrient content of rice, this paper focuses on the importance of first understanding differences in the nutrient content of rice varieties.

Rice is from the genus Oryza and is comprised of twenty-one species, only two of which are cultivated: Oryza sativa and Oryza glaberrima. Oryza sativa can be divided into three sub-species, indica, japonica and javanica. At present, 80% of all cultivated rice is from the indica sub-species.

Despite the world's heavy reliance on this agricultural product, rice genetic resources are dwindling. The influence of modern agricultural practices and focus on high-yield crop varieties has contributed to this decline. Increasing land pressure, indiscriminate use of fertilizers and pesticides and destruction of much of the world's forested areas have also contributed to the decline in plant genetic resources.

3 Methods

A thorough literature search was performed to gather existing information on nutrient composition of rice by variety. Food composition tables from China, Korea, Malaysia, Nepal, Pakistan, the Philippines, Thailand and the United States, all provided some information on the variety (or type) of rice analyzed.

A series of journal articles and book chapters containing some nutrient information of rice by variety were found, as was one book on protein content by variety. In order to draw comparisons across numerous data sources, only raw, unpolished samples were compared.

Nutrients were standardized to g/100g dry matter, in the case of proximates and mg/100g dry matter for vitamins and minerals. All nutrients were standardized to common units. For example, when protein values were expressed as N x 6.25 they were recalculated to N x 5.95 for standardization purposes.

4 Results

Varietal difference in nutrient composition were found for every nutrient analyzed. Table one provides the range and average found within varieties for protein, iron, zinc, calcium, thiamin, riboflavin, niacin and amylose.

The difference in nutrient content for the highest and lowest values within varieties was large. For example, 9g/100g for protein and 64 mg for calcium.

Table 1: Varietal differences in nutrient composition

Nutrient	Range	Average	Variety with highest nutrient content	Variety with lowest nutrient content
Protein (n=1339)	5.55 – 14.58 g/100g	8.55	Indica CR1707 (Costa Rica)	Indica Rd 19 (Thailand)
Iron (n=95)	0.70 – 6.35 mg/100g	2.28	Long grained[a] red (China)	Undermilled Red[a] (Philippines)
Zinc (n=57)	0.79 – 5.89 mg/100g	3.34	Ganjay Roozy (IRRI)	Long grain[a] Fragrant (China)
Calcium (n=57)	1.0 – 65.0 mg/100g	26	ADT-21, red (India)	Brown Japonica[a] (Korea)
Thiamin (n=79)	0.117 – 1.74 mg/100g	0.475	Juchitan A-74 (Mexico)	Glutinous rice[a] special grade (China)
Riboflavin (n=80)	0.011 - .448 mg/100g	0.091	Tapol Dark Purple (Philippines)	Mun-pu red (Thailand)
Niacin (n=30)	1.97 – 9.22 mg/100g	5.32	Long grained[a] purple (China)	Glutinous round[a] grained (China)
Amylose (n=1182)	1.0-76.0 g /100g	22.36	Ingra 410 (Brazil)	Bpi-Ri-3 (Philippines)

[a] These data come from Food Composition Tables, and do not strictly represent rice varieties

Table two demonstrates that there were once thousands of rice varieties cultivated; this genetic diversity has dwindled to less than 100 cultivated species in any given country.

Table 2: Extent of genetic uniformity in rice

Country	Number of varieties grown		
	Past	Present	Remark
Bangladesh	5,000	23	
Japan	1,302	-	>70% of area cultivated under three varieties
Rep. of Korea	4,227	12	
Philippines	-	13	
Sri Lanka	2,000	100	
Taiwan Province of China	1,679	50	> 82% of area cultivated under three varieties
Thailand	16,185	37	50% of area cultivated under two varieties

Source: Paroda, 1999

Table 3: Iron and zinc content of selected varieties grown in greenhouse conditions (average of 3 replications)

Variety	Iron mg/100g	Zinc mg/100g
Ganjay Roozy	2.64	5.89
Zuchem	2.34	5.10
YR 4194	2.32	5.40
Banjaiman	2.27	5.30
Xue Bue Nuo	2.25	4.66
IR 64446	2.22	5.35
Kinmaze	2.17	5.17
Tsuyake	2.12	4.25
CNA 6187	2.07	5.45
Miyazaki 7	2.03	4.25
IR 10198	1.58	3.79
Skybonnet	1.53	4.13
IR 60864	1.50	4.11
Heibao	1.49	3.16
Alan	1.40	3.92
IR 63877	1.31	3.64
IR 74	1.30	3.64
IR 72	1.17	3.25
IR 36	1.01	3.14

Source: Adapted from Senadhira, Gregorio and Graham,1998

Table three presents results of a study which analyzed the iron and zinc content of twenty selected varieties.The study is particularly precise in defining differences between varieties, as the plants were grown in a controlled greenhouse environment and nutrient analysis for all samples was performed at the same laboratory.

The study demonstrates that certain rice varieties contain 2.5 times more iron and 1.5 times the more zinc than other varieties. The majority of varieties at the higher end of the spectrum are traditional varieties, while those at the lower end tend to be the high yielding varieties.

5 Practical Applications

Preserving rice genetic diversity though a positive action in its own right, has additional critical importance given the global reliance on this important food staple.

There is clear value to be gained from protecting the genetic source codes which hold the key to future varietal improvements and refinements. Current practical applications of rice plant genetic resources have been realized in both the nutrition and agriculture sciences.

Some current applications of rice plant genetic resources are:

- Combining the traits of high iron and zinc content with high yield to produce more nutritious varieties
- Analyzing, classifying and labeling rice varieties by amylose content to enable the classification of varieties as low or high glycemic foods
- Merging the beneficial traits of Oryza glaberrima and Oryza sativa to create hardier, disease and drought resistant high yielding rice varieties, suitable for cultivation in West Africa
- Intercropping, rather than monocropping rice varieties with different genetic characteristics to reduce reliance on pesticides and fungicides

6 Conclusion

There are large differences in nutrient composition within varieties of rice. However, many of the varieties which are higher in nutrient content are less favored in the current yield driven market.

Too often, nutritional considerations rank far lower than other aspects of crop production. Nutritionists, dietitians and health educators are in part responsible for this, due to a lack of interest and attention drawn to differences within crop varieties.

A concerted effort should be made to incorporate varietal information when conducting food intake surveys, compiling food composition data and providing dietary guidance.

Food and Agriculture Organization
of the United Nations
Viale delle Terme di Caracalla
00100 Rome, Italy
www.fao.org

Nutrient composition of the potato

Interesting varieties from human nutrition perspective

Béatrice Mouillé, U. Ruth Charrondière, Barbara Burlingame, NeBambi Lutaladio
Food and Agriculture Organization of the United Nations, Rome, Italy

International Year of the POTATO 2008

HIDDEN TREASURE

Background

Potato is the world's number one non-grain food commodity.
The potato cultivated worldwide belongs to just one botanical species, *Solanum tuberosum*.

- The potato has four recognized species and 200 wild relatives.
- About 5000 potato varieties are grown in the Andes.
- The chemical composition of potatoes is influenced by many factors, such as the production area, cultivar, soil and climate, agricultural practice, preparation and cooking. Despite the potato's fundamental importance as a staple food, **little is known about the nutrient composition of many of the world's potato varieties**.

Objectives

The aim of this paper is to review the natural variation in the nutrient content of the potato in terms of genetic resource - for direct consumption or for breeding programmes, and in relation to nutritional properties and human diet and health.

Methods

A literature search was performed **to gather existing information on nutrient composition data of potato by species and variety**.
Nutritional data of about 1 015 different potatoes were gathered. The compilation focused on the variability within varieties for the characterization of potato varieties that represent the common market classes, breeding lines, Andean native potatoes, and wild Solanum species.
The **major macronutrients, vitamins and minerals as well as antioxidants and some anti-nutrients were reported**.

Table 1

Varietal variability in nutrient composition

Data from raw potatoes (flesh or whole potato) and expressed on a fresh weight basis.

Nutrient	Range	Average	Variety with highest content	Variety with lowest content
Protein	0.8-4.2 g/100g	2.1 (n=41)	Roja Riñon (Flesh, Tbr/T, Spain)	Revolución (Flesh, Agd, Argentina)
Total fibre Flesh	0.3-3.3 g/100g	1.7 (n=25)	Runa (Adg, Argentina)	Katahdin (Tbr, USA)
Starch	9.1-22.6	16.1	Imilla Negra (Flesh, Adg, Argentina)	Kufri Bahar (Flesh, Tbr, India)
Iron				
– Flesh	0.1-3.8 mg/100g	0.7 (n=90)	Kufri Chandramukhi (Tbr, India)	Negrita (CIP703671, Adg, Peru)
– Whole	0.7-10.4 mg/100g	1.4 (n=90)	Peluca (Tbr/T, Spain)	Cara (Tbr/T, Spain)
Potassium	239-694 mg/100g	443 (n=53)	Azucena (Whole, Adg, Spain)	Monalisa (Tbr, Spain)
Magnesium	10.8-37.6 mg/100g	20.2 (n=53)	Puca Huaryo (Cha, Peru)	Monalisa (Tbr, Spain)
Phosphorus	33.1-126 mg/100g	71.4 (n=26)	CIP 703315 (Gon/G, Peru)	Kufri Bahar (Flesh, Tbr, India)
Calcium	1.3-27.8 mg/100g	10.6 (n=127)	Jancko Anckanchi (Whole,CIP704229, Aja, Peru)	Kufri Bahar (Flesh, Tbr, India)
Vitamin C				
– Flesh	2.8-42 mg/100g	16.6 (n=88)	Chaju (Tbr, Korea)	Liseta (Tbr, Spain)
– Whole	4.6-40 mg/100g	17.1 (n=90)	Voran (Tbr, USA)	CIP705172 (Phu, Peru)
Hydrophilic antioxidant activity				
– Flesh	43-892 mcg Trolox eq./g	386 (n=488)	*S. pinnatisectum* PNT (Wild, USA)	*S. brachistotrichum* 255528 TAX 42 (Wild, USA)
– Whole	128-565	306 (n=26)	Purple Peruvian (Tbr, USA)	Atlantic (Tbr, USA)

Solanum tuberosum L. (Tbr); *S. tuberosum* subsp. *tuberosum* (Tbr/T); *S. tuberosum* subsp. *andigena* (Adg); *S. chaucha* (Cha); *S. stenotomum* subsp. *goniocalyx* (Gon/G); *S. ajanhuiri* (Aja). n = number of different varieties analyzed for each nutrient

Table 2

Iron and vitamin C in the flesh

Variety	Taxonomic	Origin	Iron mg/100g	Vitamin C mg/100g
Negra Ojosa CIP704143	Tbr Stn Adg	Peruvian Andes	0.4	12.8
Natin Suito CIP702464	Tbr Gon/G Stn/S	Peruvian Andes	0.5	18.2
Monalisa	Tbr	Spain	0.5	4.6
Puma Maqui CIP702 395	Tbr Adg	Peruvian Andes	0.6	11.0
Maria Cruz CIP704 393	Tbr Gon/G	Peruvian Andes	0.6	34.0
Cuchi Chucchan CIP706 191	Tbr Adg	Peruvian Andes	0.6	8.9
Runtu CIP703 985	Tbr Gon/G	Peruvian Andes	0.6	12.8
Superior	Tbr	Canada	0.5	26.9
Kufri Chandramukhi	Tbr	India	3.8	14.2

Results

High levels of variability were found in nutrient composition within varieties. For example, the difference for the highest and lowest value was as much as 10 mg/100g for iron when measured **in the whole potato**, and 37 mg/100g for magnesium (flesh) and 694 mg/100g for potassium (whole) **(Table 1)**.
A high variability **was also found for** vitamin C and dietary antioxidants, the highest antioxidant activity being measured in wild *Solanum* species.
Some common potato cultivars and breeding lines contain both high vitamin C and iron contents **(Table 2)**.

Discussion

Varietal differences in nutrient composition were found for all nutrients analyzed. Depending on the variety, potatoes can be a valuable source of minerals such as potassium, magnesium and phosphorus, and also of dietary antioxidants.
A high content of vitamin C enhances iron absorption, and high vitamin C / high iron potato varieties could significantly contribute to achieve the daily vitamin C and iron requirements. **Intake of one potato variety rather than another could be the source of difference between nutrient deficiency and adequacy**.

Conclusion

This study showed a wide variability in nutrient levels among the potato varieties. More data on varietal nutritional differences are needed to stimulate the identification of high nutrient content varieties, the production of more nutritious varieties, and the conservation of potato biodiversity. The use of varietal data in food composition databases or in food intake surveys may lead to more specific dietary guidelines and to the selection of potato varieties based, to some extent, on their nutritional value in breeding programs.

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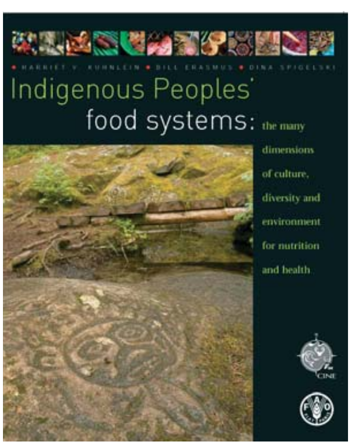
INDIGENOUS PEOPLE'S FOOD SYSTEMS

A 2009 co-publication from the Center for Indigenous Peoples' Nutrition and Environment (CINE) and FAO gives good examples of the worldwide trend to link agricultural biodiversity and nutrition. Twelve case studies, carried out among indigenous people around the world, are reported in this study; the overall conclusion is that an increase of processed and commercial food items over time results in a decrease in the quality of people's diets. For many indigenous communities, the introduction of the foods typical of industrialized societies has created diets high in energy density but poor in nutrient quality, leading to obesity and other lifestyle and health concerns. The study highlights the crucial role of a diversified diet based on local biodiversity and traditional food for food security, nutrition and health. Locally available food-species numbers varied considerably depending on the ecosystem. The Maasai of Kenya documented 35 food species in an arid zone, while there were 381 local food species/varieties documented for Pohnpei in the Federated States of Micronesia. The extent of local traditional food that was consumed also varied considerably among food systems: only the adults of Awajun and Igbo were found to obtain nearly 100 percent of their dietary energy from their own local food resources. For other groups - the Ingano, Dalit, Canadian Inuit, Gwich'in and Nuxalk, Pohnpei, and Maasai, for example - more than 50 percent of their dietary energy comes from commercial foods, increasing the intakes of energy derived from refined flour, fats and sugar; in these cases, we can truly speak of "cultural erosion".

Case study of Pohnpei (Federated States of Micronesia)

Source: Indigenous Peoples' food systems: the many dimension of culture, diversity and environment for nutrition and health, 2009, CINE, FAO.

In spite of a wide diversity of local foods (55 banana, 133 breadfruit and 171 yam cultivars; nearly 1,200 species of edible fish) the consumption of local traditional food by the population of Pohnpei has been steadily declining as their diet has shifted towards increased consumption of imported foods. An increasingly large percentage of the people in Pohnpei now show serious nutrition-related problems, notably vitamin A deficiency, obesity and diet-related non-communicable diseases.
Although more people on the island are becoming aware of the problem, few people in Pohnpei know that some of their older local banana cultivars, including Karat and utin iap, contain the highest level of beta-carotene in the world, making them veritable treasures of biodiversity. A programme aimed primarily at introducing green leafy vegetables into people's diets over a period of 15 years showed that little progress had been made, because these vegetables were neither indigenous nor well-liked. On the other hand, indigenous foods such as Karat and other local yellow-fleshed bananas, and yellow-fleshed giant swamp taro varieties, were not promoted because there were no compositional data available for them. Now that proper analysis of the composition of the Karat variety bananas has revealed their high pro-vitamin A carotenoid content, more efforts are under way to systematically promote consumption of this and other carotenoid-rich indigenous foods. This case study highlights the crucial importance for biodiversity-oriented programmes in seeking solutions based on nutrient-rich local foods and for collecting data that add to composition knowledge about foods in the local food system.



Traditional food systems of Indigenous Peoples for better nutrition

In recent years reduced access to land and natural resources, environmental degradation, climate change, globalization and the westernization of diet and lifestyle have dramatically affected the role traditional foods play in indigenous societies. Perceptions about traditional foods can also significantly affect the consumption behaviour of a community or individual. Indeed, various studies have indicated that in some communities and/or urban centres, traditional foods are perceived as "poor people's food", especially among younger generations. As a result, even when traditional foods are available in abundant supply, there may be resistance to their cultivation, harvesting and consumption.

Studies have linked these changes to a wide range of negative consequences, including: food insecurity, poor health, nutrition deficiencies, ecosystem deterioration and cultural erosion.

The consequences of such a shift in production and consumption patterns are significant. Foods consumed from non-native resources are generally processed, have higher concentrations of saturated fats, sugar and are lower in micronutrients. Their appeal comes from various factors: they often come ready to consume or are easier to prepare, and they are cheap to purchase, a fact which is of particular relevance since many indigenous peoples come from lower-income households. At the same time, however, this transition has caused a steady drop in health as processed food sources are generally inadequate in providing the necessary nutrient requirements. Indeed, many indigenous peoples today suffer from malnutrition and undernutrition, as well as diabetes, heart disease, decayed and missing teeth, and other illnesses. Understanding and maintaining the inextricable relationships between peoples and their cultures, biodiversity, traditional livelihood and knowledge systems are critical factors in ensuring the food and nutrition security of indigenous peoples. Although many traditional food practices have been lost, there is still scope to recover and strengthen local food systems so that indigenous peoples can continue to reap the benefits of their long-standing traditions. Finding solutions to these challenges is fundamental to the mandate of FAO whose stated aim is to "improve agricultural productivity, raise levels of nutrition, better the lives of rural populations, and contribute to the growth of the world economy".

Adapted from "Indigenous and Tribal Peoples: The importance of Traditional Foods for Nutrition and Health, December 2009, Draft, CINE, FAO".

NUTRITION INDICATORS FOR BIODIVERSITY

NUTRITION INDICATORS
FOR BIODIVERSITY

The development of indicators, tools and methodologies to measure and monitor biodiversity-related food composition and food consumption is critical in promoting sustainable diets.

The identification and monitoring of nutrition indicators for biodiversity is an international collaborative process, led by FAO together with Bioversity International and other partners. This initiative responds to an emerging global consensus that (1) the simplification of diets, the growing incidence of chronic diseases related to nutritionally-poor, energy-rich diets, and the neglect and decline in the use of locally available nutritionally-rich foods are linked, and that (2) biodiversity is the source of many foods and dietary components that can reverse this unhealthy trend. While food biodiversity is considered essential for food and nutrition security, and can contribute to the achievement of the Millennium Development Goals (MDGs) through improved dietary choices and positive health impacts, it is seldom included in nutrition programmes or interventions. This is largely because of insufficient data for foods counting for food biodiversity, such as, missing scientific identification, composition and methods for obtaining, analysing and using these data in food consumption studies and nutritional programmes.

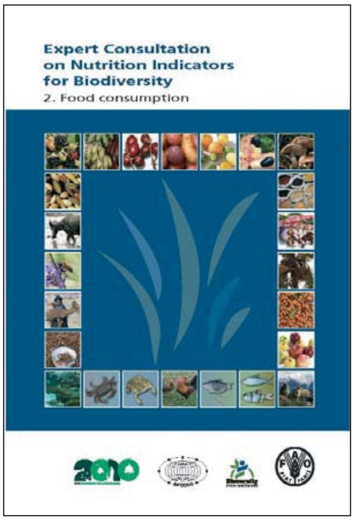
Food consumption data on wild, underutilized, indigenous and traditional plant and animal foods are limited and fragmented. Dietary surveys do not always collect intake information on species or varieties, partly because: (1) dietary assessment instruments have been developed to capture the usual or habitual intakes of foods as reported by subjects rather than detailed information on specific varieties of the foods consumed; (2) the corresponding compositional data are rarely available; and (3) it is widely believed that survey participants are not able to recognize foods at the taxonomic level below species. However, recent research suggests that this is not the case. A survey in Bangladesh has shown that more than 80 percent of households were able to identify rice by cultivar, and 38 different cultivars were named.

As the importance of food biodiversity becomes increasingly acknowledged, more research should be undertaken to study the consumption and composition of these foods. There are a limited number of studies linking

biodiversity, nutrition and health. It is therefore necessary to develop research projects to analyse the composition of wild, underutilized, indigenous and traditional foods, to compile these data into accessible databases and to collect more consumption data on food biodiversity. In order to monitor biodiversity and nutrition, two indicators were developed: one for food composition and another for food consumption.

Food composition indicator

The food composition indicator relates to nutrients and bioactive non-nutrients provided by biodiversity. It is a count of the number of foods with a sufficiently detailed description to identify genus, species, subspecies and variety/cultivar/breed, and with at least one value for a nutrient or other bioactive component. The indicator was elaborated through an Expert Consultation held in 2007. More than 10,000 foods have been counted for the indicator so far. Of these, the majority (89%) were described at the taxonomic level below species, while 11% were wild and underutilized foods identified by species or with local names. Yearly reporting is undertaken.



Food consumption indicator

The food consumption indicator relates to the dietary intakes of food biodiversity. It is a count of the number of foods enumerated in dietary surveys identified as wild or underutilized and/or described at the taxonomic level below species. This indicator was elaborated through an Expert Consultation in 2009, hence only baseline data have been collected. When different parts, shapes or stages of maturation of the same food are reported to be consumed, they should be counted separately; for example, the root and leaf, larva and adult animal, egg and bird, meat and milk, muscle meat and organ meat, ripe or unripe. No minimum amount or frequency of consumption is required.

Monitoring the indicators involves examining food composition databases and the scientific literature, and following the food consumption surveys conducted through national governments, UN agencies and NGOs. These data will be useful in demonstrating the importance of cultivar-specific composition data, their impact on nutrient intakes and the link between biodiversity, nutrition and food security. The indicator trends highlight the awareness level and the importance that is accorded to biodiversity for food composition and food consumption. Increases in the number of relevant foods reported by food composition databases and in food consumption surveys show that governments, farmers, the food industry and consumers are becoming more aware of the role of biodiversity for nutrition. This situation can be expected to lead to the conservation and sustainable use of biodiversity, improved food and nutrition security, and sustainable diets for individuals and populations.

BIODIVERSITY AND SUSTAINABLE DIETS

BIODIVERSITY AND SUSTAINABLE DIETS

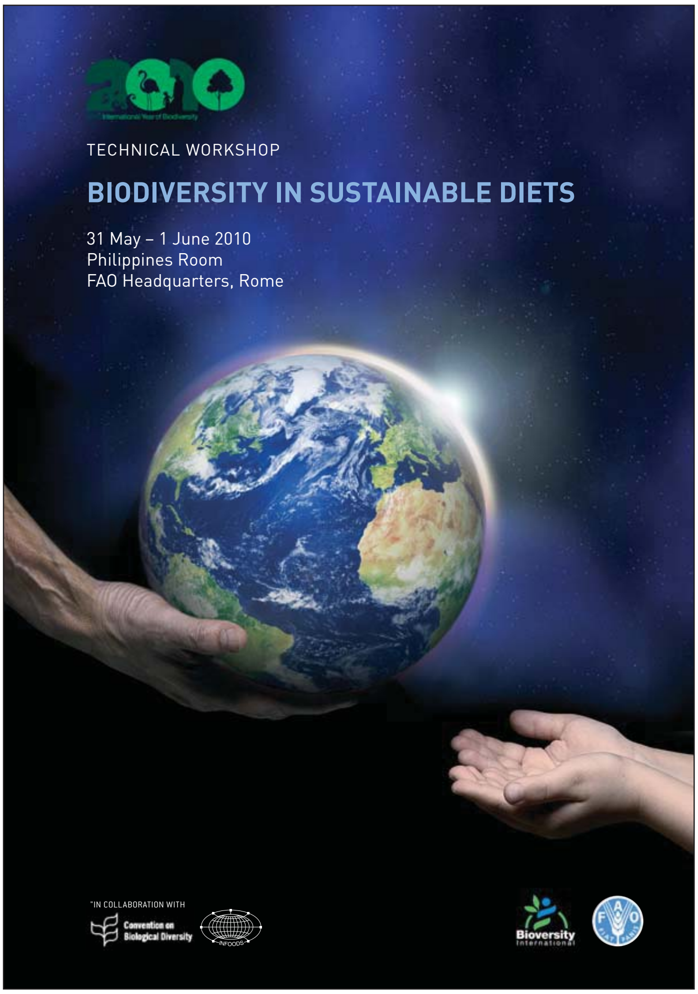
The alarming pace of food biodiversity loss and ecosystem degradation makes a compelling case for re-examining agricultural systems and diets. Sustainable diets take into account food for present and future generations, are culturally appropriate, nutritionally sound and protective of ecosystems. Sustainable diets make nutritious and healthy foods available and affordable to all, while protecting income of farmers and other workers, as well as cultures of consumers and communities. Sustainable diets position nutrition, food and biodiversity as central to sustainable development.

FAO activities in biodiversity and sustainable diets aim to highlight biodiversity, food production and food consumption as interconnected elements. The declaration of the 2009 World Summit on Food Security states that FAO "will actively encourage the consumption of foods, particularly those available locally, that contribute to diversified and balanced diets, as the best means of addressing micronutrient deficiencies and other forms of malnutrition, especially among vulnerable groups", and at the 21st Session of the FAO Committee on Agriculture it was recommended "to accelerate the transition toward sustainability". The planned FAO activities aim to provide more eco-friendly food recommendations to consumers and help clarify what is required for an environmentally-sustainable food chain. The purpose is to promote a broader assessment of the link between local food products, biodiversity, nutrition, food security and sustainability.

The promotion of the sustainable diets' concept will serve to raise awareness of consumers and governments of the role of food biodiversity in human nutrition and poverty alleviation. Sustainable diets from a biodiversity perspective will be further explored to show benefit to many sectors and institutions. Also, close involvement of civil society and the private sector will be fostered to directly engage stakeholders in the fields of environment, agriculture, nutrition, health, education, culture and trade in supporting the worldwide promotion and development of sustainable diets.

There is currently no internationally agreed definition of 'sustainable diet'. In the early 1980s, the notion of "sustainable diets" started to be explored to recommend diets which would be healthier for the environment as well as for consumers. With food globalization and the increased industrialization of agricultural systems, with no attention to the sustainability of agro-foods ecosystems, the sustainable diets' concept was neglected for many years. However, a definition, or set of guiding principles of sustainable diets, is urgently needed to address sustainability along the whole food chain, while acknowledging the interdependencies of food production, food requirements and nutrient recommendations. It will also allow the development of a series of new projects and case studies to demonstrate the synergies of biodiversity, nutrition and sustainability for the benefit of present and future generations, with particular focus on developing countries. There is growing academic recognition of the complexity of defining sustainability, as well as a growing body of evidence of the unsustainable nature of current diets.

While good nutrition should be a goal of agriculture, it is imperative that concerns of sustainability are not lost in the process. Many dietary patterns can be healthy but they can vary substantially in terms of their resource cost. The notion of sustainable diets, by stressing the concept of "getting biodiversity from the farm into the plate", should guide an innovative intersectoral effort to further promote the use of local biodiversity, including traditional foods of indigenous and local ecosystems with their many sources of nutritionally-rich species and varieties as readily-accessible, sustainable sources of quality nutrition.



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Further information - www.fao.org/infoods/biodiversity
Nutrition@fao.org