

Spirulina under the microscope

Spirulina is an organism with a nuclear structure but no membrane, belonging to the prokaryote group of blue-green algae known as Cyanophyceae. Classic taxonomic criteria show the difficulty in characterizing *Spirulina* species because of its extremely high morphological adaptability to different environments.

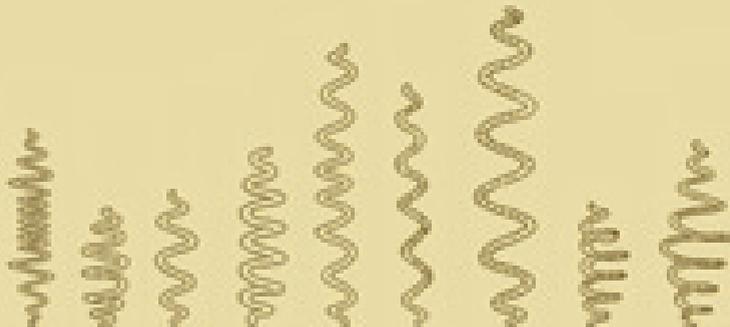
Cellular division is not mitotic. The usual organic tissues of the protoplasm are absent, yet it is considered an alga by many authors because it contains chlorophyll, like all green plants. The chlorophyll is located in the cytoplasm itself rather than in a chloroplast, and is stored in ultramicroscopic platelets that bear the complex chlorophyll pigment and carry out primary photosynthesis.

The size of the cyanobacterium cell is between 1 and 10 microns. Its wall is classic gram-negative. The granules contained in the membranes are called “phycobilisomes” and contain an essential pigment that transports energy to the PS-II, the phycocyanin that is a protein belonging to the prosthetic group. Under the microscope, it appears as a mass of intertwined unicellular spiral filaments, or trichomes, each of variable length (typically 100–200 microns) and with a diameter close to 8–10 microns. It grows and develops quickly, by cellular division, budding or even random fragmentation, in stagnant brackish and alkaline warm waters, where it forms a blue-green slime. Because of its intertwined filaments, it can be harvested and strained on the spot^[95].



LAKE OF BOUDOU ANDJA (DUM DUM), CHAD

DIHÉ NEEDS STAGNANT BRACKISH AND ALKALINE WARM WATER, ABUNDANT SUNSHINE AND A DAYTIME TEMPERATURE OF 35–37°C



SPIRULINA IS COMPOSED OF INTERTWINED UNICELLULAR SPIRAL FILAMENTS



LAKE OF BOUDDOU ANDJA (DUM DUM), CHAD





LAKE OF BOUDDOU ANDJA (DUM DUMI), CHAD

DIHÉ IS ALWAYS COLLECTED BY GROUPS OF WOMEN



LAKE OF BOUDDOU ANDJA (DUM DUMI), CHAD

DIHÉ HARVESTING REQUIRES SKILLS THAT HAVE BEEN PASSED DOWN FROM MOTHERS TO DAUGHTERS FOR GENERATIONS

TRADITIONAL HARVESTING

Dihé is traditionally harvested by women. By local standards, this is a lucrative activity, although for only a few months each year. It has been calculated that, in the Kanem region, an expert female harvester – and this is a skilled job – can produce about two *coreaux*, or 3.2 kg, per day. A study for SODELAC in 2000, which examined 21 sites in the departments of Kanem, projected that, based on the current number of women actively involved in production and the average time taken for harvesting, total production at these sites alone could be around 250 tonnes a year^[9.5].

WOMEN'S WORK

The harvesting of *dihé* requires skill and expertise, and the technique, which has been passed down from mother to daughter, represents the culmination of years of experience. It is a seasonal activity, taking place at the end of the rains. As the time approaches, tools and equipment are prepared, ready for the hard work that lies ahead. When the rains stop, the pools and wadis that have a crop worth harvesting are identified. This is very much a group activity and, when the time is right, the leader gives the order for work to begin. The women wade into the wadis or pools, their legs and arms bare, and stir up the muddy waters, taking care to eliminate as many impurities as possible, such as leaves, twigs, insects and sometimes animal dung, in the process.

First, the alga is scooped out and strained through a dum palm basket. If the concentration of alga is low, the women use a finer mesh for the initial phase of the harvest, which in turn accelerates the drying process. If the concentration is extremely low, it is not harvested at all, but is left to grow and develop for the following season. Next, a sand-filter basin is made ready and the concentrated solution is transferred there. After 10–20 minutes, the suspension, now in a more solid form, is sliced into squares or rectangles. The dried shapes are lifted out for more drying on frames, where they are left for five to six days in the sun. Once this process is completed, the sand is cleaned off the slabs. The final phase involves packing the slabs into sacks ready for the market.



A FILTER BASIN IS MADE IN THE FINEST AVAILABLE SAND



THE CONCENTRATED SOLUTION OF *DIHÉ* IS GENTLY POURED INTO A BOWL IN THE CENTRE OF THE SAND FILTER UNTIL IT OVERFLOWS

LAKE OF SURU (DUM DUM), CHAD

LAKE OF SURU (DUM DUM), CHAD



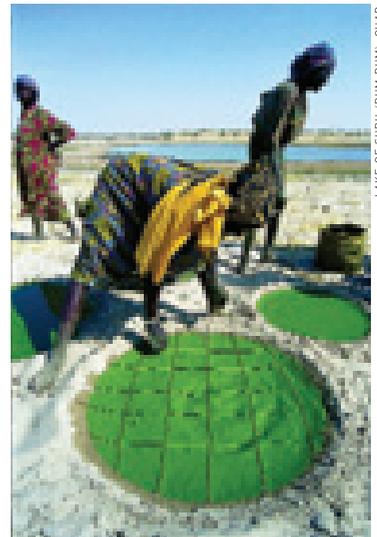
LAKE OF SURU (DUM DUM), CHAD

THE BOWL PREVENTS ANY DAMAGE TO THE SAND FILTER. ONCE THE SOLUTION HAS BEEN POURED, IMPURITIES SUCH AS LEAVES AND INSECTS ARE REMOVED



LAKE OF SURU (DUM DUM), CHAD

BEFORE THE SOLUTION SOLIDIFIES, IT IS SPREAD TO FORM A CAKE ABOUT 4-5 CM THICK



LAKE OF SURU (DUM DUM), CHAD

AFTER ABOUT 20 MINUTES THE CAKE IS SLICED INTO SQUARES



LOCAL PEOPLE AND CHILDREN SUPPLEMENT THEIR POOR DIETS WITH *DIHÉ* SAUCE, WHICH HAS A VERY HIGH PROTEIN CONTENT

COMPOSITION

Spirulina is very high in protein, very low in calories and cholesterol, and high in enzymes, minerals (iron, calcium, sodium and magnesium), and phenolic acids, which have antioxidant properties (see Table 25).



TABLE 25 **CHEMICAL COMPOSITION OF SPIRULINA***

Content	Amount
Proteins	6.5 g
Betacarotene	14 mg
Vitamin C	2 mg
Thiamin (B1)	0.37 mg
Riboflavin(B2)	0.46 mg
Niacin	1.3 mg
Calcium	150 mg
Iron	18 mg
Vitamin E	0.4 mg
Vitamin B 6	0.07 mg
Vitamin B 12	0.02 mg
Phosphorus	67 mg
Magnesium	32 mg
Copper	0.1 mg
Phycocyanin	1 500 mg
Gamma-linoleic acid	100 mg
Chlorophyll	110 mg

* for 10 g dry weight

Source: SODELAC, 2000^[9,5]

USES

Human consumption

The benefits of *Spirulina* as a low-calorie, high-protein, mineral and vitamin food supplement are now well established and recognized worldwide. Studies have shown that *spirulina* can lower cholesterol levels, stimulate the immune system and be effective in the treatment of obesity, heart disease, premenstrual stress, arthritis, anaemia and osteoporosis. *Spirulina* is also a rich source of betacarotene, a natural antioxidant, which the body converts to vitamin A and which plays a protective role in the human organism. Recent studies have concluded that a diet rich in vitamin A

and provitamin A can lower the risk of cancer. Betacarotene is considered a more effective antioxidant than synthetic *trans* betacarotene. Positive results have also been seen in performance and stamina levels when *Spirulina* is taken as a sports supplement; the blue-green alga has a high level of biotin, which is an inhibitor of lactic acid in muscles.

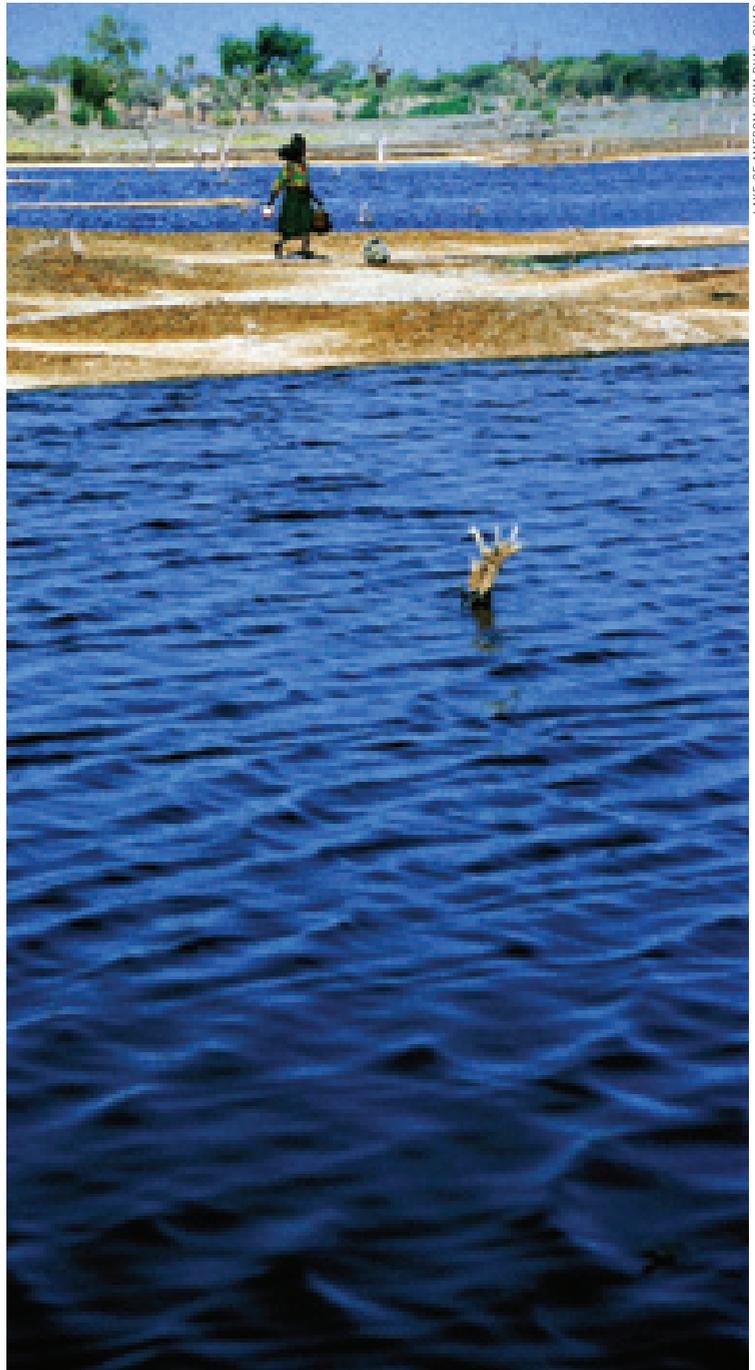
Extracts

As well as being marketed in the form of tablets or capsules, *Spirulina* is used as an additive in pasta, drinks, cakes and a number of dietary products. *Spirulina* produces phycocyanin, a naturally blue-coloured protein complex used as food colouring in pastry, ice creams and drinks. It is also used as a fluorescent marker in immunology.

Tests in Belgium (*Laboratoire de photobiologie* and *Laboratoire de biotechnologie algale*) have demonstrated that *Spirulina* has healing, antiseptic and antibiotic properties, as well as the power to enhance cell regeneration. *Spirulina* extracts are used in a range of cosmetics, skin creams, anti-acne treatments, dermatological shampoos, skin cleansers and make-up removers. A special cream is produced for veterinary medicine to heal wounds in horses.

Animal feed

Spirulina is used to feed ornamental carp and, in aquaculture, shrimps, mussels, trout and salmon. It enhances the colour of egg yolks and chicken meat, and is also widely used as a food additive for birds to brighten the colour of their feathers. It is fed to horses and cattle in order to foster growth and muscle tone and to improve the condition of pregnant females.



LAKE OF AMEROM (DUM DUM), CHAD

FOOD SECURITY AND MARKET EXPANSION

Given its high content of protein, vitamins and minerals, and its high digestibility, *dihé* represents an important source of food for children and adults in one of the world's poorest regions, where malnutrition is common. As such, *dihé* offers considerable potential in terms of food security for local communities. It also holds out hope as a source of income, especially for the women who traditionally harvest it and who are among the most neglected members of society.

At present, production levels in the Lake Chad Basin are not well known since a large proportion is produced for domestic consumption and is therefore difficult to

measure. According to different sources, production could be around 250 tonnes per year (this figure is approximately 10 percent of total world production). Just a small fraction is sold and exported to neighbouring countries. However, estimates show that, in the Kanem department of Chad alone, the average consumption of *dihé* could be as high as 50 g per person per week. On that basis, even the local market has the potential to absorb 1 400 tonnes per year – seven times the current production levels.

Locally, the market price of *dihé* ranges between \$0.80 and \$2 per kg, which is very low compared to the wholesale factory prices in industrialized countries of \$25 per kg and retail prices generally between five and ten times the wholesale figure.

It would be advisable to promote a development strategy based upon the following.

- Introduction of sieves and other simple technologies to reduce the amount of residual sand in the desiccated product.
- Dissemination of information on the nutritional qualities of *dihé* on local and regional markets (*dihé* is still considered “food for the poor”).
- Training of local women and promotion of women's associations.
- Access to microcredits.
- Testing of new forms of packaging and local uses, including the feeding of animals and fish.

AMEROM VILLAGE (DUM DUMI), CHAD



DIHÉ REPRESENTS AN IMPORTANT FOOD SOURCE IN ONE OF THE WORLD'S POOREST REGIONS AND ITS DEVELOPMENT THEREFORE DESERVES INTERNATIONAL SUPPORT



BOUDDI ANDJA VILLAGE (DUM DUM), CHAD

DIHÉ BISCUITS ARE SUN DRIED ON HOUSE ROOFS BEFORE BEING CONSUMED OR TRADED



ESSEROM VILLAGE (DUM DUM), CHAD

THE LOCAL MARKET HAS THE POTENTIAL TO ABSORB 1 400 TONNES OF PRODUCT EACH YEAR

The green gold

10 March 2002
Chocram, Chad

We arrive in the vicinity of the wadi of Suru at 8 a.m. after getting stuck twice in the sand, having a flat tyre, and enduring two hours of sandy track, which put a severe strain on our excellent driver, Jacob. But we arrive just in time to meet the women of the village of Chocram as they go, in small groups, to gather blue-green alga (*dihé*). On their heads they carry large and small enamelled basins as well as bags woven from dum palm leaves. They have no other work implements.

The day before we had paid a visit to the *Chef du canton*, Mai Alhaji M'Bodey, an old man still surprisingly full of energy and lucidity of mind. He had received us with the customary hospitality, and had answered our questions at length.

"Since time immemorial the women of the villages around here have gathered what you call "blue-green alga"; for us it is *dihé*, for others it is "green gold". In this season, every morning the

women, organized by a leader, leave in groups before the wind rises. They will return before the noon sun, loaded with *dihé* water biscuits, which had been left to dry at the gathering place the day before. You can find great quantities of these *dihé* water biscuits in our Amerom market, even in bags, but only the merchants of Mao, *Mao la blanche*, just 25 km from here, buy them wholesale. Further away, in N'Djamena, it is already difficult to find them, because not everyone has this custom of eating *dihé*. Only we Kanembu love it and know its secrets ..."

"My father's father, in the last years of his very long life, lived almost exclusively on *dihé*. He didn't even mix it with other food anymore; he only took water and *dihé*, after carefully letting the sand settle to the bottom of his bowl. He used to say that it gave him great energy, and that every day he saw the hour of his death move further away... We think he was more than a hundred years old ..."

"We have no doubt that this blue-green alga is good for the body. Our pregnant women eat it every day and feed it to the youngest children as well. Normally we eat it two or three times a week, cooked slowly in *gombo* sauce with the usual spices, to accompany rice and millet. It's the remedy for all ills."

11 March 2002
Amerom, Chad

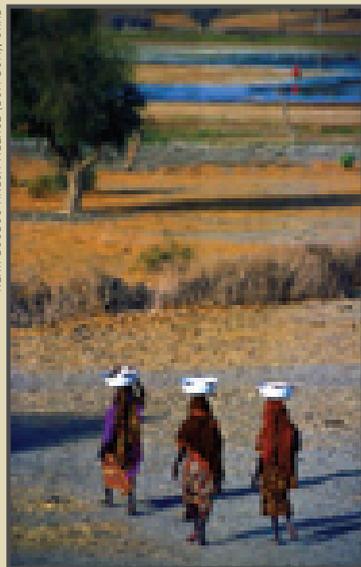
At 8 a.m. we are on the shores of the Boudou Andja wadi. About 20 women are busy in the shallow water of the lake with basins and all kinds of containers. With rapid and precise movements, they are trying to gather the largest possible amount of blue-green alga before the wind rises; the wind would make their work impossible.

When the job is done, Madame Harita Cierom, the *Chef des femmes*, stops to talk with us. She is a very assertive young woman, who asks us for very concrete things, items that are necessary and useful for all the women.

"You have come from far away. We do not know you but we know that you have come with an open heart. That is why we ask you to help us. We need sturdy clothes because our skirts are burned by the salty water, we need gloves because the salt eats away our skin, and we need rubber boots because the flesh of our feet is dry and cracked. If we were given a small credit, we could unite in a *regroupement* and be independent, and we would not have to ask anybody for anything. But now, as *Chef des femmes*, now I ask you not to forget us after you leave."



NEAR BOUDOU ANDJA VILLAGE (DUM DUM), CHAD



WOMEN MUST COLLECT *DIHÉ* EARLY IN THE MORNING BEFORE THE RISING OF STRONG WINDS

>> RIGHT: *CHEF DES FEMMES* MADAME HARITA CIEROM SAYS: "WE NEED TRAINING AND SUPPORT FOR OUR WOMEN'S ASSOCIATION" NEAR LAKE OF BOUDOU ANDJA (DUM DUM), CHAD

