



# Nutriview 2003/1

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## ■ Editorial:

### Improving the world's health

How can governments achieve sustainable development in their countries? By adopting policies and programs that promote population-wide improvements in health, according to the latest World Health Report [1]. Such strategies are more effective than those directed only towards individuals at high risk.

The report breaks new ground by identifying the main health risks in the world today, quantifying their impact from region to region, and suggesting cost-effective ways to deal with them. In the words of WHO Director-General Dr Gro Harlem Brundtland, it "provides a road map for how societies can tackle a wide range of preventable conditions that are killing millions of people prematurely and robbing tens of millions of healthy life".

From the preventable risks studied, the report identifies ten that account for 40% of the 56 million deaths and one-third of healthy life years lost globally every year. These are: childhood and maternal underweight, unsafe sex, high blood pressure, tobacco, alcohol, unsafe water/sanitation, high blood cholesterol, indoor smoke from solid fuels, iron deficiency and overweight/obesity.

The data presented show that nutrition-related disorders have the greatest impact on health and survival (before HIV/AIDS and tobacco-related illness). The burden is borne mainly by developing nations, where some 170 million children are underweight, and most childhood deaths are associated with malnutrition. On the other hand, more than one billion adults (in middle- and high-income countries) are overweight or obese due to poor diets and lack of exercise.

As the most cost-effective strategy to alleviate hunger and malnutrition, the report recommends a combination of micronutrient supplementation and food fortification with maternal counselling to continue breast feeding, and targeted provision of complementary foods. Routine treatment of diarrhea and pneumonia is also advocated.

The report also encourages nutrition measures (low intakes of salt and fat, high intakes of fruits and vegetables), as well as adequate exercise and not smoking as basic steps for the prevention of cardiovascular disease.

The report's authors stress the far-reaching health benefits that can be achieved by following their recommendations, and hope that many governments will comply. Maybe Nutriview readers can help to get the message across to them. – A. Bowley

#### References

1. World Health Report 2002—Reducing Risks, Promoting Healthy Life, World Health Organization, 1211 Geneva 27, Switzerland. Fax: (41-22) 791 4870; <http://www.who.int/whr/en/>

### 2003: First ten years of Nutriview



Time flies! It is already ten years ago that the Human Nutrition Communications Director of Hoffmann-La Roche asked me if I would be willing to take on the task of editing a new newsletter aimed at increasing understanding for the roles of micronutrients in maintaining good health. At the time, I only had a limited knowledge of the nutrition problems that developing countries have to face. However, I accepted the challenge; and have never regretted my decision since. The first months were occupied with developing a viable concept, building a team of reliable expert helpers, and drafting the texts for the first issue, which we managed to publish by August 1993.

Nutriview was created in response to the call by the participants at the 1992 International Conference on Nutrition in Rome for collaboration towards eradicating hunger and malnutrition in the world. Because of this, the Food and Nutrition Division of the World Health Organization was one of my first contacts, to identify common objectives. Since those days, enormous advances have been made in knowledge about how micronutrients influence health, and support has grown for interventions such as micronutrient supplementation and food fortification. In spite of this, we are still a long way off from achieving the goals set in 1992, and our task—to encourage more efforts to eliminate malnutrition—has not become less important. I look forward to being able to serve readers for a long time to come. – A. Bowley

## ■ Feature:

### 2003: The International Year of Freshwater

On December 12, 2002, the United Nations General Assembly launched the International Year of Freshwater 2003 to galvanize action on the world's critical

water problems. UN Secretary-General Kofi Annan expressed hopes that this initiative will play a vital role in generating greater efforts by governments, civil

society, communities, the business sector and individuals all over the world.

Today, 1.2 billion people are without access to safe drinking water and 2.4

billion lack proper sanitation. More than 3 million people die every year from diseases caused by unsafe water. World leaders have pledged to halve these numbers by 2015. This requires coordinated action, not just from governments, but also from people who use water and those who invest in it. Substantial resources are also needed: up to \$60 billion annually, which is double the amount currently spent.

Water scarcity is a critical issue for future development. During the 20th century, water use increased at more than twice the rate of population growth. Already, 40% of the world population live in countries that face a serious shortage of water. Without appropriate action, this could increase to 60% (an estimated 5.5 billion people) by 2025.

A wide range of water-related events and activities are planned for 2003. In March, to coincide with the 'World Water Day' and the 'World Water

Forum' (an international conference being held in Japan) the United Nations will release the first edition of the World Water Development Report, which gives a comprehensive view of today's water problems and offers recommendations for meeting future water demand. ■

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*This information is taken from the website <[www.wateryear2003.org](http://www.wateryear2003.org)> which provides extensive links to information materials, reports, and planned activities of the International Year of Freshwater 2003.*

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### Food sector is main water user

Water use is increasing everywhere. Humans already take more than half of the accessible freshwater in rivers, lakes and underground reservoirs. If consumption continues to rise at its current rate, by 2025 humans could take more than 90%, leaving just 10% for the rest of the world's species.

Currently, agriculture takes almost 70% of all freshwater for human use (mostly for irrigation); industry takes about 23%, leaving the rest for private households. These averages vary considerably between regions. Agriculture is mainly responsible for the rapidly depleting supply of ground-water. It takes an enormous amount of water to produce crops: 1,000 tons for one ton of grain! According to the FAO, poor drainage and irrigation practices have led to waterlogging and salinization of about 10% of the world's irrigated land. Agriculture and the food industry are also the most important sources of water pollution with organic materials. Improved systems management is called for to reduce wastage, and increase efficiency.

## ■ Technology:

### An ideal multimicronutrient supplement for children

The 'International Workshop on Multi-Micronutrient Deficiencies in the Life Cycle', which was held in Rio de Janeiro, Brazil, in November 1999, found that currently available micronutrient supplements are unsuitable for infants and young children. Tablets and capsules are usually too large for them to swallow, while syrups are instable, and involve high distribution and storage costs.

An "ideal" delivery form for infants and young children, the participants decided, would be a tablet that:

- tastes good and is easy to chew;
- is easily crumbled, so it can be sprinkled over and mixed with any food;
- is dispersible in water, so it can be dissolved in any drink;
- is chemically and physically stable under normal conditions;
- is easy to dose correctly, and provides the micronutrients needed for good health.

#### An innovative solution

In response to this challenge, our special-

ists have developed what we call the 'Foodlet' (to reflect the main ingredient and how it is used). The Foodlet is a large tablet (diameter 20mm, weight 2.8g). Made with a low compression force and a high concentration of milk powder, it is soft, and can be crumbled and mixed with any meal or drink. It can be sweetened and flavored, and can carry the amounts of essential nutrients needed. For maximum protection against oxidation and physical damage, and for easy distribution and storage, blister packs are the best form of packaging.

Micronutrients are added to the Foodlet using a precision premix. This offers many advantages in terms of uniformity of the final product, logistics, quality control, etc. Standard premixes contain 1 RDA or 2 RDA of the vitamins A, D, E, C, B1, B2, B6, B12, folate, niacin, and iron, zinc, copper and iodide. However, nutrient choices and levels can be modified to meet specific requirements.

The type of premix used depends on local conditions and technical facilities.

A premix containing only micronutrients might be the choice for experienced producers with a local source of reasonably priced, high-quality excipients. Alternatively, because of its simplicity of use and predictable results, a drum-to-hopper premix containing micronutrients and excipients may be preferred. This premix can be added directly into the tableting machine without any further preparation.



Foodlet blister pack

### Why a multimicronutrient Foodlet?

Micronutrient deficiencies rarely occur in isolation. Populations affected by one deficiency are typically deficient in several other micronutrients, which also contribute to their poor health. It has been estimated that 10–25% of pre-school children in developing countries are, in fact, affected by deficiencies of more than two micronutrients. Thus, treatment with only one micronutrient cannot be expected to improve health beyond the point where another deficient nutrient becomes limiting.

For normal growth and metabolism, children must regularly obtain all essential nutrients in adequate amounts. Evidence from randomized controlled trials suggests that giving multiple micronutrients in a single supplement is an effective way to improve nutritional status. Multimicronutrient supplements are also more cost-effective. The cost of the extra nutrients is minimal compared to the total cost of production, packaging, distribution and marketing. Thus, multimicronutrient supplementation makes sense both biologically and operationally.

The efficacy of the Foodlet has been studied by the International Research on Infant Supplementation project (IRIS) in South Africa, Vietnam, Indonesia and Peru. In these studies, children aged 6 to 12 months who had anemia or vitamin A deficiency, were given one multimicronutrient Foodlet daily (containing 1 RDA) or weekly (containing 2 RDAs). Acceptability and compliance were satisfactory. The final results should be available soon. – *Denise Bienz, PhD, and Hector Cori, Roche Vitamins Ltd.* ■

### ■ Review:

## A lesson from Canada

To help countries that would like to use food fortification to prevent and control micronutrient deficiencies in their populations, the Micronutrient Initiative has recently published a book [1] that presents Canada's experience with this technology. The eight chapters provide a historical outline of why and how food fortification became the method of choice, explain the principles of regulatory and control mechanisms, list the criteria for ensuring the effectiveness of fortification programs, and review current policies and future challenges. Of particular interest are the history notes spread throughout the book. These stories behind the issue of fortification show that even in a so-called 'developed country' the same types of questions and issues as today's had to be resolved before fortification was accepted.

From the data presented, it is clear that food fortification has played an important role in improving the health and nutritional status of the people living in Canada. Careful study of this book could help anyone involved in developing their country's future nutrition strategy to meet the basic criteria needed for success. Below are some of the key messages presented in the book.

### How it all started

In Canada, addition of vitamins and minerals to food has been used as a public health measure for more than fifty

years. Surveys conducted in Canada during the first half of the twentieth century showed that malnutrition was common. At that time, many of the population were deficient in iodine, iron, calcium, vitamin A, vitamin C, vitamin D and several B vitamins.

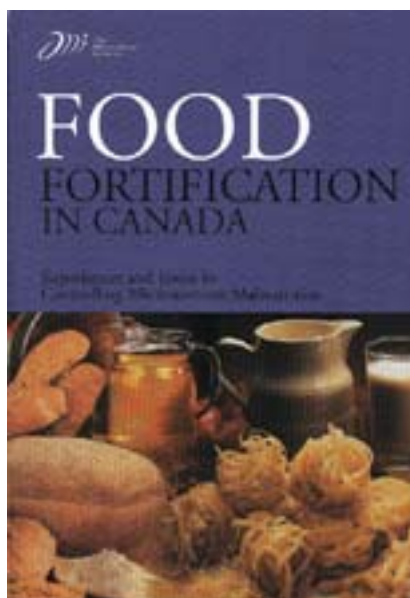
Nevertheless, the suggestion to add the missing nutrients to common foods was not widely accepted. The arguments against fortification then were similar to those still encountered today, namely that it would cost too much and might not be safe. Many felt that Canadians should be taught to eat nutritious foods,

rather than introducing synthetic vitamins to their diets.

So, initially, addition of micronutrients to foods was done on a voluntary basis. Earliest examples were iodized salt and enriched bread. Public health education programs advised consumers to select fortified products or take supplements. However, this did not have the desired impact. Most people still chose to eat the nonfortified alternatives.

The virtual elimination of goiter following introduction of mandatory salt iodization in 1949 confirmed that this was the right approach. In spite of this, it took until the 1970s to establish mandatory fortification on a broad basis.

Today, fortification is mandatory in the whole of Canada for salt (iodine), whole, condensed and powdered cow's milk (vitamin D), fat-reduced milk (vitamins A and D), evaporated milk (vitamins C and D), fruit-flavored drinks (vitamin C), white flour (thiamine, riboflavin, niacin, folic acid, iron), margarine (vitamins A and D), infant formulas and substitute foods (vitamins and minerals to ensure nutritional adequacy). Regulations also allow addition of other micronutrients in defined amounts to selected types of food. With this voluntary program, consumers who do not eat enough of one type of fortified food may get the desired nutrients through another. Experience has shown that this carries little risk of overconsumption.



### Keeping to the rules

A key factor for the success of a fortification program is that it is done strictly according to a well-defined set of rules. Canadian food law has served for many years as a reference for international agencies. Because Canadian food law is relatively simple and widely applicable, the FAO has drafted a model food act based on it for use by other countries.

It is equally important to implement an efficient system for controlling and enforcing the existing legislation. In Canada, this is done nationally by a single agency, the Canadian Food Inspection Agency (CFIA). CFIA inspectors are equipped with wide-ranging powers to ensure that manufacturers, distributors, retailers and importers, who ultimately carry the responsibility for food safety, meet the set standards.

The regulations for addition of nutrients to foods are based on a defined gov-

ernment policy. This provides a uniform set of principles for ensuring a rational, consistent approach to achieve the desired public health objectives. Canada's policy is based on the FAO/WHO *Codex of General Principles for the Addition of Essential Nutrients to Foods*.

### Improving effectiveness

To ensure the success of a food fortification program it is also important to:

- choose the right food vehicle(s) to provide the target population(s) with the necessary nutrients without exposing them to increased risks.
- choose the right strategy (mandatory/voluntary) to ensure adequate consumption of the fortified food.
- monitor changes in lifestyle and eating habits to make sure that consumers do eat the fortified food.
- consult with all stakeholders before taking decisions.

- keep up with scientific knowledge, and amend regulations accordingly.

### Looking to the future

Public health issues, economic interests, industry and consumer concerns are not static. It is therefore important to review policies and regulations from time to time. This is best done in consultation with all stakeholders.

It is worthwhile considering food fortification as a strategy to improve people's nutritional status. Canada has shown that it works, and will probably continue to use it to deal with future changes in its population and its food supply. – A. Bowley

### Reference

1. Mahshid Lotfi. Food fortification in Canada: experiences and issues in controlling micronutrient malnutrition. pp82. The Micronutrient Initiative 2002.

## ■ Conference report:

### West Africa initiates regional food fortification strategy

The 'Private Sector-Public Sector Dialogue on Food Fortification in West Africa' (organized by the West African Health Organization, the Micronutrient Initiative, Helen Keller International, UNICEF, and the Ministries of Health of Côte d'Ivoire and Ghana, with support from the local office of the USAID MOST Project) was held in Accra, Ghana, on October 15–17, 2002. At the meeting, specialists from government ministries, private food companies and consumer groups from Burkina Faso, Côte d'Ivoire, Ghana, Mali, Niger, Nigeria and Senegal met with representatives of international organizations to discuss ways to eliminate micronutrient malnutrition in the region.

Their main objective was to accelerate national and regional efforts for addressing the problem in an effective and sustainable manner. One of the key strategies under consideration was the fortification of basic foods. The workshop participants reached a broad consensus on the problem, and selected appropriate strategies and actions.



*A typical rural market stand in West Africa. Many of the foods sold here could be fortified.*

### Potential for fortification

The workshop was inaugurated by Ghana's Minister of Economic Planning and Regional Cooperation, who set the tone for the meeting by stressing the need for peace, stability, democracy and good governance as prerequisites for improving health and nutrition.

The following speakers highlighted the magnitude and severity of the micronutrient deficiency problem in the region, and reviewed the various inter-

ventions available to address it. They noted that current levels of effort are insufficient to eliminate micronutrient malnutrition, and encouraged stakeholders to consider food fortification as a way to accelerate corrective action.

Participants agreed that there is ample potential for fortification of basic foods in the region and that it can be done cost effectively. It needs to be part of an overall package that includes supplementation, dietary promotion and public health approaches. An important step is to establish a regional policy framework and process on food fortification, and then make this into a strong supportive instrument.

Experience with food fortification in Côte d'Ivoire (vitamin A in oil) and Morocco (iron and B vitamins in flour) shows that large-scale fortification can be successfully implemented in the region; it must be supported by feasibility and effectiveness studies, partnership building, systematic planning, implementation and monitoring. For effective fortification, an enabling market, manu-

facturing base, industry capacity and government capacity need to be in place. The key role of the food industry in enabling fortification, and the importance of engaging industry in the planning process is clear. Regarding the issue of small-scale fortification, it was recognized that this poses special challenges that need to be addressed.

### Meeting country-specific needs

Workshop participants were introduced to the concept of the food fortification cycle as a systematic way of moving from situation analysis to feasibility study, partnership building, implementation, monitoring and evaluation. Nigeria used this method to develop its vitamin A fortification program. Being iterative, it enables changes to be made based on evaluation.

A study conducted in Burkina Faso, Guinea, Mali and Niger using the Fortification Rapid Assessment Tool (FRAT) identified four promising food vehicles for fortification: sugar, cooking oil, wheat flour and bouillon cubes. It was also shown that a significant number of local industries have sufficient capacity to integrate fortification within their existing manufacturing processes at an affordable cost. Other speakers stressed the importance of quality assurance and monitoring, as well as measures to promote the use of fortified foods. As an example of this, participants heard about the highly successful social marketing campaign to promote fortified flour in Morocco.

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*The FRAT is a simplified 24-hour recall questionnaire designed to provide enough information about consumption patterns of potential food vehicles to allow a confident and informed decision about the most appropriate food vehicle for a fortification program. The results of the FRAT will also provide data for an initial examination of safe and effective fortification levels, and will answer some questions about use and availability of the food in the household. For further details, see: <http://www.pathcanada.org/english/content/fratt.html>*

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In the second part of the workshop, each of the participating countries summarized its current situation, showed its proposed plan of action and timeline, and informed where it needed assistance to move forward.

### Ready for action

Following a final panel discussion, the participants drafted a consensus statement summarizing the chosen strategy, and the specific regional and national actions needed to accelerate progress and achieve sustained impact. Some of the main points included in this document follow.

*1. Guiding principles:* The following principles should be advocated for and accepted at the highest policy levels in the public and private sector:

- Maximize access to affordable, safe and efficacious fortified foods as a long-term commitment.
- Encourage fortification with iron, vitamin A, folic acid, other vitamins and minerals as needed.
- Promote food fortification as one element within an integrated and comprehensive program in accordance with recognized guidelines on healthy eating.
- Absorb costs of fortification along the production-to-consumption chain to avoid jeopardizing sustainability of the process.

*2. Policy and strategy:* A regional policy and strategy on fortification needs to be developed and approved. ECOWAS through WAHO (West African Health Organization) would be the appropriate body to lead such a process with the following technical support:

- Integrate the agreed principles and strategies into the plans and processes of health, development and trade organizations and associations in the region.
- Develop a regional framework covering legal requirements, standards, regulations and guidelines on food fortification for endorsement by regional bodies.
- Ensure free trade of fortified foods conforming to regionally accepted standards across countries in the region while controlling illegal importation.

- Develop and encourage regional collaboration and support for training, research, capacity building, quality assurance and procurement of equipment and premises.

*3. National strategies and actions:* A national partnership structure or committee should champion and oversee the implementation of a national food fortification program and ensure policy support at the highest level. This committee should prepare a national food fortification strategy and plan identifying priority actions for both public and private sectors to create an enabling environment for fortification and mechanisms to minimize costs, enhance supply and create demand through the following measures:

- Facilitate procurement of equipment and premises for fortification.
- Collect and analyze data needed to identify appropriate and effective vehicles for fortification, including feasibility studies and information on distribution and storage of potential vehicles.
- Conduct social marketing of fortified foods to raise demand.
- Establish a legal and regulatory framework in each country; legislation should be harmonized at national and regional levels.
- Ensure adequate monitoring and quality assurance systems.

### An achievable vision

Ghana's Director General of Health closed the workshop with a visionary message for a West Africa free of malnutrition. Participants left the meeting with greater clarity about the steps needed to move the agenda forward in their respective countries and a motivation to continue, expand and build on the public-private dialogue started in Accra. – *Shawn K. Baker, Regional Director for Africa, Helen Keller International, Abidjan, Côte d'Ivoire.* ■

## ■ Conference report:

### Millers discuss opportunities for universal flour fortification

On October 24, 2002, after the annual meeting of the Association of Operative Millers (Middle East and East Africa District) in Mauritius, the Micronutrient Initiative (Ottawa, Canada) and the Centers for Disease Control and Prevention (Atlanta, USA) convened a 'Policy Planning Forum' with the wheat industry to explore possibilities for launching a global public-private initiative supporting universal flour fortification (UFF).

Objective of the meeting was to gain support from industry and civic leaders for adoption of flour fortification with iron and folic acid and other essential minerals and vitamins as a normal milling practice in large mills around the world, and in all other places where it is technically feasible and beneficial for wheat consuming populations.

#### A step worth taking

Wheat flour is an ideal vehicle for fortification. Annual global wheat production is around 600 million tons, and wheat is consumed in almost all countries of the world (average annual per-capita intake: 100 kg). In 1997 only six countries had a per-capita intake less than 10 kg (Somalia, Tanzania, Congo, Nigeria, Myanmar and Vietnam).

Even where wheat is not the main staple, flour fortification could have a significant impact on micronutrient intakes. In Indonesia for example (average wheat flour intake: 20 kg) fortification of wheat flour with iron at a level of 50 mg/kg provides an additional intake

of 1000 mg iron annually. This is equivalent to more than two months of iron supplementation at 30 mg/day, which has been shown to correct iron-deficiency anemia in women and children.



In most countries, flour milling is concentrated in a few, large, relatively modern centers that are already technically equipped to handle large-scale fortification or could be easily adapted for the purpose. The technology required is simple (a commercially available premix is added near the end of the milling process) and readily available at low cost (fortification adds about 0.5% to the flour price). Flour fortification has been successfully practised in some countries (e.g. USA and Canada) for more than 50 years, and has proved to be safe and effective.

#### More support needed

Currently, more than thirty countries fortify wheat flour on a national scale, and numerous others are preparing to

start. Nevertheless, less than 15% of the wheat flour sold worldwide is fortified. The meeting organizers therefore stressed the importance of building a strategic alliance between the private and public sectors to encourage greater efforts for implementing flour fortification in the rest of the world.

Hopes are that this UFF initiative can repeat the successes achieved with universal salt iodization (USI). Since this was adopted in 1993, it has accelerated progress towards elimination of iodine deficiency disorders considerably. For its initiators, UFF now faces the same barriers as USI did ten years ago: too much debate about what is the "best" way to go, which micronutrients to include, what dosage levels, etc., and concerns about influencing markets in favor of large companies.

Today, USI is widely accepted as a principle to be achieved, and as a normal standard for all salt produced for consumption by animals and humans. A similar level of collaboration is needed to ensure the success of UFF as well. ■

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*This information is taken from the documentation distributed to the participants at the meeting. Further details (PowerPoint slides) can be found on the Micronutrient Initiative website <<http://micronutrient.org>> by entering <UFF> in the search field.*

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#### Erratum

In Nutriview 2002/4, we inadvertently listed the ITANA Council member from Malawi as Ms Chrissie Chawanje. As holder of a PhD in food science, she should have been listed as Dr Chawanje. Here is the photo again with the correct caption.

*ITANA Council (from left): Dr Judith Waudu, Kenya, Ms Fatima Ouattara, Mali (Vice President), Dr Moussa Ouedraogo, Burkina Faso, Dr Chrissie Chawanje, Malawi, Prof Demetre Labadarios, South Africa (President), Ms Mofor Teugwa, Cameroon, Prof Prisca Tuitoek, Kenya (Treasurer), Dr Delana Adelekan, Nigeria (Secretary), Mr Ridha Mokni, Tunisia*



## Age-related macular degeneration (AMD)

### Public health significance

AMD is a leading cause of impaired vision in Europe and North America. In the USA, more than 13 million people over 65 years of age are affected. Surveys have shown that the incidence increases from 1.2% in people 52–64 years to 20–37% in those over 75. In the UK, almost 50% of new registrations for blindness in 1990 were due to AMD.

### Risk factors

A family history of the disease, female sex, and a pale-colored iris increase the risk for AMD. Smoking, excessive alcohol consumption and sun exposure are known lifestyle-related risk factors. People with elevated plasma lipids and patients with cardiovascular disease are also more prone to the disorder.

### Clinical features

The macula (anatomical names: macula lutea or macula retinae) is the centre for sharp and focused vision. Degenerative changes in AMD show as breakdown of the macular epithelium and deposits of cell debris (drusen). In advanced disease, fluid may accumulate and the retina may become detached.

Research carried out in recent years suggests that the degenerative process probably begins in youth, and can be slowed down or prevented by protecting the eyes against excessive sunlight and ensuring adequate intakes of certain antioxidant nutrients.

### Involved nutrients

The macular pigment consists mainly of lutein and zeaxanthin. These two xanthophyll carotenoids absorb the blue light that is a major source of retinal damage. In addition, they are antioxidants that quench free radicals produced by oxidative stress. Only lutein and zeaxanthin (out of some

600 carotenoids found in nature) are selectively incorporated into the macula. Zeaxanthin concentrations are highest in the central conical depression (fovea centralis retinae).

Higher levels of lutein and zeaxanthin accumulate in the macula following an increase in dietary intakes with food or supplements. Data from epidemiological studies indicate that individuals with higher intakes of lutein and zeaxanthin are less likely to develop AMD than those with low intakes. This suggests that both carotenoids play a protective role against AMD.

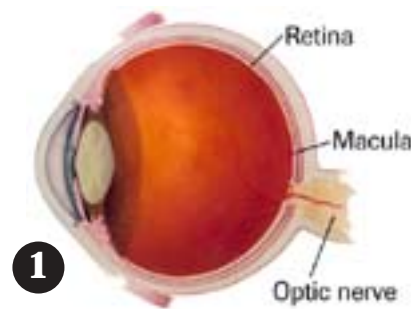
### Food sources

Lutein and zeaxanthin occur in a wide range of foods along with other carotenoids. Among the richest food sources are sweet yellow corn, egg yolk, kiwi fruit, pumpkin, zucchini, spinach,

squash, grapes and peas. A balanced diet rich in vitamins and carotenoids provides 2–6 mg of lutein/zeaxanthin daily. Although official recommendations for intake are not yet available, this should be enough to ensure adequate macular concentrations. Supplements for AMD prevention are sold in several countries.

### Information sources

1. National Eye Institute, National Institutes of Health, USA: [www.nei.nih.gov](http://www.nei.nih.gov)
2. Macular Degeneration Foundation Inc. [www.eyesight.org](http://www.eyesight.org)
3. Webvision. The organization of the retina and visual system: <http://webvision.med.utah.edu>
4. Nutritional and environmental influences on the eye. Ed. Allen Taylor. Boca Raton: CRC Press, 1999. (ISBN 0849385650)



People suffering from macular degeneration might see distorted and garbled words that are missing.

1. The macula is situated at the back of the eye in the retina. (National Eye Institute).
2. In early AMD, vision becomes distorted. Later, central vision is lost, (seen as a dark spot).
3. Background of a normal eye. The macula appears as a darker spot in the center (Webvision).
4. Changes on the retina in macula degeneration. Debris (drusen) appears as yellow spots around the macula (Webvision).