

Global Healthy Diet Approach to Nutrition

MICHAEL B
KRAWINKEL

ABSTRACT *The world faces a double challenge in human nutrition: meeting energy and nutrient requirements to overcome and prevent undernutrition, and achieving a diet that helps to prevent caloric overnutrition. These goals can be achieved using bioactive plant compounds from vegetables and fruits, which are usually available locally when food sovereignty is respected.*

KEYWORDS *nutrition transition; nutrient requirements; bioactive plant compounds; healthy diet; food sovereignty*

The world faces multiple challenges to nutrition, from hunger and undernutrition, nutrient deficiencies, and disease-related malnutrition on one end to caloric overnutrition leading to overweight and obesity on the other end (Keding *et al.*, 2013; Steyn and McHiza, 2014). In fact, these ends are not far from each other but rather two sides of the same coin and – perhaps unexpectedly – they occur in developing, ‘emerging’ and industrialized countries, at the national, regional, community and family level.

Before a healthy diet can be considered, nutrition security is a prerequisite. As illustrated in Figure 1, there are preconditions in the fields of agriculture and food systems, care and health. All of these together facilitate nutrition security and are the basis for a healthy diet. As many contributions to this issue of the journal illustrate, nutrition security demands primarily political and economic answers: poverty, land rights, gender equality, market access as well as other social and cultural issues. Still, a nutritional perspective keeping in mind human requirements can contribute to identifying appropriate solutions to nutrition challenges.

Diets, food, nutrients

Fundamental to a healthy diet is the safe provision of all nutrients, water and energy. This is usually addressed when food plants and animal-derived foods are considered as the basis for human diets. A somewhat misleading nutritional science has taken the attention away from diets and focused on macro- and micro-nutrients only. This has shifted policies and interventions more towards supplementation and fortification (or biofortification) of micronutrients and food energy and away from sustainable food systems (Müller and Krawinkel, 2005; Flynn *et al.*, 2009). In the field of development cooperation, diets based on the nutritional value of natural foods are often neglected,

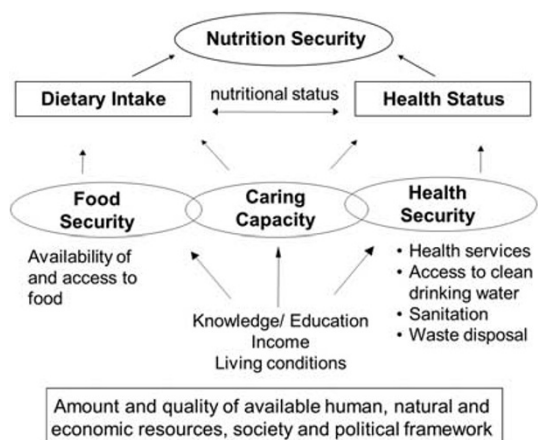


Figure 1: Conceptual model of nutrition security with immediate, underlying, and general preconditions (modification of the UNICEF-conceptual model of childhood malnutrition)

and the trend is towards promoting ‘cheap and easy’ alternatives, such as processed food, nutrient supplements and ‘fortificants’.

A ‘healthy diet’ approach is important for the prevention of malnutrition, as well as the prevention of nutrition-related diseases in a world population experiencing increasing longevity. At the same time, we are facing the challenge that more and more people do not know the dietary resources of their own environment: what can be found in the wild, what can be grown in home-, community-, and school gardens, or what can be bought locally (Okigbo, 1977).

Neglected and underutilized plants sometimes get attention only when it comes to patent rights and marketing prospects (Nelson, 2005). At the same time, income-poor populations do not have access to nutrient-rich food and sometimes become dependant recipients of aid based on special products (ready-to-use-food, RUF) instead of support to make optimal use of their own resources (Chaiken *et al.*, 2006; UNICEF, 2014).

There is plenty of research – sometimes funded by companies producing vitamins and minerals – showing a significant correlation between swallowing a nutrient supplement and a higher nutrient status in the individual during the study period and for some time after (Duque *et al.*, 2014).

However, providing nutrient supplements is expensive because the people most in need usually live in remote areas and the distribution costs are high. It is much less expensive, and more sustainable, to support local food production. Therefore, long-term solutions for nutrient deficiency problems are to be found in local food systems rather than in new food, plants and diets (Feenstra, 1997).

In general, research on complex nutrition interventions aimed at improved family diets is complex and – compared with laboratory settings – often compromised by, for example, unplanned events in the study regions. For this reason, as well as for the lack of an outcome in marketable products and services, these studies are rare and suffer from a systematic underfunding.

When nutrition policies aim at helping populations to consume diets based on the nutritional potential of their regions, communities and homes, they need to address the local resources and analyse their contribution to the composition of the diet throughout the year. Thereby, possible deficits can be specifically identified and sustainable strategies for overcoming them can be created. This approach drives our attention first to the local food resources, and only secondly to the nutrients (Neff *et al.*, 2009).

Still, the fundamental requirement for any diet is to provide sufficient energy and nutrients, as well as safe drinking water. The fact that this challenge is not met globally must be considered against the fact that the amount of food available on earth exceeds the global need (Conforti, 2011). Up to now, international agricultural research has mainly addressed the question how to maximize yields, calculated in tons and calories. The real challenge – that is increasing agricultural food production for low-income farmers and consumers in their local environment – requires a different approach: identifying traditional and indigenous knowledge, protecting agro-biodiversity, and developing strategies for increasing productivity locally (Kuhnlein and Receveur, 2007). An additional aspect is the reduction of postharvest losses in specific local conditions, as these losses significantly reduce the amount of available staples, fruits and vegetables (Oerke, 2006; Sharma and Singh, 2011).

Table 1. Food and bioactive plant compounds (adapted from Dapkevicius, 2002)

Fruits and vegetables

Apples	Quercetin, epicatechin, chlorogenic acid, <i>p</i> -coumaric acid, phloridzin
Citrus fruits	Naringenin, hesperetin, hesperidin, eriocitrin, naringin, meoeriocitrin, natrituin, <i>p</i> -coumaric acid, caffeic acid, ferulic acid
Grapes	Tannic acid, quercetin, procyanidines, other phenolics
Onion	Quercetin, myricetin
Carrots	Lignin, carotene
Tomato	Quercetin, lycopene, rutin, pruning
Garlic	<i>S</i> -Allylcysteine, S-allylmercaptocysteine
Horseradish	Sinigrin
Azuki beans	Procyanidin dimers

Oilseeds and oil crops

Cocoa	Catechin, epicatechin, chlorogenic acid
Soybean	Genistein, daidzein, glycitein, phenolic acids, tocopherols, amino acids, peptides
Peanuts	Taxifolin
Mustard seed	Sinigrin, phenolic acids, sinapic acid methyl ester

Cereal

Rice	Orizanol, isovitexin, cyanidine-3-O- β -D-glycopyranoside, pinoresinol, other phenolics
Wild rice	Phytic acid, luteolin glycoside, <i>p</i> -hydroxy acetophenone glycoside, 3,4,5-trimethoxycinnamin acid
Barley leaves	2'-O-glucosylisovitexin
Oat	Esters of caffeic and ferulic acids

Bioactive plant compounds

Next to hunger and undernutrition, caloric overconsumption has become a global challenge (Shelley, 2012). Billions of people are overweight due to higher intakes of fat and oils as well as sugar and high-calorie sweetened beverages (Zhai *et al.*, 2009). This development does not stop at the levels of overweight and obesity. It is associated with higher risks for diet-related chronic non-communicable diseases (NCD) (Siegel *et al.*, 2014). Owing to a lack of access to curative care, the morbidity and mortality risks associated with diabetes mellitus type II, stroke, and coronary heart disease are much higher in low-income countries compared with industrialized countries (Schmidt *et al.*, 2011; Mocumbi, 2013).

Dietary approaches are being developed to help in the prevention of chronic nutrition-related diseases (Boeing *et al.*, 2012). In some conditions, diet can even help in ameliorating the severity of the disease, for example the consumption of bitter melon in diabetes mellitus (Klomann *et al.*, 2010). What makes vegetables and fruits so important for the prevention of NCD is their content of bioactive compounds, in addition to fibre and nutrients. Table 1 provides a short list of some of these compounds in various fruits, oils, and cereals (Dapkevicius, 2002).

Considering the bioactive plant compounds leads to a broader view on food and diets than the one restricted to nutrients and energy: sources of bioactive plant compounds are mostly vegetables and fruits. As summarized in Table 2, many studies

Krawinkel: Global Healthy Diet Approach to Nutrition

Table 2. *Bioactive plant compounds and their effects (modified after United States Department of Agriculture)*¹

<i>Alkaloids</i>	... a wide variety of plants contains nitrogen-bearing molecules. Many of these plants have been used to create drugs for medicinal purposes. One example is vincristine, which was derived from the Madagascar periwinkle (<i>Catharanthus roseus</i>) and is used to treat some types of cancer. Another example is atropine found in deadly nightshade.
<i>Bitters</i>	... a variety of plants lumped together because of their very bitter taste. This bitterness causes stimulation of the salivary glands and digestive organs. As such, bitters can be used to improve appetite and strengthen the digestive system. Examples of bitters include wormwood and hops.
<i>Cardiac Glycosides</i>	... found in various medicinal plants (Foxglove, Lily of the Valley) and have strong direct action on the heart. Cardiac glycosides such as digitoxin, digoxin, and convallotoxin support strength and rates of contraction in heart failure. These compounds also have a diuretic effect stimulating urine production.
<i>Cyanogenic Glycosides</i>	These are based upon cyanide, a very deadly poison, but in small doses, they can serve as a muscle relaxant. The bark of wild cherry and the leaves of elderberry (<i>Sambucus racemosa</i>) contain cyanogenic glycosides used to suppress and soothe dry coughs.
<i>Flavonoids</i>	Some have anti-viral and anti-inflammatory properties. Flavonoids found in many plants like lemon and buckwheat are known to strengthen capillaries and prevent leakage into tissues.
<i>Minerals</i>	... One example of a plant high in minerals is horsetail. The high silica content in horsetail plants is used for arthritis because it supports the repair of connective tissue.
<i>Phenols</i>	Phenols are plant compounds produced to protect against infection and herbivory by insects. They are often anti-inflammatory and antiseptic and can have anti-viral properties. Wintergreen and willow contain salicylates. Members of the mint family often contain phenols.
<i>Proanthocyanins</i>	... have been documented to be valuable in protection of circulation specifically in the heart, eyes, and feet. Red grapes, blackberries, and hawthorn berries all have high levels of proanthocyanins.
<i>Saponins</i>	... in two main forms of saponins, steroidal and triterpenoid. Steroidal saponins are very similar to the chemical structures of many of the human body's hormones including estrogen and cortisol. Examples plants containing saponins include agave, wild yam, and several members of the lily family. Several native plants are used in a process to produce synthetic hormones for humans.
<i>Tannins</i>	Tannins serve as a deterrent to herbivory by insects and grazing animals given that that they provide a harsh unpalatable flavour. Examples of plants high in tannins include oak bark and black catechu.

have shown the beneficial health effects of the consumption of these food groups for dietary prevention of chronic NCD. This prevention is the only option for low-income populations who will not be able to afford the additional costs of treatment for cardiovascular diseases, stroke, cancers, and metabolic diseases (Johansson *et al.*, 2014).

Some vegetables do even exert curative effects, such as lowering blood sugar and serum cholesterol levels, influencing the development of malignant tumours (cancerogenesis), and other disease-related conditions. Regarding the exact mechanisms, some aspects are rather simple, for example inducing satiety (i.e., the feeling of being full) while others are quite complex. Sophisticated analytical methods are applied to the study of plant extracts, though often it is not just one compound but rather the whole composition exerting the specific effect of the vegetable (Habicht *et al.*, 2011). Therefore, Table 2 is to be read as an illustration of the diversity of compounds rather than a list of specific effects caused by the specific substance or group of compounds.

In conclusion, for overcoming all forms of undernutrition and nutrient deficiencies as well as the prevention of non-communicable chronic diseases, a healthy diet is required. This diet provides all nutrients and sufficient energy. In addition, it is rich in bioactive plant compounds. The healthy

diet must not be expensive but can, in most circumstances, be achieved by making use of local agro-biodiversity.

While the world is still concentrating on the challenge of fighting hunger and undernutrition, the new challenge of preventing overweight and obesity demands our attention too. For both fields nutrition can contribute a lot when the great diversity of natural resources and the various properties of food plants are considered. Human nutrition is much more than meeting dietary requirements of nutrients and energy: it can help an ageing global population to stay healthy. Longevity is great only when it can be appreciated in good health.

This 'making use of local agro-biodiversity' is supported best by food sovereignty, which aims at self-reliance and local-control as one goal of socioeconomic and cultural development. This approach carries nutrition policies beyond the scope of nutrient-focused activities as it is not just based on physiological requirements but on knowledge and skills (Penny *et al.*, 2005) as well as rights (Patel, 2012). It is to be built on indigenous knowledge and can be strengthened by supportive information from modern technologies. A healthy diet is a nutritional concept covering both aspects: requirements of the body and dignity in eating.

Note

1 United States Department of Agriculture/Forest Service. Active Plant Ingredients Used for Medicinal Purposes. <http://www.fs.fed.us/wildflowers/ethnobotany/medicinal/ingredients.shtml>

References

- Boeing, Heiner, Angela Bechthold, Achim Bub, Sabine Ellinger, Dirk Haller, Anja Kroke, Eva Leschik-Bonnet, Manfred J. Müller, Helmut Oberritter, Matthias Schulze, Peter Stehle and Bernhard Watzl (2012) 'Critical Review: Vegetables and fruit in the prevention of chronic diseases', *European Journal of Nutrition* 51(6): 637–663.
- Chaiken, Miriam S., Hedwig Deconinck and Tedbabe Degefe (2006) 'The Promise of a Community-Based Approach to Managing Severe Malnutrition: A case study from Ethiopia', *Food and Nutrition Bulletin* 27(2): 95–104.
- Conforti, Piero (ed.) (2011) 'Looking ahead in world food and agriculture: Perspectives to 2050', Rome: Food and Agriculture Organization of the United Nations, <http://www.fao.org/docrep/014/i2280e/i2280e.pdf>, accessed 28 October 2014.
- Dapkevicius, Airidas (2002) 'Isolation, Identification and Evaluation of Natural Antioxidants from Aromatic Herbs Cultivated in Lithuania', PhD Thesis, Wageningen, Netherlands: Wageningen University, cited from P.M. Kris-Etherton, Hecker, K.D., Bonanome, A. *et al.* (2002) 'Bioactive compounds in foods: Their role in the prevention of cardiovascular disease and cancer', *The American Journal of Medicine* 113(9): S2:71-88.

- Duque, Ximena, Homero Martinez, Jenny Vilchis-Gil, Eugenia Mendoza, Sergio Flores-Hernández, Segundo Morán, Fabiola Navarro, Victoria Roque-Evangelista, Anayeli Serrano and Robertino M. Mera (2014) 'Effect of Supplementation with Ferrous Sulfate or Iron Bis-Glycinate Chelate on Ferritin Concentration in Mexican Schoolchildren: A randomized controlled trial', *Nutrition Journal* 13(71): 1–10.
- Feenstra, Gail W. (1997) 'Local Food Systems and Sustainable Communities', *American Journal of Alternative Agriculture* 12(1): 28–36.
- Flynn, Albert, Tero Hirvonen, Gert B.M. Mensink, Marga C. Ocké, Lluís Serra-Majem, Katarzyna Stos, Lucjan Szponar, Inge Tetens, Aida Turrini, Reg Fletcher and Tanja Wildemann (2009) 'Intake of selected nutrients from foods, from fortification and from supplements in various European countries', *Food & Nutrition Research Supplement* 1, 53: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2791664/pdf/FNR-53-2038.pdf>.
- Habicht, Sandra D., Veronika Kind, Silvia Rudloff, Christian Borsch, Andreas S. Mueller, Josef Pallauf, Ray-yu Yang and Michael B. Krawinkel (2011) 'Quantification of Antidiabetic Extracts and Compounds in Bitter Gourd Varieties', *Food Chemistry* 126(1): 172–176.
- Johansson, Eva, Abrar Hussain, Ramune Kuktaite, Staffan C. Andersson and Marie E. Olsson (2014) 'Contribution of Organically Grown Crops to Human Health', *International Journal of Environmental Research and Public Health* 8;11(4): 3870–3893.
- Keding, Gudrun B., John M. Msuya, Brigitte L. Maass and Michael B. Krawinkel (2013) 'Obesity as a Public Health Problem Among Adult Women in Rural Tanzania Global Health', *Science and Practice* 1(3): 359–371.
- Klomann, Sandra D., Andreas S. Mueller, Josef Pallauf and Michael B. Krawinkel (2010) 'Antidiabetic Effects of Bitter Gourd Extracts in Insulin-Resistant db/db Mice', *British Journal of Nutrition* 104(11): 1613–1620.
- Kuhnlein, Harriet V. and Olivier Receveur (2007) 'Local Cultural Animal Food Contributes High Levels of Nutrients for Arctic Canadian Indigenous Adults and Children', *Journal of Nutrition*, April 137(4): 1110–1114.
- Mocumbi, Ana Olga (2013) 'Focus on Non-Communicable Diseases: An important agenda for the African continent', *Cardiovascular Diagnosis and Therapy* 3(4): 193–195.
- Müller, Olaf and Michael Krawinkel (2005) 'Malnutrition and Health in Developing Countries', *Canadian Medical Association Journal* 173(3): 279–286.
- Neff, Roni, Anne Palmer, Shawn Mckenzie and Robert Lawrence (2009) 'Food Systems and Public Health Disparities', *Journal of Hunger and Environmental Nutrition* 4(3–4): 282–314.
- Nelson, Amy (2005) 'Is There an International Solution to Intellectual Property Protection for Plants? *George Washington International Law Review* 37, Jg., S. 997.
- Oerke, Erich-Christian (2006) 'Crop Losses to Pests', *Journal of Agricultural Science* 144(1): 31–43.
- Ogigbo, B.N. (1977) 'Neglected plants of horticultural and nutritional importance in traditional farming systems of tropical Africa', *Acta Horticulturae* (ISHS) 53: 131–150, IV Africa Symposium on Horticultural Crops.
- Patel, Rajeev C. (2012) 'Food Sovereignty: Power, gender, and the right to food', *PLoS Med* 9(6): e1001223.
- Penny, Mary E., Hilary M. Creed-Kanashiro, Rebecca C. Robert, M. Rocio Narro, Laura E. Caulfield and Robert E. Black (2005) 'Effectiveness of an Educational Intervention Delivered through the Health Services to Improve Nutrition in Young Children: A cluster-randomised controlled trial', *Lancet* 365(9474): 1863–1872.
- Schmidt, Maria Inês, Bruce Bartholow Duncan, Gulnar Azevedo e Silva, Ana Maria Menezes, Carlos Augusto Monteiro, Sandhi Maria Barreto, Dora Chor and Paulo Rossi Menezes (2011) 'Chronic non-Communicable Diseases in Brazil: Burden and current challenges', *Lancet* 377(9781): 1949–1961.
- Sharma, Gaurav and S.P. Singh (2011) 'Economic Analysis of Post-Harvest Losses in Marketing of Vegetables in Uttarakhand', *Agricultural Economics Research Review* 24(2): 309–315.
- Shelley, Jacob J. (2012) 'Addressing the Policy Cacophony Does not Require More Evidence: An argument for reframing obesity as caloric overconsumption', *BMC Public Health* 12(1042): 1–8.
- Siegel, Karen R., Shivani A. Patel and Mohammed K. Ali (2014) 'Non-Communicable Diseases in South Asia: Contemporary perspectives', *British Medical Bulletin* 111(1): 31–44.
- Steyn, Nelia P. and Zandile J. McHiza (2014) 'Obesity and the Nutrition Transition in Sub-Saharan Africa', *Ann, New York Academy of Sciences* 1311(1): 88–101.
- UNICEF (2014) 'Procurement of food aid products', https://supply.unicef.org/unicef_b2c/app/displayApp/%28cpsize=25&layout=7.0-12_1_66_68_115_2&uiarea=2&care=50D129DA6B9F08F2E1000009E710FC1&cpnum=1%29/.do?rf=y.
- Zhai, Fengying, Huijun Wang, Shufa Du, Yuna He, Zhihong Wang, Keyou Ge and Barry M. Popkin (2009) 'Prospective Study on Nutrition Transition in China', *Nutrition Reviews* 67(Suppl. 1): 56–61.