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From malnutrition to HIV: spirulina is an effective solution which continues to reveal its secrets

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Abstract. Spirulina presents major advantages in the fight against chronic malnutrition based on its micronutrient composition, its health potential and the fact that it can be grown locally. International solidarity associations, such as Antenna Technologies and Entrepreneurs du Monde whose goal is to reduce extreme poverty and public health problems in developing countries, have undertaken production and distribution programmes of spirulina, especially in West Africa. The quality of spirulina produced in these developing countries continues to increase to the extent that it can now be exported. Thus, associations such as Spirulidaire market a traditional, fair and supportive spirulina in France and Europe and thus promote local producers.

The perception of spirulina continues to evolve with the multiplication of field initiatives and the accumulation of scientific data. New studies demonstrate that spirulina also presents clinically significant anti-viral and immuno-stimulating effects in people infected by HIV.

Keywords. Spirulina, malnutrition, HIV-AIDS, microcredit, Togo, Burkina Faso, fair and supportive trade.

Rediscovered a few decades ago, spirulina is grown and distributed locally. Thanks to the joint action of the Antenna Technologies Foundation and the Association Entrepreneurs du Monde, it helps to reduce extreme poverty and public health problems in developing countries. However, it has not yet revealed all its secrets.

More than hunger, the true challenge in global health is malnutrition. This pathological condition is due to a micronutrient (vitamins, minerals and essential amino acids) deficiency, which does not allow the body to continue its growth and maintain its vital functions.

All experts agree that malnutrition in the world is not the sole possible outcome: the problem is not the amount of food produced, but rather the access to a diversified diet and the high price of food.

1 Who are the victims of malnutrition and what are the consequences?

Children under 5 years of age (about twenty million children according to WHO) are principally affected, but also pregnant and breast-feeding women. Malnutrition has numerous harmful consequences in young children: increased risk of mortality, lowered immune defences, slower motor development, and decreased cognitive and learning capacities in school.

2 A solution to fight chronic malnutrition

Various organisations, such as Antenna Technologies, have chosen to act for the prevention of childhood malnutrition. This prevention is mainly based on providing populations with education on nutrition, developing and consuming locally-grown products and making food supplements more widely available.

Spirulina presents major advantages in the fight against chronic malnutrition due to its micronutrient composition, its health potential and the fact that it can be grown locally.

3 Nutritional aspects of spirulina

This micro-organism, which is photosynthetic and reproduces rapidly, is called “spirulina” due to its spiral filament appearance under the microscope. Its scientific name is *Arthrospira platensis*.

Initially, the impressive protein content of spirulina attracted the attention of researchers and the industry. Afterwards, numerous particularly interesting properties were revealed on a nutritional level: balanced protein composition, presence of rare essential lipids as well as numerous minerals and vitamins.

Devoid of a cellulose wall, spirulina is easy to digest raw or dried (Figure 1). Numerous nutritional tests have proven the bioavailability of its micronutrients.



Figure 1. Spirulina flakes and powder.

- an exceptional *protein* content (60-70%, almost twice that of soy bean),
- *8 essential amino acids* that the body cannot synthesise: isoleucine (essential for growth), leucine (stimulates brain functions), lysine (required for antibody, enzyme and hormone production), methionine (rich in sulphur and anti-oxidant properties), phenylalanine (essential for the thyroid), threonine (improves intestinal and digestive function), tryptophane (serotonin regulator) and valine (natural mental and physical capacity stimulant).
- rich in *vitamins*: vitamin A= Beta carotene (one gram of spirulina covers the daily vitamin A requirements of an adult), B group vitamins (B1, B2, B3, B5, B6, B7, B8, B9, B12), vitamin D, vitamin E and vitamin K.
- the second source, after mother's milk, of *gamma-linolenic acid* (fatty acid precursor of mediators involved in anti-inflammatory and immune processes).
- contains at least fifteen pigments including *chlorophyll* and especially *phycocyanine* (anti-inflammatory, anti-oxidant, antitumoral, etc.).
- rich in minerals: iron, magnesium, phosphorous, potassium, calcium and selenium.

Due to this great wealth of nutrients that play key roles in the body, spirulina is often referred to as "top food" or "super food" and even "ideal food for the XXIst century" (FAO, 1984).

4 Spirulina's advantages

- Local, autonomous and sustainable solution: spirulina is produced and distributed locally thus creating revenue especially for the female population. Women are actually very interested in this food with exceptional nutritional qualities that they can grow themselves (Figure 2).
- Effective: 1 to 3 grams of spirulina per day for 4 to 6 weeks are enough to rehabilitate a malnourished child (see clinical trials performed by Antenna and the Medical College of Madurai in South India).
- Spirulina requires very little space relative to the amount of protein produced (15 times less than sugar cane, 20 times less than soy bean and 250 less than rice).
- Spirulina culture requires very little water (3 or 4 times less than soy bean, 5 times less than maize and 40 less than beef).



Figure 2. Spirulina harvest in India and Niger. © Antenna

- High yield (5 to 6 grams of dry product per day and per m^2).

Spirulina is grown and enjoyed in numerous countries in Africa (Mali, Burkina Faso, Niger, Mauritania, Senegal, Ivory Coast, Benin, Togo, Cameroon, CAR, DRC, Kenya, Malawi, South Africa, Madagascar, etc.), Asia (India, China, Thailand, Philippines, Cambodia, etc.), Europe (France, Spain, Italy, etc.) and America (United States, Mexico, Ecuador, Brazil, etc.). It has already received an official recognition in most of these countries.

Spirulina has been rated G.R.A.S. (Generally Recognized As Safe) by the United States Food and Drug Administration and China has declared it a national food.

5 New studies reveal therapeutic aspects

The genome of spirulina has been entirely sequenced and registered in July 2009 by Antenna Technologies, two private Swiss companies–Biorigin AS and Fasteris–and the Haute École Spécialisée Hepia of Geneva, represented by the Plants and Pathogens research group.

By registering the spirulina genome with GenBank, they chose to make it public and freely accessible to all potential users and thus prevented it from being patented. Any interested person can thus go faster and further in seeking the multiple potential uses of spirulina. Among

these, let us note nutritional applications, industrial ecology by carbon complexing or the production of molecules for therapeutic use.

Effective in the treatment of malnutrition, *spirulina also presents clinically significant anti-viral and immunostimulating effects in people infected by HIV.* Spirulina contains several molecules which have been studied for their biological activities.

A new study performed in Cameroon and published on the 2nd May 2011 in Nutrition and Metabolic Insights demonstrated the nutritional efficiency of spirulina in terms of weight gain in HIV-infected malnourished people. This study *also showed the recovery of immunity markers and the decrease in viral load* related to its additional therapeutic properties, especially interesting observations in this immuno-depressed patient profile. The authors concluded that this new study confirms the interest in "considering spirulina routinely for this type of patient".

Scientific studies on the nutritional and therapeutic advantages of spirulina are multiplying and support this expansion. However the recognition of the virtues of spirulina has been delayed and slows down its development in southern countries. Large-scale clinical tests are now required, but the means are absent due to a lack of political will. However, the accumulation of positive results over time, in addition to the increasing mass of accounts from health professionals, should lead decision-makers in the field of malnutrition to react. NGOs and health institutions have already been using it for many years to successfully treat tens of thousands of children. It would be important to have the support of opinion leaders, inter-governmental associations, major NGOs and journalists. To date only the FAO and some countries that have integrated spirulina in their national health and nutrition programmes, have recognised its potential.

Appendix 1
A new project in Togo carried out by Antenna Technologies and Entrepreneurs du Monde

In the framework of the improvement of food safety and economic development of Togo, a new project (carried out by Antenna Technologies and Entrepreneurs du Monde) proposes to increase the impact of spirulina on the nutritional situation of the region, through the extension of an existing spirulina production and distribution centre in Agou Nyogbo (120 km from Lomé), to create an autonomous, lasting and economically viable structure.

- Creation of a 500-m² spirulina farm which will produce 900 kg of spirulina products per year, 1/3 distributed for humanitarian purposes and 2/3 marketed.
- Creation of a distribution network for the promotion and distribution of spirulina, composed of women micro-entrepreneurs trained in sales techniques and nutrition, to make this product available to disadvantaged populations.

The budget of the 1st phase is of €66,000 and the search for funding is ongoing.

More information at: http://www.antenna-france.org/modules/libre.php?id=180

Appendix 2
Geneva Antenna Tehnologies Foundation

For over 20 years, the aim of the *Geneva Antenna Technologies Foundation* has been to reduce extreme poverty and public health problems in developing countries through technological and scientific innovation. Its main fields of action are malnutrition and access to drinking water, but also in a**griculture, medicine, energy and microcredit.**

Breaking news: in July 2011 the Antenna Foundation received the solidarity innovation award by the Fondation Georges Latécoère for its WATA technology, an electrolyser intended for locations where there is no drinking water. Almost 2,000 WATA are already being used in the world. Numerous humanitarian associations have acquired it (UNICEF, Red Cross, etc.), thus saving populations affected by cholera epidemics, child diarrhoea and other fatal water-borne diseases.

The spirulina production and distribution programmes in Africa and Asia are coordinated by the association Antenna Technologies France in collaboration with the Antenna Technologies Foundation.

Antenna's approach is to build spirulina production and distribution centres to fight against malnutrition (putting aside one third of the production for humanitarian use), while creating economically viable and sustainable activities (thanks to the commercial sales of two thirds of the production for the local or export markets).

Some figures for 2010:

- The growing surfaces reached 4.800 m², i.e. a 33% increase with respect to 2010.
- 4,2 tonnes of spirulina were produced, i.e. a 4% increase with respect to 2010.
- 16,750 children benefited of humanitarian aid.
- 74 direct jobs were created within the production farms.

More information on spirulina and the actions of Antenna Technologies at: www.antenna.ch and www.antenna-france.org

Appendix 3
Microfinance at the service of health

Extract from an article by Raphaëlle Birot, agricultural engineer, published in Rural 21 in January 2010.

In the region of Koudougou in Burkina Faso, microcredit and a highly nutritious algae, spirulina, have been associated to improve the health and income of the Burkinabè living in rural settings. The key to the success of the pilot project is the adaptation of a standard marketing methodology and field immersion with local actors. The objective today is to optimise the model to make it lasting and reproducible taking into account contextual differences.

Burkina Faso is the first spirulina producer in West Africa, but the plant is little known and it is not much consumed. The State and the Health Ministry have supported the construction of a large farm in Nayalgue near Koudougou, which made it possible to multiply national production three-fold. Unfortunately, neither the distribution networks nor the means of promotion were developed to match and consequently stocks are accumulating. This is is very hard to understand as we know that one Burkinabè child in five is malnourished.

Entrepreneurs du Monde wished to promote spirulina in poor rural populations in the Central region of the country. They were inspired by standard marketing methods and tools, adapting them to a development project context. The first step is that of a supply chain diagnosis and reveals a true need for rich food such as spirulina. The observation also reveals that malnutrition is caused by difficult access to quality food but also by a deficit in the nutritional education of the mothers.

Entrepreneurs du Monde associated itself with AsIEnA, a Burkinabè microfinance institution that works in rural settings with groups of women. They support them in their savings and credit activities but also in improving their revenue-generating activities and certain aspects of daily life (via training in hygiene, nutrition, etc.). Both structures created a plan of action to develop the sales networks and publicise spirulina and its nutritional usefulness. The "village sales network" consists in inviting one person per group to follow several one-day training sessions. They are introduced to spirulina, learn to manage a stock and win the loyalty of the customers, but they are also taught about nutrition so that they can tell clients about it. After her first training session the woman sells her first batch of spirulina sachets in her village and nearby markets. Once she has sold her stock, she reimburses her credit and can acquire new stock. The second network, called "social sales network", caters for the needs of the members of the microfinance groups. They can buy spirulina half-price and are taught about the importance of nutrition and the use of spirulina.

After two years of existence of the project, almost 225 kg of spirulina have been sold, i.e. more than 50 percent of the annual sales volume of the second farm of the country which has been in existence for over 10 years.[1]

The salespeople are proud of their jobs and the population listens to the nutritional advice. The consumers appreciate spirulina and tell of improved health.

Entrepreneurs du Monde and AsIEnA believe that creating new job opportunities locally and supporting the entrepreneurial spirit among the poorest families will reduce poverty.

With this aim, the "spirulina, microfinance and health" project has been replicated in other regions of Burkina Faso. Structures in Benin and Mali also wish to reproduce the experience, adapting it to their countries.

Since 1998, *Entrepreneurs du Monde* works in developing countries to help the poorest families to start or develop a small economic activity. This not-for-profit French association acts in the field through local partners.

In slums and isolated rural areas in developing countries, the poorest populations, often illiterate, do not find work in the formal sector. However, they are all driven by a strong wish to do something to improve the daily life for their families. Thus, with true entrepreneurial spirit, they suddenly open a small shop, man a fish-stall or start a sewing workshop, etc. They do not lack the courage or common-sense to create or develop these small activities, but miss the seed capital and the ability to diversify their sources of revenue. Furthermore, the hygiene and health conditions in which they live are often appalling and this encouraged Entrepreneurs du Monde to develop social business programmes that will have an economic, health and environmental impact for the beneficiaries and their communities.

Entrepreneurs du Monde supports these micro-entrepreneurs by offering them:

- Loans to develop a gainful activity,
- Savings to be able to deal with unforeseen expenses and guarantee their projects in the long term
- Simple training sessions to help them become independent,
- An individualised follow-up to reinforce the impact of its action on the family,
- A group dynamic to promote cohesion and mutual assistance,
- And in some programmes, access to micro-health insurance so that the costs do not reduce the capital and weaken the socio-economic progress accomplished.

Entrepreneurs du Monde acts in two ways:

- *As an incubator for microfinance programmes* with a strong social vocation: –it identifies and

[1] Updated date for the re-print of this article in FACTS

supports small local structures (cooperatives, associations, microfinance institutions), which share its social vision of microfinance, are located in slums or rural settings, wish to support micro-entrepreneurs more, and become permanent.

- *By creating or supporting supply chains* to promote, always through microcredit, products with a significant impact on a socio-economical and environmental level: spirulina, portable gas stoves or improved cookstoves, solar-powered lamps, etc.

A few figures to describe Entrepreneurs du Monde:

- 37 permanent staff
- 26 partners, including 20 microfinance institutions
- in 13 countries
- a budget of €3.8 million
- €6.7 million in outstanding loans

More information at: www.entrepreneursdumonde.org

Appendix 4
Spirulidaire–spirulina, as a link between producers and consumers in different countries

In France there are different projects to support spirulina producers, as well as programmes to fight malnutrition in southern countries. This is the case of Spirulidaire, which markets a *traditional, fair trade and supportive* spirulina.

In order to sell such spirulina in France and Europe, Spirulidaire principally turns to farms where the activity is penalised by the presence of overstocks while at the same time the local population would benefit from consuming spirulina to improve its nutrition. The three main obstacles to this consumption are generally the price, the ignorance concerning spirulina and the lack of a distribution network. Social misconceptions are added to these problems; for instance, in India, it is considered more meaningful to take medicines than to preserve health through natural food.

To help spirulina be more widely promoted and consumed, Spirulidaire undertakes first to purchase a minimum annual volume at a fair price set with the producers. The farm then agrees to provide quality spirulina produced under satisfactory social and environmental conditions. The farms selected to date are the following:

- the *Petit Séminaire farm* which has been producing spirulina for over ten years in *Burkina Faso*. It has developed true *know-how in traditional production procedures* that guarantee *the spirulina has a mild taste*. http://www.spirulineburkina.org/
- the *Gandhi Rural Rehabilitation Center* (GRRC) farm, created in 1983 in India by three disabled workers who wished to *escape poverty by working with their hands*. Along with the production of fabrics and market gardening, the production and consumption of spirulina ensures the health and *fulfilment of the employees* and their families. http://grrc.org.in/
- the *Mopti farm in Mali*, founded in 2007 by the association Au Fil de la Vie supported by Antenna Technologies. The farm is currently autonomous with 600 m² of production ponds. The growing techniques have almost been mastered, although there is still room for improvement to attain optimum productivity. The spirulina has been subjected to several analyses and is of very high quality. However, the *farm has difficulty in selling its production* and has reduced its growing surface to develop distribution programmes;
- the *Sidi Bibi farm in Morocco*, founded in 2009 by two young Frenchmen, whose main goal is to *produce a very high quality spirulina while creating local jobs*. Spirulidaire works with them for a *greater local integration of their enterprise and a humanitarian distribution* of part of their production.

These farms' *methods* produce spirulina with a pleasant taste. This is an important characteristic for its introduction to and appreciation by French consumers. Those who must eat it for health reasons are particularly grateful.

The activity of Spirulidaire comes under *fair trade* objectives. "Our relationship is based on the distribution and mutual sharing of experience and know-how," says Denise, manager of the Petit Séminaire farm.

Beyond the fair price and the purchase of only part of the production, Spirulidaire has exchanges with the producers on technical points. In particular, this concerns analyses and the search for scientific information to *overcome production difficulties*. Furthermore, Spirulidaire has links with the company HyES which develops a *biological nutrient production model for growing spirulina*. This research and development programme is based at the *Ecodomaine du Bouquetot in Normandy*. The results of this research will be shared with producers in the South, whose production will then be independent.

Finally, spirulina sales in France are opportunities to raise *customer awareness of responsible buying with respect to the producers and poor populations of producing nations*. A French buyer will therefore buy Spirulidaire because it is good for him/her, for the producer and because it helps to make spirulina more accessible to those who need it.

More information at www.spirulidaire.org or www.hyes.eu

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