GREENPEACE

Vitamin A deficiency: diverse causes, diverse solutions

Summary

Vitamin A deficiency (VAD) affects about 40% of the world population. Many of those affected from vitamin and mineral deficiencies (VMD) appear to have enough to eat but still regularly miss vitamins and micronutrients such as iron, iodine or calcium in their diet. VAD especially affects small children and pregnant or breastfeeding mothers, resulting in higher susceptibility to other diseases and irreversible blindness. VAD can be combated with a variety of food and medicine-based approaches, including house gardens, increased food diversity, food fortification and medical vitamin A supplementation. Promising results come from countries such as Bangladesh, Indonesia, Vietnam, Nepal and the Philippines, where the irreversible blindness of children could be eliminated.

Nationwide supplementation programmes combined to supplement children once or twice a year with high-doses of Vitamin A are combined in at least 43 countries with National Immunisation Days. They are a key factor in reducing VAD on an acute basis, but on the long term, well-designed home garden programmes, including education for a more diverse diet, are the most sustainable way to reduce VAD and other VMDs on the household level. Once the home gardens are established, they provide sustainable, all-year-round availability of diverse food. Home gardens and small-scale animal production have proven to improve the vitamin A status of mothers and children, even on very small pieces or in landless households.

The goal of combating VAD is not to provide medical treatment, it is to avoid VAD and another VMDs. By combating VAD with home gardens, sustainable systems are created that provide food security and diversity from the grassroots level, in a way that is empowering women and protects agro-biodiversity.

Contents

Introduction

Worldwide, about 852 million people are classified as undernourished by the Food and Agricultural Organization (FAO 2004) in 2000-2002. However, another 2.5 times as many people suffer from "hidden hunger". People suffering from hidden hunger appear to get enough to eat - at least in terms of calories - but are lacking in micro-nutrients such as vitamins and minerals such as iron or iodine. These micronutrients are essential for human health, and their lack can lead to lifelong physical and cognitive disabilities (FAO 2004).

The effects and symptoms of *Vitamin and Mineral Deficiencies* (VMDs) are often general and vague. They include listlessness, increased severity or frequency of illnesses, poor eyesight and/or impaired cognitive development and physical growth. Thus, these symptoms can often go unrecognised, especially for children already living in poor conditions. Hidden hunger has been present throughout history, although is now largely overcome in the industrialized countries (UNICEF et al. 2004). This is mainly due to a relatively high level of food security, (preventive) healthcare focussing on risk groups such as infants or pregnant women, and food fortification and supplementation. In many developing countries, however, hidden hunger still remains a major source of public health problems. VMDs are thought to affect some 40% of the world population (MI & UNICEF 2004). Micronutrient deficiencies are most prevalent where there is poverty, environmental deprivation and social disparity.

Micro-nutrient deficiencies, the hidden hunger, are widespread. This briefing examines one such micro-nutrient, vitamin A, and details the steps that have been taken to combat this deficiency in a sustainable way.

Vitamin A Deficiency (VAD)

Vitamin A deficiency (VAD) occurs when too little vitamin A is present in the food over a long period. Vitamin A is fat soluble and excessive vitamin A can be stored in the liver, so VAD does not occur immediately when there is no vitamin A in the food, but when the storage in the body has been exhausted (FAO/WHO 2002). Vitamin A plays several crucial roles in the human body. In the retina of the eyes, it is needed for the adaptation to darkness, so VAD leads to night blindness. Besides that, vitamin A is important in all body tissues to maintain growth and health of cells. In particular, epithel cells are affected by lack of vitamin A, leading to a weakening of the immune system and to irreversible blindness due to eye lesions (xerophthalmia; FAO 1997, FAO/WHO 2002).

VAD can occur to individuals of all age. However, it is particularly relevant to children under 6 years of age. VAD-related blindness is most prevalent in children under the age of 3, because this period is characterised by high requirements of vitamin A to support growth, the transition from breastfeeding to other food, and increased numbers of infections (FAO/WHO 2002). An estimated 250,000 to 500,000 children worldwide become partially or totally blind each year due to VAD, and about half of them die within a year of losing their sight (WHO 2003). Most of the 100 to 140 million children affected by VAD worldwide have sub-clinical manifestations (WHO 2003). That is, they are vitamin A deficient, but they don't (yet) have the classical symptoms such as night blindness. They are more likely to be more severely affected by measles, tuberculosis, diarrhoea and other illnesses and thus have a higher mortality risk. WHO (2003) estimates that the elimination of VAD could reduce childhood mortality by 25% and the mortality through measles by 50%.

VAD is also common in pregnant women in the Global South, because pregnant and breast-feeding women have higher demands of vitamin A. It exposes them to a higher risk of death during or shortly after giving birth. Nearly 600,000 women die from childbirth-related causes every year, the vast majority of them from complications that could be reduced through better nutrition including provision of vitamin A (WHO 2003). In addition, children born by mothers with VAD start their life with precious little vitamin A stored in their bodies.

VAD affects about 40% of the global population. Mainly children and pregnant and breastfeeding women, because their demand of VAD is higher. VAD increases the susceptibility towards other diseases and can cause irreversible blindness.

Natural vitamin A sources

Vitamin A (retinol) is present in animal products such as milk, eggs, meat and especially in liver. The body can also form vitamin A from pro-vitamin A (beta-carotene and certain other carotenoids) which are present in a wide variety of orange-coloured fruits and vegetables, such as carrots, sweet potato, cassava, and mango, and in green leafy vegetables such as spinach, radish and pumpkin leaves.

Whether a person gets sufficient vitamin A from their food depends on various factors: the total food intake, general health, the vitamin A demand of the body, how much of the (pro)vitamin A is absorbed by the body and the efficiency of conversion of pro-vitamin A to vitamin A (the bio-availability). (Pro)vitamin A is fat-soluble, so without fat or oil in the food it cannot be absorbed in the gut. The bio-availability of pro-vitamin A compounds also depends on food matrix (Table 1) and the how food is prepared. For example, more pro-vitamin A is taken up from cooked and mashed vegetables than from raw products. Dietary deficiencies in other nutrients such as zinc and fat/oil can limit the rate of conversion, while a lack of vitamin A can, in turn, decreases iron metabolism (FAO/WHO 2002). Hence, a balanced and diverse diet is of importance in maintaining the body's capacity to absorb pro-vitamin A and convert it to vitamin A (Brown et al. 2004, Dijkhuizen et al. 2004, Rahman et al. 2002, Kuhnlein & Pleto 1997).

Food composition tables are often used to estimate specific nutrient intakes as well as the adequacy of diets for population groups (Hels et al. 2004). However, whilst these tables can be standardized, the actual food eaten is not standardized. Pro-vitamin A content may be influenced by factors such as seasons and growing conditions, stage of maturity, picking-to-market conditions, plant variety, and variations in the cleaning and in the cooking conditions (Hels et al. 2004). For example, the bio-availability of pro-vitamin A in raw spinach leaves is much lower then that of steamed and pureed spinach with a bit of oil (Haskell et al. 2004). Similarly pro-vitamin uptake is lower from salads with no- or low fat salad sauces then from salad sauces with oil (Brown et al. 2004).

According to the FAO/WHO (2002), available food composition data for most food currently consumed in the world are incomplete, outdated, or insufficient for evaluating true bio-availability. This is even more true for dietary changes for those who move to urban centres where most food is obtained from supermarkets where traditional products might not be sold (Graebner et al. 2004), and where green vegetables high in beta-carotene, such as mustard and radish leaves (Hels et al. 2004) disappear from the diet (FAO 2004).

Table 1: Retinol Activity Equivalent. (IOM 2002, IVACG 2004)

Retinol Activity Equivalent (RAE)	Commonly Used Units
1 µg RAE =	1 RE of retinol (vitamin A)
	1 µg retinol (vitamin A)
	2 µg beta-carotene in oil
	12 µg beta-carotene in mixed foods
	24 µg other provitamin A carotenoids in mixed foods

Combating VAD

In 1990, the elimination of VAD by 2001 was adopted as a goal by the United Nations Children's Fund (UNICEF, 1990) and reiterated by FAO/WHO in 1992 (FAO/WHO, 1992). Substantial progress has been made since then but VAD (or VMD in general) is still prevalent, even though "*very significant progress has been made over the last 15 years"* (MI & UNICEF 2004). In May 2002, the United Nations (UN) again called for the elimination of VAD, this time by 2010 (UNICEF et al. 2004). Global statistics are available up to 2000 but there is less information available concerning recent developments and supplementation trends (MI & UNICEF 2004).

VAD is a public health problem in about 100 countries, but the number of people affected by VAD has been decreasing in the last 20 years (WHO 2003, FAO/WHO 2002, SCN 1998). Especially the level of clinical VAD is falling (MI et al. 1998). In some countries, e.g. Bangladesh, VAD related blindness was eliminated several years ago (SCN 1998). This is largely due to international and national efforts to combat VAD.

43 countries now have formal supplementation programmes (see "Supplementation" below) reaching at least two-thirds of all young children, and 10 countries have virtually eliminated VAD since VAD was identified as a public health problem (MI & UNICEF 2004). In Indonesia, Vietnam, Bangladesh, Nepal and the Philippines, VAD-induced blindness has been eliminated (SCN 1998, 2002, HKI 2003b, Nepalese Ministry of Health et al. 1998). For many countries, reductions in VAD can only be estimated by indirect indicators. It is estimated that VAD is still a public health problem today in about 96 to 118 countries, mainly in Africa and South-East Asia (WHO 2003, FAO/WHO 2002).

In general, it is acknowledged that VAD is not so much a problem lacking in solutions, but the problem is whether VAD is given enough priority by international, regional and national politicians and policy makers.

"Although elimination of VAD is only one of the [World Health Assembly] and World Summit for Children nutrition-related goals, it has unique features: For example, as compared with the challenge of controlling protein-energy malnutrition, elimination of VAD achieved rapidly. The cost-effectiveness ratio is also highly favourable. It is therefore a test case of political will, and managerial capacity to implement known technologies and known solutions" WHO (2000).

Combating VAD requires action at several different levels: on individual/household and on population level; on daily and on long-term basis; with preventative and with remedial treatment. The factors that contribute to VAD are as diverse as the solutions.

There are two basic strategies to reduce VAD, which are described below in detail:

1) **Food-based strategies**
2) **Medicine-based strategies.**

1) Food-based strategies

Diversification and home gardens

The most promising long-term approach to VAD is the (re)introduction of home gardens. With home gardens, the aim is not to cure VAD specifically, but to provide food on a daily basis to avoid the occurrence of VAD and of VMDs in general. VAD is one of the most visible vitamin and nutrient deficiencies so is usually indicative of additional forms of VMD. One of the advantages of food-based approaches is that their focus is on food groups and not single nutrients, leading to covering all or most micronutrient requirements, with no high doses or adverse effects. (SCN 2002).

A study in Bangladesh showed that home gardens or homesteads can be quite small in size and still be effective. In the study, most gardens were about 40 m^2 and produced four different vegetables throughout the year. Mothers and children ate vegetables more than three times a week, mostly from their own gardens and production could be increase further through improved garden techniques (HKI 2003c).

> **"*Food-based strategies are often described as a sustainable approach because the process empowers individuals and households to take ultimate responsibility for the quality of their diet by growing their own nutrient-rich foods and making informed consumption choices. These strategies are said to be the ideal long-term goal toward which society strives – food availability, wise consumer selection, proper preparation, and adequate feeding [...]. Food-based strategies are also appealing because they can address multiple nutrients simultaneously, including energy, proteins, and various micro-nutrients, without the risk of antagonistic nutrient interactions or overload.*"** (Ruel 2001)

Successful programmes, especially from Asian and African countries, show a combination of nutrition education; training in food processing and gardening techniques; the (re)introduction of local plants or varieties and animals, and the creation of garden nurseries. An example is the *Bangladesh Homestead Gardening Programme*, a nation-wide initiative now covering more then 180 sub-districts and reaching more

then 700,000 households. Launched by the non-governmental organisation (NGO), *Helen Keller International* (HKI) in 1993, the programme works with more then 40 local NGOs in Bangladesh to improve and diversify diets through year-round production of fruit and vegetables. Village nurseries serve as hub of the project to introduce new agricultural techniques and plant varieties; to supply high quality seeds, to access to micro-credit and to offer technical assistance on issues as soil fertility, fencing, irrigation, tools and pest control. The FAO is providing extensive training material for preparing field workers in South East Asia or Africa (for example FAO 1995).

Through interaction with the overwhelming female clientele, the programmes also serve as a means of introducing up-to-date nutritional knowledge (MI & UNICEF 2004). Riding on the success of the Bangladesh project, similar models are now used in Cambodia and Nepal (HKI 2003a). Reports from South Africa show similar positive effects (Faber et al. 2002).

In poor households, the overwhelming part of the diet might consist of staple grains and vegetables. However, even relatively small amounts of plant products can provide sufficient RDA of pro-vitamin A. A study in Brazil showed that vegetables such as slender amaranth (*Amaranthus viridis*), smooth sow-thistle (*Sonchus oleraceus*) and malanga (*Xanthosoma sagittifolium*) can provide considerable amounts of beta-carotene (pro-vitamin A) (Graebner et al. 2004). Similarly, a study in Bangladesh showed that the daily consumption of cooked green leafy vegetables or sweet potatoes has a positive effect on vitamin A status in the human populations at risk of VAD. 75g of Indian Spinach, a low-cost green leafy vegetable available all year round in Bangladesh, proved to provide enough pro-vitamin A on a daily basis (Haskell et al. 2004).

Home gardens can bring back local food variety, plant varieties and local sources of vitamin rich products back into the daily diet. As Graebner et al. (2004) describe: "*Decades ago, these vegetables [amaranth, sow-thistle, malanga] were widely cultivated and used by Brazil's large rural population. However, nowadays, the majority of the Brazilian population is concentrated in urban areas, where these vegetables are not usually cultivated, and nor are they found in supermarkets. Therefore these plants are considered non-conventional vegetables, and are sometimes confused with harmful weeds in vegetable gardens."*

Research and breeding programmes can help by promoting conventionally-bred varieties with high pro-vitamin A concentrations. For example, an estimated 10 million children at risk from VAD in Africa could meet their *recommended dietary allowance* (RDA) if they would eat orange sweet potatoes instead of white ones. Changing the sweet potato variety, without even changing the amount eaten, could contribute about 40 % of their RDA (IVACG 2003).

The introduction of new plants of high nutritional value can also be promoted in home gardening projects. For example, fruits, leaves and other parts of the Moringa tree (drumstick, *Moringa oleifera*) have high concentrations of vitamins and minerals. The Moringa tree is a fast-growing, drought-resistant tree native to sub-Himalayan India and is now been grown throughout the tropics and subtropics. The Church World Service promotes this plant in their West African projects as a nutritional supplement for children and mothers as well as for numerous other purposes such as animal feed and building material (CWS 2000).

In the current situation, many more households rural areas are malnourished, especially smallholder farmers, then urban households (FAO 2004, see Table 2). 50% of undernourished are small-scale farmers, only 20% are urban poor (FAO 2004). Although no accurate data exists for the distribution of VAD among these groups, one can expect that it follows similar lines. While it is tragic that those households that actually produce agricultural products go hungry, it is also a chance to introduce sustainable home gardens.

Table 2: Distribution of undernourished people globally by location/occupation. (Hunger Task Force, quoted in FAO 2004)

Location/occupation	% of total undernourished people
Smallholder farmers	50
Rural landless	20
Urban poor	20
Pastoralists, fisher peoples, forest-dependent	10

Even small home gardens provide households with a variety of fruits and vegetables throughout the year. They improve the vitamin A status of household members as well as the levels of other vitamins and minerals. New and existing home gardens can be improved with better agricultural practices, access to appropriate seeds and plant varieties and training. Programmes that include demonstration gardens and village nurseries might take longer to implement but, once established, they are a sustainable source vitamins and minerals on household level (FAO/WHO 2002).

Animal products

Animal husbandry, even on a small scale such as keeping chickens, can improve the vitamin status by egg consumption, as HKI projects in Bangladesh, Cambodia and Nepal showed (HKI 2003a). This can be a useful strategy in countries or regions where vitamin A-rich animal products or oils are affordable and accessible to families likely to be affected by vitamin A deficiency (Vitamin A Global Initiative 1998). Other home garden projects in Asia promote poultry, dairy cows and/or fish (IVACG 2003). Raising animals can be an option even for landless household in rural areas, if animals can range freely and feed, for example, on roadsides.

Projects promote keeping dairy animals, fish or poultry. In a pilot project in Bangladesh (HKI 2004), the egg production in households could be increased in 3 months from 21 to 200 eggs. The egg consumption of mothers and children doubled from 1 to 2 eggs per week, thus making a significant contribution to the RDA of vitamin A.

Rice paddies offer the opportunity to grow fish and other edible animals (such as frogs and snails) in non-vegetarian households. In fact, these animals are often part of the traditional rice production systems. In many case it was reported that they disappeared due to the introduction of agrochemicals in the Green Revolution, and when higher rice yields were gained on the cost of a the diverse, overall food production. Efforts to (re)introduce fish into rice paddies therefore also take rice production practices as such into account (Hickey & Mittai 2003).

Small-scale animal husbandry, such as keeping chickens, guinea pigs or fish, even with a only few animals, can contribute significantly to the VAD status. Even bigger animals such as cows or goats can often be kept by the rural poor and landless. In rice production areas, fish from rice paddies are part of the traditional diet, but their (re)introduction might require changes away from agrochemical based practices.

Generating income

Home gardens or *Homestead food production* (HFP) can reduce extreme poverty, because it can be implemented by households of lower socio-economic status, and on very small plots of lands, even on roofs. Besides producing food, home gardens can also provide income directly and indirectly by replacing some of the foods otherwise bought (Faber et al. 2002). "*Such programmes empower women and contribute to achieving gender equality, as it is mainly a woman's activity that includes deciding on the use of the resources generated. It is also usually implemented in an environmentally friendly way. The important steps for a successful HFP program are to first make sure that food availability is the main constraint for increasing production. Then, build on existing practices for food production (generally not introducing new foods), and use locally available organizational infrastructure, techniques and resources.*" (SNC 2002).

HKI (2003a,b) found for home gardens in Bangladesh, that by making vegetable and fruit available throughout the year, they provide households with direct access to important nutrients which otherwise might not be available or not within their economic reach. In addition, the increased production of the home gardens enabled households to sell surplus. Additional income was used for other important household needs such as other food, clothing and education, but also for seeds, tools and fencing, whereby the home garden production becomes more sustainable. According to HKI, this indicates that homestead food production is not only important for food security but also for poor households to meet other basic needs, thus contributing to poverty alleviation.

Reducing post-harvest losses and food preparation

The importance of combining agricultural practices with educational programmes is well illustrated by a project in Kenya. Conventional sweet potato varieties, naturally rich in beta-carotene, were crossbred to develop new varieties and introduced to women's groups. One group participated in on-farm trials and received minimal agricultural support for the production of the new varieties, whereas the second group also

received nutritional education, lessons on food processing and technical assistance. The group that received the education showed a significant increase in the frequency of consumption foods rich in pro-vitamin A (Ruel 2001).

Fruits and vegetables lose vitamins after they are harvested. Improvement of storage and food-preservation facilities significantly reduces post-harvest losses. At the household level, the promotion of effective cooking methods and practical ways of preserving foods such as solar drying of seasonal, micronutrient rich foods such as papaya, mangos, tomatoes or leafy green vegetables may significantly increase the access to vitamin-rich food in other seasons (FAO/WHO 2002).

The use of such solar drying was promoted to preserve fruit and vegetables for future seasons with less availability of fresh food in Tanzania. The vitamin A status of the local population increased but a closer look revealed that the vitamin A came from an increase in consumption of animal products. While the aim was to introduce a new practice, the side effect of raising awareness about VAD was even more successful, highlighting again the need to combine different approaches to improve vitamin A levels (Ruel 2001).

Often, appropriate methods of storing and processing plant products, of cooking in order to retain vitamins and of extending the availability of fruits and vegetables over the year are part of community tradition but may be unrecognised. For example, traditions such as keeping oil in dark bottles to keep the vitamins in unrefined oil can improve their nutritional value. Other important knowledge can be part of traditional food preparation such as imifino, a collection of various dark green leaves eaten as a vegetable in South Africa with leaves grown wild or from vegetables such as pumpkin and beetroot (Faber et al. 2002).

As Ruel (2001) states, *"In fact most of these strategies are well documented and even part of the cultural background of many populations, but large-scale community trials documenting their effectiveness are surprisingly few.*" The danger is that such knowledge might escape (Northern) scientists setting up VAD programmes, especially when they are unfamiliar with local vegetables. In addition, such traditional knowledge is becoming increasingly lost with the introduction of globalised, standardized food products. Home gardens and educational programmes by local NGOs can help to preserve such plants and the knowledge about them.

Availability to (pro)vitamin A rich foods can be increased significantly through appropriate storage and food processing. Education about traditional and new practices can increase the bio-availability of (pro)vitamin A from the available food, and it can also make individuals more aware of the need for diverse and healthy food. On the other hand, actual food preparation and dietary practices must be considered to achieve adequate (pro)vitamin A in food-based approaches (FAO/WHO 2002).

Nutrition education

Home garden projects are most effective when combined with promotional and educational programmes (Faber et al. 2002).

In Indonesia, health education adverts on the radio were used to promote the consumption of vitamin A-rich food (such as dark green leafy vegetables). This social marketing caused a change of attitude and of the food given to their children among mothers (Ruel 2001). An education and behaviour change project was set up to increase the quality of the meals offered in community kitchens (comedores populares) of Lima, Peru. As a result, the intake of foods rich vitamin A, iron and vitamin C increased significantly among women using the community (Ruel 2001).

In India, a nutrition education and home gardening project increased knowledge of the signs of vitamin A deficiency, such as eye symptoms, as well as awareness of the importance of dark green, leafy vegetables for weaning children. Household intakes of dark green, leafy vegetables more than doubled among participants following the intervention (Ruel 2001). Other programmes promote food-to-food fortification, for example mixing a tablespoon of carrot puree into a baby's rice porridge (Lorch 2001).

In general, well-designed promotional activities using nutrition education, social marketing and mass media campaigns (with or without home gardening) are successful. They achieve significant increases in the consumption of micronutrient-rich foods, and of (pro)vitamin A rich food in particular (Ruel 2001). Compared with the house gardening programmes in the 1980s, which did not include education activities, the new generation of integrated production and education projects have been much more successful in improving knowledge, awareness, attitude, and practices related to vitamin A (Ruel 2001).

Health education

In the early stages of VAD, symptoms such as night-blindness can be difficult to recognise, especially in infants. Medical staff are not always sufficiently aware of the early symptoms of VAD such as spots on the eyes or night-blindness (IVACG 2003). Parents and medical staff need to be trained to raise awareness that between something that looks like a normal eye infection and total blindness can sometimes only lie a couple of days in which high doses of vitamin A can save the eyesight of a child. They also need to be aware that certain foods can make illnesses less severe and can prevent blindness in children.

Besides knowing how to grow pro-vitamin A rich fruits and vegetables and how to process them, parents need to be aware of the importance of vitamin A and the symptoms of VAD. Programmes to raise awareness, especially among mothers, show a positive impact on the vitamin A status of children.

Summary

Food-based approaches are broad-based projects. They offer assistance in setting up homestead food production, improving the productivity of home gardens, and in keeping small and dairy animals. However, they also raise awareness about VAD and give education about storage and food processing. Successful projects work with local NGOs on the grassroots level. Once the gardens are established they prove to be sustainable in providing all-year-round availability of diverse food. This does not only improve the vitamin A status, especially of women and children, but it also improves the status of other essential vitamins and minerals. Homestead food production often generates additional small incomes which can be spent (often by the women who produce them) on other food products, education or assets to improve the gardens.

2) Medicine-based strategies

General health care

Illnesses, such as malaria, measles and parasitic infections reduce the uptake of nutrients from food. At the same time, these illnesses increase the body's demand for vitamin A. Controlling diseases both medically and through better hygiene (e.g. clean and safe drinking water) can help the body to absorb and retain essential vitamins and minerals. For example, a training programme for health workers in Nepal to distribute vitamin A capsules now also includes de-worming to increase the effect supplementation with very little additional cost (IVACG 2003). Vaccinations against measles are considered to improve the general vitamin A status of a population (WHO 2003).

Supplementation

Supplementation refers to periodic administration of pharmacological preparations of vitamin A in capsules to groups at risk, mainly to young children (FAO/WHO 2002). In contrast to other vitamins, the body can store vitamin A quite easily in the liver. Sufficient vitamin A can be given to children by giving them one, preferably two high-dose capsules per year (WHO 2003, MI & UNICEF 2004). Vitamin A supplementation is considered to be a "*highly cost-effective child survival intervention*" (IVACG 2003). A single capsule costs about 2 US$ cents (MI & UNICEF 2004). On average, approximately 100 million vitamin A capsules were distributed globally per year in the 1990s, with high levels of coverage reached in the mid 1990s (Mason et al. 2001).

In about 40 developing countries, vitamin A supplements are given during *National Immunization Days* (NID) or in conjunction with other mass immunization campaigns (MI & UNICEF 2004, IVACG 2003). In Africa and South-East Asia, this is by far the most common method. More then 40 developing countries are now reaching two-thirds or more of their young children with at least one high-dose vitamin A capsule every year (MI & UNICEF 2004). Coverage with the necessary two doses is much lower but the effort to date is estimated to have saved the lives of more than 300,000 young children per year (MI & UNICEF 2004). Over time, the supplementation programmes aim to prevent the irreversible blindness of hundreds of thousands more children (MI & UNICEF 2004).

Vitamin A supplementation can be integrated into mother and child health clinics and community programmes instead of, or in addition to, the centralised NID programmes. Such decentralised vitamin A supplementation programmes have reportedly led to high coverage rates for children (Mason et al. 2001). 44 countries reported adopting policies for supplementation of all mothers with a high-dose vitamin A capsule

within 8 weeks after childbirth, thereby providing both mother and the breastfed child with vitamin A (Mason et al. 2001).

However, while supplementation programmes are effectively reaching numerous children, they might not be as effective as they could be if given to children or pregnant women who are also deficient in other micronutrients. In particular, zinc deficiency limits the bio-availability of vitamin A. Combined zinc and vitamin A supplementation have shown to improve the vitamin A status of children and pregnant women (Rahman et al. 2002, Dijkhuizen et al. 2004).

A high-dose vitamin A capsules are also used to treat acute VAD (Sommer 1995), especially when hours or days can make the difference between reasonable vision and total blindness (FAO 1997). However, local health centres might not be equipped with vitamin A capsules between NIDs or other centralized distribution efforts (HKI 2001). Weekly, low dose supplementation is recommended to pregnant women to avoid maternal and foetal mortality (FAO/WHO 2002).

Fortification

Fortification is the enrichment of food products with specific vitamins and minerals, such as vitamin A. Butter, margarine and oil, but also sugar and biscuits, can be fortified with vitamin A. Food fortification is not restricted to developing countries, but a normal procedure in food production in industrialized countries. About 25 to 50% of additional vitamin A in the diet of the average European now comes from fortified food products (MI & UNICEF 2004).

In Latin America and the Caribbean, where supplementation is not common, more reliance is placed on fortification. Food fortification is an option where people have access to milled or processed food (Mason et al. 2001). The majority of people will have some access to flour, sugar, salt, margarine and cooking oil, which can be fortified. The cost of fortification of such products can be as little as a few cents per person per year. Fortification requires the co-operation of food processors, but governments can have some influence on food processing. For example, governments can make fortification compulsory, introduce subsidies, reduce duties for imported vitamins and/or offer storage facilities for vitamins below costs (MI & UNICEF 2004). Nicaragua initiated a national programme of vitamin A fortification of its domestic sugar supply starting with the 1999-2000 sugarcane harvest, and an improvement of the vitamin A status of Nicaraguan school children resulted (Ribaya-Mercado et al. 2004).

Food fortification can be effective for schoolchildren or other individuals fed from an organized food distribution system. For example, in a programme in South Africa, fortified biscuits containing about half the RDA for vitamin A were given to children at school. They proved to be successful in ensuring a sufficient daily vitamin A intake that might not be covered by their normal food. VAD prevalence dropped from 45 % to 20 % of children over the period of the school year (IVACG 2003).

Fortification can also reinstate the natural vitamin A content of a foodstuff if it has been lost during processing. Although it is preferable to process food in such a way that vitamins and other nutrients do not get lost in the first place, often this is not possible so the food is fortified after processing. For example, dried skimmed milk exported by EU and other countries for food aid programmes, has added vitamin A so that the milk made from this powder has a similar vitamin A content as fresh milk (Lorch 2001).

Summary

Supplementation and food fortification are successful strategies for situations in which the normal diet does not provide enough vitamin A, but they can only complement food-based strategies, not replace them (FAO/WHO 2002). By default, supplementation and fortification can only focus on one or a few vitamins and minerals. Current supplementation programmes are strongly based on centralized health care and NIDs, and this system might be difficult to maintain in future (MI & UNICEF 2004). Even as food-based approaches are more sustainable, vitamin A capsules will remain a necessary medical approach in refuge camps and after natural catastrophes. General health care and better hygiene are also important contributions to improving the vitamin A status of a population.

Conclusions

Supplementation in form of vitamin A capsules will always be a necessary step for specific situations - be it during pregnancy and breastfeeding, in refuge camps or after natural catastrophes. Food fortification is a complementary approach but is restricted because it can only focus on specific vitamins and nutrients.

The more sustainable strategy is a diverse diet through which everybody gets the necessary amounts of (pro)vitamin A along with other vitamins and minerals. Home gardens and homesteads are the best option to do that because they offer a secure supply of diverse food. In such a system, it is not necessary to count the amount of each individual vitamin - the goal is a secure supply, a healthy diet that contains everything needed. Food fortification and medical supplementation are supply driven and beyond individuals control, home gardens are sustainable solutions on a household level. Whilst food-based approaches usually take longer to implement, once established are sustainable.

In contrast to centralized supplementation or fortification programmes, home gardens and other food-based approaches take place on household level and they can take local conditions into account. Once they are established, the supply of vitamins and minerals is maintained on household level, and thus within the control of those in danger of becoming vitamin A deficient. However, while a diversity of solutions is available, it also needs political commitment to fight malnutrition effectively.

The goal of combating VAD is not to provide medical treatment, it is to avoid VAD and another VMDs. By combating VAD with home gardens, sustainable systems are created that provide food security and diversity, in a way that is empowering women and protects agro-biodiversity.

Antje Lorch
ifrik – research on genetic engineering
www.ifrik.org
lorch@ifrik.org

References

Brown, M.J., Ferruzi, M.G., Nguyen, M.L., Cooper, D.A., Eldrige, A.L., Schwartz, S.J. & White, W.S. 2004. Carotenoid bioavailability is higher from salads ingested with full-fat than with fat-reduced salad dressings as measured with electrocehmical detection. American Journal of Clinical Nutrition 80: 396-403.

CWS (Church World Service) 2000. *Moringa oleifera*. Church World Service website 2000 [http://www.churchworldservice.org/moringa/index.html]

Dijkhuizen, M.A., Wieringa, F.T., West C.E. & Muhilal. 2004. Zinc plus ß-carotene supplementation of pregnant women is superior to ß-carotene supplementation alone in improving vitamin A status in both mothers and infants. American Journal of Clinical Nutrition 80: 1299-1307.

Faber, M., Phungula, M.A.S., Venter, S.L., Dhansay, M.A. & Benadé, A.J.S. 2002. Home gardens focusing on the production of yellow and dark-green leafy vegetables increase the serum retinol concentrations of 2–5-y-old children in South Africa. American Journal of Clinical Nutrition 76: 1048-1054.

FAO/WHO 1992. World declaration on nutrition. International Conference on Nutrition, Rome, Italy, December 1992. [http://www.fao.org/docrep/U9920t/u9920t0a.htm]

FAO 1995. Improving nutrition through home gardening. A trainage package for preparing field workers in South East Asia. FAO, Rome Italy.

FAO 1997. Human nutrition in the developing world. FAO, Rome, Italy.

FAO/WHO 2002. Human vitamin and mineral requirements. Report of a joint FAO/WHO expert consultation Bangkok, Thailand. Rome, Italy.
[http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/004/Y2809E/Y2809E00.HTM]

FAO 2004. The state of food insecurity in the world 2004 (SOFI 2004). FAO, Rome, Italy.
[http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/007/y5650e/y5650e00.htm]

Graebner, I.T., Siqueira, E.M.A., Arruda, S.F.& de Souza, E.M.T. 2004. Carotenoids from native Brazilian dark-green vegetables are bioavailable: a study in rats. Nutrition Research 24: 671-679.

Greenpeace 2001. Vitamin A: Natural sources vs "Golden rice". Background report.
[http://archive.greenpeace.org/geneng/reports/food/VitaAvs.PDF]

Haskell, M.J., Jamil, K.M., Hassan, F., Peerson, J.M., Hossain, M.I., Fuchs, G.J., & Brown, K.H. 2004. Daily consumption of Indian spinach (*Basella alba*) or sweet potatoes has a positive effect on total-body vitamin A stores in Bangladeshi men. American Journal of Clinical Nutrition 80: 705-714.

Hels, O., Larsen, T., Christensen, L.P., Kidmose, U., Hassan, N. & Thilsted, S.H. 2004. Contents of iron, calcium, zinc and β-carotene in commonly consumed vegetables in Bangladesh. Journal of Food Composition and Analysis 17: 587-595.

Hickey, E, Mittai, A. (eds.) 2003. Voices from the South. The Third World Debunks Corporate Myths on Genetically Engineered Crops. Food First/Institute for Food and Development Policy and Pesticide Action Network North America; http://www.foodfirst.org/progs/global/ge/sactoministerial/voices.php

HKI (Helen Keller International) 2001. What are vitamin A knowledge and practices among mothers and health workers? Nutrition Bulletin (Philippines) , Vol. 1, Issue 1. [http://hkiasiapacific.org/_downloads/PhilNutrBul_vol1_iss1.pdf]

HKI 2003a. Integration of animal husbandry into home gardening programs to increase vitamin A intake from foods: Bangladesh, Cambodia and Nepal. Special Issue (Asia-Pacific) January 2003
[http://hkiasiapacific.org/_downloads/APRO%20Special%20issue%20Jan%202003.pdf]

HKI 2003b. HKI's homestead production program sustainbly imporves livelihoods of households in rural Banglades. Homestead Food Production Bulletin (Bangladesh) No 1, September 2003. [http://hkiasiapacific.org/_downloads/HFP%20BD%20Bulletin%201.pdf]

HKI 2003c. Monitoring activities in village nurseries and household gardens. Summary Report of Surveys 14-19. NGO Gardening & Nutrition Education Surveillance Project (NGNESP), Dahka, Bangladesh. [http://hkiasiapacific.org/_downloads/NGNESP%20Summary%20Rd%201419.pdf]

HKI 2004. Homestead food production improves household food and nutrition security. Homestead Food Production Bulletin (Bangladesh) No 2, November 2004. [http://hkiasiapacific.org/_downloads/HFP%20BD%20Bulletin%201.pdf]

IOM (Institute of Medicine) 2002. Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc:a report of the Panel on Micronutrients Subcommittees on Upper Reference Levels of Nutrients and of Interpretation and Uses of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine (U.S.). National Academy Press. Washington DC. www.nap.edu

IVACG (International Vitamin A Consultative Group) 2003. Improving the vitamin A status of populations. Report of the XXI IVACG. Washington, USA. [http://ivacg.ilsi.org/file/IVACGfinal.pdf]

IVACG 2004. Vitamin A Conversions to SI. IVACG website, revised June 2004. [http://ivacg.ilsi.org/file/webBookmark.pdf]

Kuhnlein, H.V. & Pelto, G.H. (eds.) 1997. Culture, environment, and food to prevent vitamin A deficiency. International Nutrition Foundation for Developing Countries (INFDC) & International Nutrition Foundation for Developing Countries (INFDC). [http://www.unu.edu/unupress/food2/UIN07E/uin07e00.htm]

Lorch, A. 2001. Is this the way to solve malnutrition? Biotechnology and Development Monitor 44/45, 18-22. [http://www.biotech-monitor.nl/4408.htm]

Mason, J.B., Lotfi, M., Dalmiya, N., Sethuraman, K. & Deitchel, M. 2001. The Micronutrient Report. Current Progress and Trends in the Control of Vitamin A, Iodine, and Iron Deficiencies. Micronutrient Initiative; Ottawa, Canada. [http://www.tulane.edu/~internut/publications/MI%20REPORT.pdf]

MI (Micronutrient Initiative), UNICEF (United Nations Children's Fund) & Tulane University, 1998. Progress in controlling vitamin A deficiency. Micronutrient Initative; Ottawa, Canada. [http://www.micronutrient.org/resources/publications/pub13.htm]

MI & UNICEF 2004. Vitamin & Mineral Deficiencey. A Global Progress Report. Micronutrient Initative; Ottawa, Canada. [http://www.micronutrient.org/reports/]

Nepalese Ministry of Health, New ERA, Micronutrient Initative, UNICEF Nepal & WHO 1998. Nepal Micro Nutritent Status Survey 1998. Ministry of Health, Kathmandu, Nepal.

Rahman, M.M., Wahed M.A., Fuchs G.J., Baqui, A.H. & Alvarez, J.O. 2002. Synergistic effect of zinc and vitamin A on the biochemical indexes of vitamin A nutrition in children. American Journal of Clinical Nutrition 75: 92-98.

Ribaya-Mercado J.D., Solomons, N.W., Medrano, Y., Bulux, J., Dolnikowski G.G., Russell, R.M. & Wallace, C.B. 2004. Use of the deuterated-retinol-dilution technique to monitor the vitamin A status of Nicaraguan schoolchildren 1 y after initiation of the Nicaraguan national program of sugar fortification with vitamin A. American Journal of Clinical Nutrition 80: 1291-1298.

Ruel, M. T. 2001. Can food-based strategies help reduce vitamin A and iron deficiencies? International Food Policy Research Institute; Washington, USA. [http://www.ifpri.org/pubs/fpreview/fpreview05.htm]

Sommer, A. 1995. Vitamin A deficiency and its consequence. A field guide to detection and control, WHO (World Health Organisation); Geneva, Switzerland. Third edition.

SCN (Standing Committee on Nutrition) 1998. Report of the SCN Working Group on Micronutrients. 25th Session Oslo, Norway 1998. United Nations System
[http://www.unsystem.org/scn/Publications/AnnualMeeting/SCN25/vitaminadeficiency.html]

SCN 2002. Report of the SCN working group on micronutrients. 29th session in Berlin, Germany, March 2002. United Nations System.
[http://www.unsystem.org/scn/Publications/AnnualMeeting/SCN29/29micronutrients.htm]

UNICEF 1990. Goals for children and development in the 1990s. World Summit for Children, New York, USA, 1990. [http://www.unicef.org/wsc/goals.htm]

UNICEF, WHO, New Economic Partnership for African Development, Development Bank of Southern Africa, Micronutrient Initiative, & Global Alliance for Improved Nutrition 2004. Vitamin & Mineral Deficiency. A partnership to End Hidden Hunger in Sub-Saharan Africa. UNICEF; New York, USA. [http://www.unicef.org/videoaudio/PDFs/africa_dar.pdf]

Vitamin A Global Initiative 1998. A strategy for acceleration of progress in combating vitamin A deficiency. UNICEF, MI, WHO, CIDA & USAID). [http://www.unicef.org/immunization/files/Vit_A_strategy.pdf]
WHO 2000. Vitamin A deficiency. WHO website updated 17 Feb 2000. [archived at http://web.archive.org/web/20000605053045/http://www.who.int/vaccines-diseases/diseases/vitamin_a.htm]
WHO 2003. Combating vitamin A deficiency. WHO website, updated September 2003. World Health Organisation, Rome, Italy. [http://www.who.int/nut/vad.htm]

Abbrevations

FAO	Food and Agriculture Organization of the United Nations
HFP	Homestead food production
HKI	Helen Keller International
IVACG	International Vitamin A Consultative Group
MI	Micronutrient Inactive
NGO	Non-governmental organization
NID	National Immunization Days
RDA	Recommended dietary allowance
RE	Retinol equivalent: conversion factor for different vitamin A sources
UN	United Nations
UNICEF	United Nations Children's Fund
VAD	Vitamin A deficiency
VMD	Vitamin and mineral deficiency
WHO	World Health Organization