

# Spirulina farming

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[https://wiki.lowtechlab.org/wiki/Culture\\_de\\_la\\_spiruline/en](https://wiki.lowtechlab.org/wiki/Culture_de_la_spiruline/en)

Dernière modification le 26/03/2021

 Difficulté **Moyen**

 Durée **6 mois**

 Coût **80 EUR (€)**

## Description

Domestic cultivation of a highly nutritious micro-algae

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# Introduction

Spirulina is a micro-algae, more precisely a spiral cyanobacterium of about ¼ millimetres. It has thrived in hot, desert regions for more than three billion years. At the origin of plant and animal life, Spirulina has largely contributed to the creation of the earth's atmosphere by producing oxygen from carbon dioxide. If it is of particular interest to us today it is because it is also a super-food. Spirulina's rich constitution is due to the fact that its cell wall is made of protein. On the other hand, in the plant world, the cells have a cellulose wall, which is difficult to digest. Spirulina also has a high concentration of vitamins and iron. This ideal composition and its ease of assimilation make spirulina a food supplement coveted by great athletes. But Spirulina is sold expensive while it is simple and quick to grow. Its yield is very good: on the same space Spirulina produces five hundred times more protein than a cattle breeding. In the same way it takes about 13,500 litres of water to produce one kg of bovine proteins whereas only 2,500 litres are needed for micro-algae. Numerous associations and NGOs (Univers la Vie, Antenna, etc) cultivate it to fight against famine and malnutrition in the world. It exists in its natural state around the tropical belt (Peru, Mexico, Chad, Ethiopia, Madagascar, India...) and even in France, in the Camargue. The family culture makes it possible to integrate spirulina into its daily diet. The French Spirulina Federation recommends a consumption of fifty grams of fresh spirulina per day, or about 10 grams of dry spirulina. In this objective of local production, it is necessary to have 1m<sup>2</sup> of cultivation basin per person.

## Preliminary information

### *The growing medium*

Spirulina lives naturally in volcanic lakes, rich in salt and bicarbonate of soda, with a high PH, close to 10. This is its environment but not its food, as fish do not feed on sea salt. In the culture of spirulina, the objective is to recreate as close as possible the native environment of spirulina. In its natural state, Spirulina is rarely taken except by pickers and flamingos. In pond the harvests are much heavier, it is thus necessary to regularly bring food to the culture to allow its renewal. In the culture of spirulina, it is thus necessary to dissociate the culture environment from the living environment and the food:

culture medium = living environment + food

### *The development environment.*

Spirulina lives naturally in warm climates. When the temperature of its living environment is below 18°C, it hibernates. From 20°C it starts to develop. From 30°C its production intensifies strongly. At 37°C, the optimal temperature of the environment, the population increases by a quarter every eight hours. Above 42°C, spirulina dies. In France, outdoor cultivation, with a translucent cap, is possible from mid-April. The deep green colour of spirulina is obtained by photosynthesis. For this, spirulina needs a strong luminosity but not a long exposure to the sun. It is important to shake the pool to prevent the spirulina on the surface from burning and to allow the deep ones to benefit from the light. The culture must be 20cm deep maximum so that all the spirulina can benefit from good sunlight.

### *The concentration*

One of the health indicators of spirulina is its concentration. To measure it there is a very simple instrument: the Spirumeter or Secchi disk. It is a white disc at the end of an axis graduated in centimetres. The concentration of spirulina is measured by dipping the disc into the culture solution. When the disc disappears, the graduation on the surface is read, the Secchi concentration index. The lower the index, the more concentrated the spirulina is. For a healthy spirulina, the concentration should be between 2 and 4. At 2 it is very concentrated, it can be harvested. At 4 it is at its minimum cultivation concentration, for example after a harvest.

This tutorial is produced in collaboration with Gilles Planchon, a specialist in the domestic culture of spirulina, trainer and researcher on the natural living environments of microalgae.

Find here the video tuto and the construction of a basin of family culture.



## Matériaux

### Spirumeter.

- White plastic cap
- Screws
- Wooden or plastic rod or ruler

### Medium of culture.

- Drinking water
- Sea salt
- Bicarbonate of soda

### Mineral Food

- Potassium Nitrate
- Monoammonium phosphate
- Iron Sulfate
- Potassium Sulfate (optional)
- Magnesium sulfate (optional)

or

- Pre-weighed food for sale N50 and N250

### Natural food

- White vinegar
  - 100g rusty nails
  - 5 to 10 lemons or citric acid
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## Outils

### Spirumeter

- Rule
- Screwdriver

### Medium of culture

- Tray of 200L or more

### Mineral Food


- Food canister (>10 liters)
- Balance

### Natural food

- 2 bottles of one liter
- Balance

### Seeding, cultivation and maintenance

- Garden hoses
- Strainer
- Aquarium pump (500 to 1000 liters/hour)
- Cans of different volumes (from 20 to 200 liters for example)
- Measuring glass
- Balance

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## Étape 1 - Building a Spirumeter or Disc of Secchi

- Screw a white plastic cap at the end of a ruler or a plastic or wooden rod of about 20 centimeters,
- Scale the stem from 0 to about ten centimeters, with the 0 at the level of the cap.



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## Étape 2 - Preparing the culture environment: the living medium

- Fill a large volume canister (100 to 200L) with water, ideally from a rainfall or a low calcareous source.
- Add the baking soda at a rate of 1kg/100liters of water.
- Add the sea salt at a rate of 500g/100litres of water.
- Shake well to dissolve them
- Transfer the volume of the canister into the culture basin with a pump (aquarium type or natural siphon). Repeat the operation until the tank is full.
- Make a mark 20 cm from the bottom to see if the water evaporates and top up with water if necessary.

**WARNING** *If tap water: Shake (pump or bubbler) during ½ day: the chlorine in the water evaporates and the limestone precipitates with the bicarbonate of soda, when the living medium is transferred to the pool, the limestone remains at the bottom of the canister. If rainwater: filter*

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## Étape 3 - Preparing the culture medium: food

The rich composition of spirulina comes from its diet, it is mainly composed of nitrogen, phosphorus, potassium, magnesium and iron. The food used in the family culture can be of mineral or natural origin. Mineral fertilizers obtained by chemical synthesis or by the exploitation of natural deposits are less ecological than natural food produced locally. Both preparations are presented.

**Mineral Food** The components of this preparation are agricultural fertilizers, they must be water-soluble. They can be found in agricultural cooperatives or garden stores. For about 10 litres of food (*Milieu LIB from the book La Spiruline pour Tous - Culture Familiale*):

- Put 10 liters of water in a bucket
- Add 1kg of Potassium Nitrate
- Add 100g of Monoammonium Phosphate
- Add 10g of Iron Sulphate
- Add 50 g of Potassium Sulphate (optional)
- Add 50g of Magnesium Sulphate (optional)
- Shake well until all components are diluted.
- Transfer to a closed container
- Label and keep away from the sun.

Or

- Pre-weighed food for sale N50 and N250

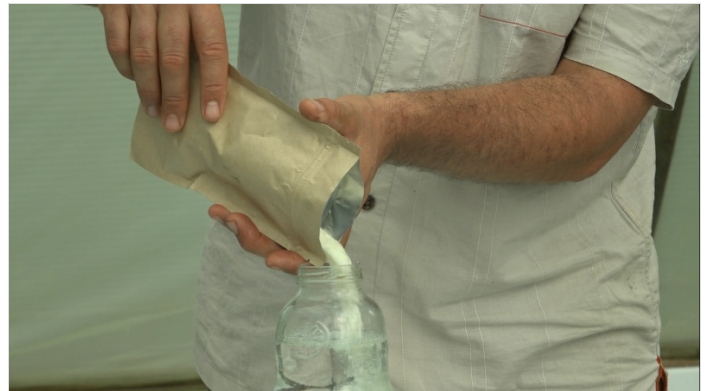
**Natural food** The components of the mineral food are found in ideal proportions in the urine [1]. By adding a solution of iron oxide or "juice of rusty nails" spirulina benefits from a local and organic food ideal for its productivity and resistance. The high pH and salinity of the culture medium reduces the risk of contamination. However, only "organic" urine should be used, from people with a healthy diet (non-smokers, without medication or contraceptives). Human urine is now widely used in agriculture and many studies exist on the subject [2]. For 1 litre of urine-based food:

- Put 10cl of white vinegar in a 1 litre bottle. It eliminates odours, eliminates bacteria and preserves ammonia.
- Complete with healthy urine
- Label and keep away from the sun.

Jus de clous rouillés : pour 1litre de jus de clou

- Mettre 100g de clous dans une bouteille. (Idéalement des clous déjà rouillés, ils indiquent une composition uniquement ferreuse et non d'autres alliages)
- Ajouter un litre de vinaigre blanc
- Ajouter le jus de 5 à 10 citrons ou une cuillère à soupe d'acide citrique
- Attendre 10 jours (durée nécessaire à obtenir la concentration adéquate en oxyde de fer)
- Filtrer le jus, étiqueter et conserver à l'abri du soleil
- Mettre les clous de côté pour une prochaine utilisation

**WARNING** Prepare the iron solution at least 10 days before the starting date of spirulina culture. If you leave the nails more than 10 days in the solution, the iron oxide concentration will rise. It will be necessary to dilute the juice with water.



## Étape 4 - Preparing the culture medium: food dosing

The basin was filled with the living environment in the previous stage. Now it is time to bring in the food:

- Mineral: 2 liters/100liters of medium

Or

- Organic: 1 litre of urine + 200ml of Iron solution/100 litres of culture medium



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## Étape 5 - Cultivation: acquisition

The culture medium is ready to welcome spirulina, you just have to get some. It is possible to get spirulina from anyone who has a family culture. It is also possible to contact a producer near you to know if he can supply fresh or concentrated spirulina (Gilles Planchon can make shipments to France). One kilogram of fresh pressed spirulina normally costs around 50€.

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## Étape 6 - Cultivation: quick sowing with freshly pressed spirulina

With freshly pressed spirulina, cultivation can begin as early as the harvesting phase, for this purpose a large quantity of unwashed spirulina must be introduced directly into the basin. It can be kept for 3 to 5 days in a refrigerator. It takes about 500g of freshly pressed spirulina to seed a 500 litre basin. A concentration of about 4cm will be obtained with a spirum meter. The first harvest will be possible one week later.

- Dissolve the freshly pressed spirulina in a small volume of culture solution (around 30l) first by hand and then with a strainer to break up lumps.

**WARNING** *Foam indicates an increase in protein so spirulina that breaks: let it rest and shake more gently.*

- Gently transfer the concentrated spirulina into the basin, preferably in the evening. The contents of the canister can be gently poured directly into the pond or you can use an aquarium pump or a natural siphon.
- Check the concentration and add culture medium if it is higher than 3 %.
- Ensure good agitation during the first 4 days (but not at night)
- Shade the pool for the first few days

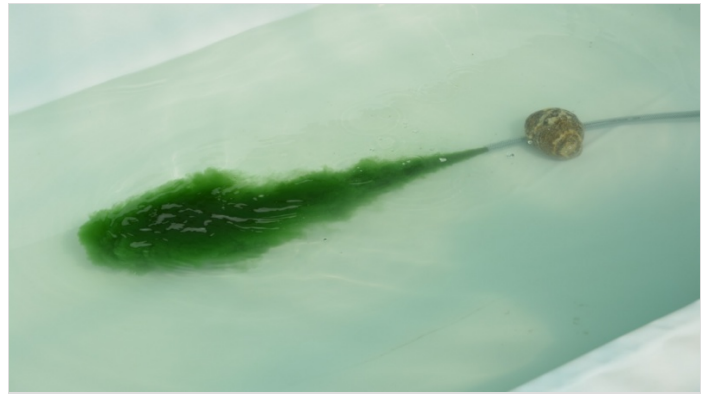




## Étape 7 - Cultivation: rapid sowing with concentrated spirulina

It is possible to seed his pond with concentrated spirulina. Unlike pressed spirulina, spirulina has not been separated from its living environment. It has a very high concentration, it must be quickly transferred to its new growing basin. It should not remain more than 12 hours in transfer.

- Gently transfer the concentrated spirulina into the basin, preferably in the evening. It is possible to pour the contents of the canister directly into the pond gently or to use an aquarium pump or a natural siphon.
- Check the concentration and add culture medium if it is higher than 3 %.
- Ensure good agitation during the first 4 days (but not at night)
- Shade the pool for the first few days



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## Étape 8 - Cultivation: growth phase

It is also possible to start the spirulina culture with a smaller volume and grow it to the final volume of the basin. Under ideal conditions, it takes 30 days to go from one litre of culture to 500 litres. The growth phase is more economical because very little spirulina is needed at the beginning. The growing phase can start indoors from the beginning of April.

- Get fresh or concentrated spirulina (see steps above).
- Dilute it with culture medium to obtain a concentration of 3 to 4 on the Secchi disc (For 100 litres of culture solution you need 2 litres of mineral feed or 1 litre of urine and 200ml of iron solution).
- When the concentration approaches 2, increase the culture volume by 1/4. Change container if necessary.
- Repeat the above two steps until a volume equivalent to 10 cm in height is obtained in the final basin, transfer to the basin. Under ideal conditions, the increase in culture volume can be done daily.
- Continue to add culture medium until the final culture volume of 20 cm is reached.
- Make a mark at 20 cm from the bottom to see if the water evaporates and top up with water if necessary.



## Étape 9 - Growing spirulina: Agitation

Spirulina needs a lot of light but should not be left in direct sunlight for long periods of time. For this, it makes the growing medium stir regularly during the day. The simplest solution is to use an aquarium pump, which can be found in pet shops. An ideal pump should be able to move the volume of the pond in one hour. In our case, the pump has a flow rate of 1000l/hour for a 500 litre pond.

- Install the pump underwater, as close to the surface as possible to allow good mixing.
- Install a timer to not stress the spirulina too much: alternate 15 minutes of agitation for 30 minutes of agitation rest.
- Turn off the pump at night for the breathing phase of spirulina

**TIP** For small volumes, stirring can be done by hand, with a strainer, at least four times a day.



## Étape 10 - Growing spirulina: concentration

Check the concentration of spirulina regularly, ideally once a day.

- If the concentration of Spirulina exceeds Secchi 2 the PH becomes too high and Spirulina may die: harvest
- If the concentration of Spirulina falls below Secchi 4, the culture medium is too bright: shade.

## Étape 11 - Growing spirulina: Evaporation

With the heat of the pond, the water evaporates but the food, salt and baking soda remain in the pond.

- Add water regularly to return to the initial volume, indicated by a marker 20cm from the bottom.

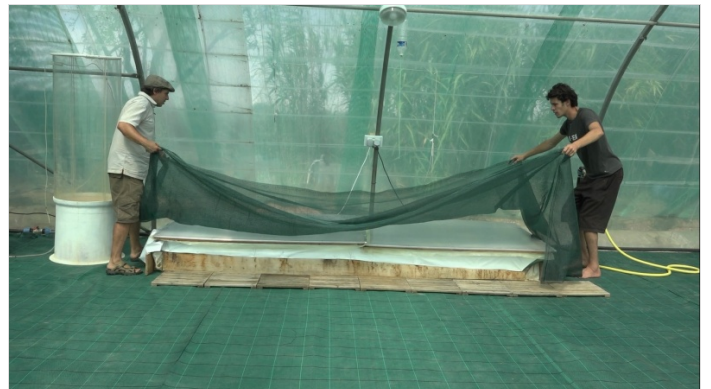
**REMINDER** Tap water can be calcareous, it must be softened or use rainwater or osmosis water (see *Preparing the culture medium: the living environment*).

## Étape 12 - Growing spirulina: Shade

Spirulina needs a lot of light but not direct exposure to strong sunlight.

- Adjust the shade according to the seasons, brightness and temperature.

**WARNING** If the spirulina is exposed to strong luminosity while the culture medium is at low temperature, for example at the end of winter, there is a risk of photolysis (the spirulina breaks and dies). Shade the pond when the culture medium is cool.



## Étape 13 - Growing spirulina: Purging

Over time the basin becomes loaded with organic matter (dead spirulina, other algae...). In order to keep a healthy growing environment, it is necessary to replace  $\frac{1}{4}$  once or twice a year:

- Collect the spirulina above a tank and not above the growing tank. Thus the culture medium does not return to the pond.
- Make a new growing medium as seen in the 'growth phase' part and add it to the pond.
- Get rid of the old growing medium (undiluted it can be used as a weed killer, diluted to 10% it enriches the compost, otherwise put it in the drain).

## Étape 14 - Growing spirulina: Wintering

When the outside temperature becomes too low for the crop (pond temperature below 18°C), the crop must be overwintered.

- Insulate the basin from the outside (cardboard, straw, etc.)
- Cover the pool so that the light is low. Spirulina must not be in total darkness or it dies.

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## Étape 15 - Growing spirulina: Conservation

When you buy spirulina or for winter storage, you can put part of it, pressed but not washed, in the refrigerator. It can be put back into culture by following the rapid sowing phase.

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## Étape 16 - Harvest

- Check the concentration of spirulina, if the Secchi is higher than 2.5 (if the Secchi disc is no longer visible from 2.5 cm or less), harvesting is possible.

**TIP** *Harvesting is more efficient in the morning. As long as the basin has not been agitated, the spirulina is in patches on the surface of the basin* **TIP**.

### Harvest

- Install a support (frame, sieve) above the growing basin
- Place a 30micron nylon fabric in the holder to act as a filter.
- Pump the culture medium (or use a pitcher) and pass it through the filter, the culture medium returns to the basin, the spirulina remains in the filter. Harvest as much as possible  $\frac{1}{4}$  from the pond.

**TIP** With a 1000/hour pump and a 500-litre tank, you can filter up to 125 litres, i.e. about 8 minutes of pumping time.

**WARNING** *Check the concentration during the harvesting phase, shake the basin and take a jug, the concentration must remain above 4. If the concentration is lower, stop harvesting and shade.*

- Collect the spirulina in the centre of the filter

**WARNING** Once the spirulina is harvested, avoid touching it by hand, its culture medium (high concentration of salt and baking soda) protected it from bacterial aggression.

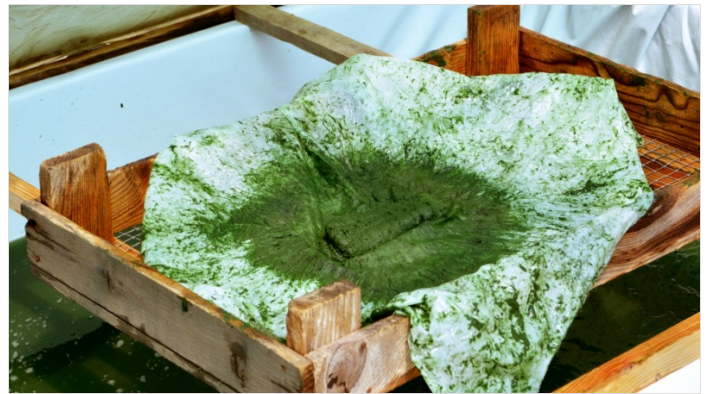
- Press the spirulina by hand by rotating the nylon fabric and pressing on the biomass. The pressing must be progressive. Maintain pressure until the escaping liquid turns slightly green/
- Put the spirulina in the fridge
- Rinse the material (nylon, frame, sieve) over the basin to compensate for evaporation.
- Weigh the pressed spirulina
- Compensate in food in relation to the harvested spirulina so that it can grow again and return to the maximum concentration for a new harvest :
- Mineral food: 200 ml per 100 grams of freshly pressed spirulina

"or

- Organic food: 200 ml of urine + 10ml of iron solution for 100 grams of fresh pressed spirulina
- For a good distribution of food, shake the basin by hand with a strainer.

**WARNING** *Spirulina breathes at night, it should not be fed in the evening. Favour harvests in the morning.*





## Étape 17 - Contenu pédagogique à télécharger

Vous pouvez télécharger une fiche pédagogique créée par le Low-tech Lab à l'occasion de l'exposition "En Quête d'un Habitat Durable" dans la partie "Fichiers" du tutoriel (onglet au niveau de la section "Outils-Matériaux")

**LA SPIRULINE**  
PRODUCTION ALIMENTAIRE

**SUPER ALIMENT, LA SPIRULINE EST À LA FOIS RICHE EN PROTÉINES, EN VITAMINES ET EN FER. LA CULTURE FAMILIALE PERMET D'INTÉGRER CETTE MICRO-ALGUE À SON ALIMENTATION QUOTIDIENNE.**

**Un micro-algue de 2 milliards d'années**  
La spiruline est un micro-algue, c'est-à-dire un organisme unicellulaire qui a existé sur Terre il y a plus de 2 milliards d'années. Elle est capable de produire sa propre nourriture à partir de lumière et de CO2.

**Cultiver la spiruline**  
La spiruline est cultivée dans des bassins ouverts, sous une lumière naturelle ou artificielle. Elle se développe très rapidement et peut être récoltée après seulement quelques jours.

**Indicé à 3 milliards**  
La spiruline est un super aliment riche en protéines, en vitamines et en fer. Elle est facile à digérer et peut être consommée par tous, y compris les personnes souffrant de problèmes de santé.

**DEPUIS VINGT ANS, MIEUX PARTIR FAIR LE DÉVELOPPEMENT DE CULTURES DE SPIRULINE ESTUVALES ET DOMESTIQUES DANS LE PAYS DES CONTINENTS, ACCUMULANT ET PARTAGEANT SON EXPÉRIENCE SUR LE TERRAIN.**

**LOW TECH**

# Étape 18 -

Vous avez deux minutes ? Que vous souhaitiez ou non réaliser cette low-tech, votre réponse à ce formulaire nous aiderait à améliorer nos tutos. Merci d'avance pour votre aide !

Comme tout le travail du Low-tech Lab, ce tutoriel est participatif, n'hésitez pas à ajouter les modifications qui vous semblent importantes, et à partager vos réalisations en commentaires.

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## Notes et références

For more information on the family culture of Spirulina :

- Spirulina for all - Culture Familiale par Gilles Planchon aux éditions Passerelle Eco

For strains, materials and products necessary for spirulina cultivation as well as registration for training courses:

- spirulinasolutions.fr

For the basin construction :

- Tutoriel bassin de culture de spiruline.
- Spiruviecian
- Facebook Page de Spiruvie

Other references :

- Universlavie
- Antenna
- Wikipedia
- Arte - the superpowers of urine
- Ecosanres.org
  
- Documentation by Amandine Garnier, Camille Duband & Clément Chabot, August 2017

- Vérifier que le milieu de culture qui retourne au bassin est transparent,

Si vert : présence de chlorelle : ajouter du sel dans le milieu de culture Si marron : forte concentration de spiruline morte : ombrer

- Rassembler la spiruline au centre du filtre

**ATTENTION** *Une fois la spiruline récoltée, éviter de la toucher à la main, son milieu de culture (forte concentration de sel et de bicarbonate de soude) la protègeait des agressions bactériennes*

- Presser la spiruline à la main en faisant tourner le tissu de nylon et en appuyant sur la biomasse. Le pressage doit être progressif. Maintenir la pression jusqu'à ce que le liquide qui s'échappe devienne légèrement vert/
- Mettre la spiruline au frais
- Rincer le matériel (nylon, cadre, passoire) au-dessus du bassin cela permet de compenser l'évaporation
- Peser la spiruline pressée
- Compenser en nourriture par rapport à la spiruline récoltée pour qu'elle puisse se développer à nouveau et revenir à la concentration maximale pour une nouvelle récolte.

Nourriture minérale, 200 ml pour 100 grammes de spiruline fraîche pressée ou Nourriture organique, 200 ml d'urine et 10 ml de solution de fer pour 100 grammes de spiruline fraîche pressée

- Pour une bonne répartition de la nourriture, agiter le bassin à la main, avec une passoire.

**ATTENTION**

- La spiruline respire la nuit, il ne faut pas la nourrir le soir. Privilégiez les récoltes le matin.

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