For a Healthy Daily Life

# Superfood Spirulina

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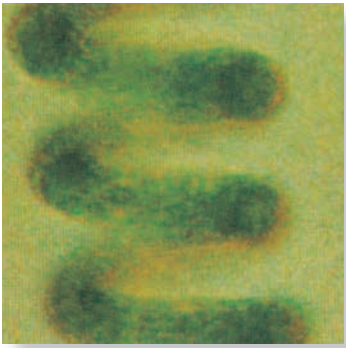
# What Is Spirulina?

## ❖ Big Power of Small Algae

See the photograph below. It is an image of spirulina under the microscope. Its name spirulina is derived from Latin spira, meaning "a coil," and it has a spiral shape.

Spirulina is a type of algae having a blue-greenish color in the group of blue-green algae. Although each spirulina cell is very small and barely visible to the eye, being 0.3 ~ 0.5 mm in length, it has immeasurable vital force inside. Spirulina is now considered as a well-balanced nutritious food beneficial to health.

Now, take a look at its secrets.



## ❖ Spirulina's Profile

Spirulina is the oldest plant, which appeared on earth more than three billion years ago. For an unimaginably long period of time, it has grown naturally in salt-water lakes in the tropical areas of Africa and Latin America. It grows in lakes as if blue-green paint has been poured into them.

Since ancient times, people around such lakes have used spirulina as food. Although they did not have any knowledge of modern nutrition, they probably knew from their experiences that spirulina is a superior nutritious food.

It was 1964 when spirulina was first known to the world. A Belgian botanist studied green dry cakes of high nutritional value, called "Dihe," in Chad, Africa, and found that they were made from spirulina.

Soon, the study of spirulina started. Scientists around the world, including Dr. Clement of the French Petroleum Institute, who first started the culture of spirulina, revealed the amazing nutritional value, digestibility and multiplication rate of spirulina one after another. Following the Conference of the International Association of Applied Microbiology in 1967, the World Food Conference by the UN in 1974 and many other international conferences, the FDA of the US officially approved spirulina as a nutritious food. NASA uses it as a space diet.

Spirulina, which has a long history of being used by natives since ancient times, has appeared today as a superior food after many years of study and development. Its pure culture and mass production is now possible, and its value as "an ideal nutritious food" is rapidly increasing.

# Spirulina Has Five Main Nutrients!

Talking about nutritious food, many people think of eggs and meat. Spirulina, however, has more nutrients than eggs and meat (Table 1).

In addition to protein, saccharide, fatty acids and vitamins, spirulina abundantly contains minerals, such as calcium, phosphorus, magnesium and iron, which tend to be deficient in daily diets. It contains all five main nutrients. Since it is easily digested, such nutrients are smoothly absorbed in the body. It is thus called a leading superfood or whole food.

Table 1 Main nutrients contained in 100 g of spirulina

| | |
|---|---|
| Energy | 260.0 ~ 390.0 kcal |
| Protein | 51.7 ~ 80.0 g |
| Fat | 6.7 ~ 8.3 g |
| Carbohydrate | 10.0 ~ 15.0 g |
| - Saccharide | 3.3 ~ 5.0 g |
| - Dietary fiber | 6.7 ~ 10.0 g |
| Sodium | 433.3 ~ 650.0 mg |
| (Sodium chloride equivalent | 1.1 ~ 1.7 g) |
| Calcium | 263.3 ~ 495.0 mg |
| Iron | 61.7 ~ 115.0 mg |
| Potassium | 1050.0 ~ 1800.0 mg |
| Magnesium | 200.0 ~ 383.3 mg |
| Zinc | 3.3 ~ 6.7 mg |
| Copper | 0.3 ~ 0.8 mg |
| Manganese | 1.5 ~ 8.0 mg |
| Selenium | 5.0 ~ 10.0 μg |
| Phosphorus | 550.0 ~ 1400.0 mg |
| Total chromium | 0.5 ~ 3.3 ppm |
| Iodine | 0.0 ~ 1.7 mg |
| β -carotene | 80000.0 ~ 200000.0 μg |
| Vitamin $B_1$ | 2.2 ~ 4.8 mg |
| Vitamin $B_2$ | 2.2 ~ 4.8 mg |
| Vitamin $B_6$ | 0.7 ~ 1.3 mg |
| Vitamin $B_{12}$ | 183.3 ~ 400.0 μg |
| Vitamin E | 6.3 ~ 12.0 mg |
| Niacin | 11.7 ~ 20.0 mg |
| Folic acid | 133.3 ~ 300.0 μg |
| Pantothenic acid | 0.8 ~ 1.8 mg |
| Biotin | 20.0 ~ 45.0 μg |
| Vitamin $K_1$ | 1033.3 ~ 1933.3 μg |
| Vitamin $K_2$ | 16.7 ~ 133.3 μg |
| Inositol | 65.0 ~ 140.0 mg |
| γ -Linolenic acid | 900.0 ~ 1833.3 mg |
| Linoleic acid | 833.3 ~ 1666.6 mg |
| Total carotenoid | 200.0 ~ 450.0 mg |
| Phycocyanin | 4500.0 ~ 12000.0 mg |
| Chlorophyll a | 600.0 ~ 1250.0 mg |
| Nucleic acid (RNA) | 2200.0 ~ 3500.0 mg |
| Nucleic acid (DNA) | 600.0 ~ 1000.0 mg |

## 1.Rich in Good Proteins!

Protein is a vital component of each part of our bodies. Spirulina contains protein three times as much as beef or two times as much as soybeans (Table 2).

The protein contained in spirulina is also of excellent quality. The quality of protein is determined by how well-balanced the essential amino acids, which cannot be synthesized in the human body, contained in it are. Table 3 shows how good the protein contained in spirulina is. The quality of the protein satisfies the values recommended by FAO (the Food and Agriculture Organization of the United Nations).

Table 2 Protein content of spirulina compared with foods

| | Spirulina | Soybeans | Beef | Eggs | Fish |
|---|---|---|---|---|---|
| Protein | 65 ~ 70% | 34.3% | 19.3% | 12.7% | 20.0% |

Table 3 Essential amino acids in foods

| | Spirulina | Chlorella | Soybeans | Beef | Eggs | Fish | FAO value |
|---|---|---|---|---|---|---|---|
| Isoleucine | 3.25 ~ 3.9% | 5.5% | 1.80% | 0.93% | 0.67% | 0.83% | 4.2% |
| Leucine | 5.9 ~ 6.5 | 7.7 | 2.70 | 1.70 | 1.08 | 1.28 | 4.8 |
| Lysine | 2.6 ~ 3.3 | 5.7 | 2.58 | 1.76 | 0.89 | 1.95 | 4.2 |
| Methionine | 1.3 ~ 2.0 | 1.5 | 0.43 | 0.43 | 0.43 | 0.58 | 2.2 |
| Cystine | 0.5 ~ 0.7 | 0.4 | 0.48 | 0.23 | 0.35 | 0.38 | 4.2 |
| Phenylalanine | 2.6 ~ 3.3 | 4.1 | 1.98 | 0.86 | 0.65 | 0.61 | 2.8 |
| Tyrosine | 2.6 ~ 3.3 | 1.5 | 1.38 | 0.68 | 0.49 | 0.61 | - |
| Threonine | 3.0 ~ 3.6 | 4.3 | 1.62 | 0.86 | 0.59 | 0.99 | 2.8 |
| Tryptophan | 1.0 ~ 1.6 | 1.1 | 0.55 | 0.25 | 0.20 | 0.30 | 1.4 |
| Valine | 4.0 ~ 4.6 | 4.9 | 1.86 | 1.05 | 0.83 | 1.02 | 4.2 |

## 2.Rich in Pigments

Spirulina also contains a lot of three main natural pigments: green **chlorophyll,** blue **phycocyanin** and orange **carotenoid.**

These pigments play an important role of regulating the body.

1) **Chlorophyll** has a structure similar to that of hemoglobin in the blood and is called "the green blood."

2) ***β*-carotene** is a precursor of vitamin A and has nutritional functions same as vitamin A. β-carotene does not have an adverse effect as vitamin A even if taken excessively.

3) **Phycocyanin** has a vivid blue color and is used as a natural food color for frozen desserts.

## 3.Rich in Dietary Fiber

Spirulina contains about 5 ~ 12% dietary fiber, which is composed of 80% pectin, a soluble dietary fiber, and 20% cellulose, an insoluble dietary fiber. On the other hand, the cell membranes of chlorella is composed only of cellulose.

## 4.A Gold Mine of Minerals and Vitamins

Spirulina contains a variety of vitamins: β-carotene, vitamins B1, B2, B6 and B12, vitamin E, niacin, folic acid, pantothenic acid, biotin, vitamins K1 and K2 and inositol. Especially, ***β*-carotene** is abundant, about 16 times as much as carrot or about 26 times as much as spinach.

Spirulina contains all **B vitamins (vitamin B1, vitamin B2, vitamin B6, niacin, pantothenic acid, biotin, vitamin B12 and folic acid),** any of which alone is difficult to display its effects. While **vitamin B12** is very difficult to take from vegetable foods, spirulina contains it more than five times as much as beef liver.

Minerals contained in spirulina are **calcium, iron, phosphorus, zinc, magnesium, iodine, copper, selenium, manganese** and **chromium.** Although minerals are not the nutrients which can be converted into energy, they are closely related to bones, cells

and hormones, and regulate the functions of the body. Although the necessary amount of each mineral is small, taking too little or too much minerals causes troubles in the body. Since these minerals function well by interacting with each other, taking spirulina, which contains all of them, allows you to easily maintain your health.

## 5.Contains γ (Gamma)-Linolenic Acid

Spirulina contains about 7% fat. In addition to fatty acids such as linoleic acid, arachidonic acid and palmitic acid, it contains γ -linolenic acid, which is a polyunsaturated fatty acid contained in mother's milk. Through metabolism, γ -linolenic acid is converted into prostaglandin E1, which is a physiologically active substance necessary for maintaining health.

Table 4 Comparison of fatty acid contents in fat

| | Essential fatty acid | Linoleic acid | γ -linolenic acid |
|---|---|---|---|
| Spirulina | 44.6% | 21.7% | 22.9% |
| Human milk | 16.7% | 15.1% | 1.6% |
| Cow milk | 1.3% | 1.3% | minute |

## 6.Produces Glycogen

Normally, plants produce starch (carbohydrate) through photosynthesis and store it as nutrition. On the other hand, spirulina produces glycogen, instead of starch, through photosynthesis. It is thought that spirulina produces and stores glycogen, which is normally found in animals, because it is a prehistoric organism (plant) which appeared on earth before the differentiation into plants and animals occurred. This is a spirulina's wonder and mysterious characteristic.

In our bodies, glycogen is stored in the liver and the

muscles and gradually decomposed to be used as energy. This is why glycogen is called "muscle gasoline" or "animal starch." Besides spirulina, foods containing glycogen abundantly are shellfish, shrimps and liver.

## 7.Spirulina Is Alkaline and High in Nucleic Acid

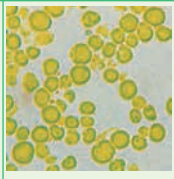
Each human cell has a cell nucleus at its center. There are two types of nucleic acid: deoxyribonucleic acid (DNA), which exists within the nucleus, and ribonucleic acid (RNA), which exists both inside and outside the nucleus. Spirulina contains both nucleic acids. Nucleic acids are necessary for cells to renew themselves and are also essential nutrients to allow B vitamins to function efficiently.

100 g of spirulina contain about 2,850 mg of RNA and about 800 mg of DNA.

The metabolism of nucleic acids eventually produces uric acid in the body. While too much uric acid causes "gout," spirulina is an alkaline food of alkalinity 18 and can be safely taken even by those having high uric acid values.

# Digestibility and Nutritional Values So Different from Chlorella and Euglena!

Many of you might wonder what is the difference among chlorella, euglena and spirulina. It's true that their tablets have similar ingredients, colors and shapes. However, chlorella belongs to the group of green algae, spirulina to the group of blue-green algae, and euglena is a single-celled microorganism (monad). They are different in many ways.

| | Spirulina | Chlorella | Euglena |
|---|---|---|---|
| Appeared | ~ 3.5 bn yrs ago | ~ 2 bn yrs ago | ~ 0.5 bn yrs ago |
| Mass culture | 1975 | 1951 | 2005 |
| Classification | Blue-green algae | Green algae | Monad |
| Shape | Spiral | Spherical | Spindle-shaped:columnar tapered at the ends. Swims with a flagellum and moves by changing its shape of cell: called "euglenoid movement." |
| Image |  |  |  Photo by NEON |
| Color | Blue-green | Green | Yellowish green with shining paramylon inside |
| Size | 0.3 ~ 0.5 mm in length. Large algae and easy to collect. | About 0.002 ~ 0.01 mm in diameter. Very small and necessary to separate with a centrifuge. | About 0.03 ~ 0.05 mm, 1/10 of spirulina. Necessary to separate with a centrifuge. |
| Habitat | Salt-water lakes in tropical areas. (strongly alkaline lake) Grows only in strongly alkaline (pH 9 ~ 11) water at 32 ~ 42℃ (other organisms cannot live). | Fresh water. Grows mostly in any habitat (even in a tank with little light). | Fresh water. Grows mostly in any habitat (some types live in the sea). |

| | Spirulina | Chlorella | Euglena |
|---|---|---|---|
| Photosynthesis | Produces glycogen, which is readily used as energy (while ordinary plants produce starch through photosynthesis). | Produces starch. | Produces starch. It is thought that "paramylon" (a β-glucan polymer) is produced to store the produced starch. |
| Pigments | Chlorophyll, Carotenoid, Phycocyanin | Chlorophyll, Carotenoid | Chlorophyll, Carotenoid |
| Time first used as food | Has been eaten as food since ancient times around its habitats in Mexico and Africa (has a history as food for a few thousand years). It became known to the modern society after chlorella, and thus the time of its mass culture was later than chlorella. | Has no history as food in ancient times. It has become popular after its mass culture was made possible. | Has no history as food.<br>After 2005, capsule supplements containing euglena and other ingredients have been popular. |
| Characteristics | 1. Contains good protein much and a variety of vitamins and minerals.<br>2. Highly digestible, about 95%.<br>3. Has a long history as edible algae and thus its evidence is plenty.<br>4. Has high contents of nucleic acids, SOD enzyme, chlorophyll, phycocyanin, β-carotene and γ-lenolenic acid.<br>5. Disadvantage: the vitamin C content is very low.<br>6. Does not cause green stools.<br>7. Flavor is similar to seaweed.<br>8. Alkaline (alkalinity 18) | 1. Superior nutritional balance.<br>2. Low digestibility and tends to cause green stools.<br>3. Digestibility is about 65% (for products in which cell walls have been broken).<br>4. Tends to cause green stools.<br>5. Flavor is similar to powdered green tea.<br>6. Acid (acidity 24). | 1. Superior nutritional balance.<br>2. Highly digestible, about 93%<br>3. Contains paramylon, DHA and EPA.<br>4. Evidence is not enough.<br>5. No product of 100% euglena.<br>6. Does not easily cause green stools.<br>7. Has bitterness. |
| Main product type in the market | Mostly pure type (100% spirulina) | Mostly pure type (100% chlorella) | Mainly capsule type containing other ingredients |

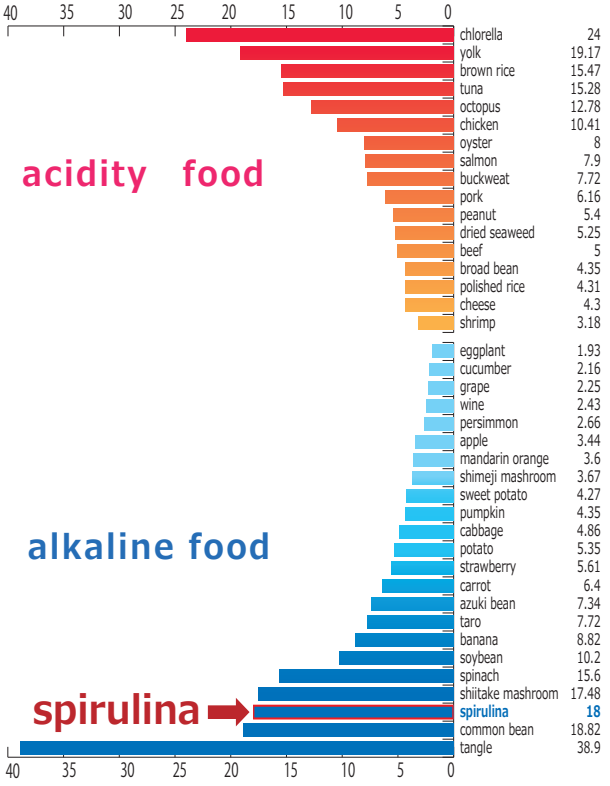
## ❖ Spirulina's Alkalinity Is 18

Another value of spirulina is that it is alkaline.

Today's dietary life is full of acid foods, such as meat, instant foods and sweet foods, and tends to lack alkaline foods, such as vegetables and seaweeds (Figure 1).

Taking spirulina helps you to make your diet more balanced for a healthy life.

Fig. 1




* The figures above do not show pH of the foods but their acidity or alkalinity,which are obtained by measuring water solutions of their ash remaining after being burned (express the acidity or alkalinity of not the foods themselves but the minerals in the foods).

# Spirulina Can Be Produced Safely and Abundantly

## ❖ Safety

Strong drugs may have strong side effects. On the other hand, spirulina is a natural food which have been used as food since ancient times. It is thus gentle and harmless to the human body.

The method of its culture and production is also safe and hygienic. Spirulina has been proved to be a safe food through strict toxicity tests by various research organizations.

## ❖ Production Process

The production of spirulina consists mainly of four processes: 1) culture, 2) filtration, 3) washing and dehydration and 4) drying.

Outdoor culture pond of spirulina

1) Culture: Spirulina is cultured under the same condition as its original habitat, salt-water lakes, in tropical areas. An alkaline culture solution with nutrition is poured into a wide shallow culture pond, which is stirred by gentle streams. This allows spirulina to efficiently carry out photosynthesis and to multiply.

2) Filtration: Spirulina of 1) multiplies in the form of algae. It is then separated from the culture solution through filtration.

3) Washing and Dehydration: The condensed spirulina of 2) is placed on vacuum dehydration filter and repeatedly washed with clean water and dehydrated.

4) Drying: The dehydrated spirulina is instantaneously dried with a spray dryer and made into fine powder.

# Spirulina Q & A

**● At what time of the day should I take spirulina?**
You can take spirulina at any time. It is a food and has no specific rule like drugs. You can take it at convenient time for you: before or after eating meal or between meals.

**● Can small children take spirulina?**
Small children can take spirulina. The amount would be about half that for adults.
Products of 100% spirulina are made only from "algae" called spirulina. You can think that you take a certain amount (grams) of spirulina a day in the same way as you eat vegetable or seaweed. Since a tablet of our product weighs 200 mg, 40 tablets become 8 g of spirulina.
The best way for children's health and growth is not to force them to take too much but to allow them to take an amount comfortable for them each day. You can change their daily amount depending on their physique, activity amount and liking.

**● Can pregnant women take spirulina?**
Pregnant women can take 100% spirulina. There are, however, some spirulina products containing additional ingredients which should be avoided by pregnant women. Read carefully the explanation and instruction of the product you purchased.

**● Can I take spirulina in a large amount?**
In case of 100% spirulina, taking it in a large amount (roughly more than 50 tablets a day) will not cause any harm to your health. However, spirulina is not such a food as to bring a better effect quickly or to improve your health problems quickly even if taken in a large amount. The human body has a limit of nutrition absorption, and taking in nutrition beyond the limit only causes the body to discharge it as unnecessary. The best way to improve your health is to continue to take a proper amount everyday.

**● Taking 40 tablets everyday is not easy.**
Taking 40 tablets a day is only a guide. In case of 100% spirulina, it is OK to take a rough amount. You can take an amount you think good for you, whether 5 tablets, 10 tablets or 20 tablets a day. You can also change the daily amount depending on your physique, activity amount, meal amount and degree of tiredness.

**● Taking spirulina caused blackish stools.**
Since spirulina contains pigments abundantly, taking it may cause dark stools depending on other food you eat. Although it is not trouble, you can reduce your daily amount if you do not like it.

**● Taking spirulina has made my palms yellowish.**
Spirulina contains $\beta$-carotene abundantly. Eating a lot of green and yellow vegetable or citrus fruit, which contains $\beta$-carotene abundantly, at times causes yellowish palms. This is called aurantiasis. The color of the palms will go back to normal if the amount of taking spirulina, green and yellow vegetable, its juice or citrus fruit is reduced. The amount of $\beta$-carotene contained in 100 g of spirulina is about 20 ~ 30 mg, and that in 40 tablets (8 g) is about 1.6 ~ 2.4 mg.

**● The color of tablets in a transparent container has become bluish.**
Spirulina contains natural pigments (green, blue, yellow and brown). If it is placed in a bright environment for a long time, the surface color of the tablet fades and becomes bluish. Even if the surface is bluish, you can still take the tablet if its inside is still green. It is recommended to store spirulina tablets in a lightproof container or aluminum bag.

**● Why are spirulina tablets subtly different in color?**
Spirulina tablets have deeper or lighter colors, mainly because their water contents are different. Depending on the environments of the process of washing after harvesting, drying and forming into tablets, the produced spirulina tablets have slightly different water contents and colors. In addition, different culture environments may bring different contents of pigments.

**● Why are the nutritional values of spirulina given in ranges?**
Unlike industrial products, the contents of nutrients and pigments in spirulina slightly vary depending on the time of harvesting and weather conditions. The nutritional values therefore vary from production to production. This is why we show the nutritional values in ranges.

**● I don't like the spirulina's odor much.**
Spirulina has a particular odor like a smell of the sea, which some people do not like very much. Such people may take spirulina in soup such as miso soup. Putting it in vegetable juice or yogurt drink also reduces its particular smell, making it easier to take.

**● How does spirulina go with medicines?**
People who take anticoagulants, such as warfarin, or those who have been instructed by doctors to refrain from natto(fermented soy beans), green juice and chlorella should not take spirulina. This is because vitamin K, which is contained in spirulina abundantly, weakens the effect of such drugs.
In addition, those who are receiving medical treatment for serious illness are recommended to consult their doctors.

**● I am photosensitive. Is it OK to take spirulina?**
Chlorophyll in spirulina may affect photosensitivity. You should refrain from taking spirulina.

**● I threw up after I took spirulina.**
Spirulina does not seem to agree with you. Refrain from taking it.
There is data showing that people who throw up after taking even a small amount (1 ~ 5 tablets) of spirulina tend to be short of gastric acid. If gastric acid is not enough, spirulina cannot be digested and may rush back or cause green stools.
Whether your gastric acid is enough or not can be examined with baking soda water. If you burp a few minutes after drinking baking soda water, your secretion of gastric acid is normal. If you do not burp even 30 minutes after drinking baking soda water, it is possible that you are short of gastric acid. In such a case, it is recommended to take spirulina together with water containing citric acid, lemon juice or vitamin C.

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