Spirulina against Malnutrition

Micronutrients, proteins, and essential fatty acids are also vital for brain activity. Because of this reason, UN General Assembly accepted and encouraged "spirulina production and potential benefits of spirulina" in November 2005 based on FAO and WHO revised draft resolution (A./C.2/60/L.14/Rev.1).

Only in India, there are 85 Million children, who are 0-6 years old. 34 Millions of these children are under threat of malnutrition. Most part of this threat is resulting from animal origin protein source deficiencies.

Children Nutrition and Spirulina

There is a decrease in energy and protein needs of babies after 4-5 months of postpartum period when supplements in addition to the mother's milk is insufficient or colostrums amount is not enough. In this period when the mother's milk is not enough or begins decreasing, in addition to the mother's milk, extra nutrition supplements are essential. Babies older than 11-12 months may begin to eat the food what the other family members eat.

It is expected that the weight of the baby is doubled 4 months after the birth. Energy and nutritional needs of the babies are listed below by FAO and WHO.

Age	*3-6 months*	*6-9 months*	*9-12 months*	*1-2 years*	*2-3 years*	*3-5 years*
Weight (kg)	7	8,5	9,5	11	13,5	16,5
Energy (kcal/ day)	700	810	950	1150	1350	1550
Proteins (g/day)	17	20	20	20	23	26
Vit. A (ug/day)	300	300	250	250	250	
Fe (mg/day)	7	7	7	7	7	

Energy need of a baby for the first 4-5 months is 700 kcal/day. This information also indicates that the baby needs 800 ml mother's milk per day.

Daily average protein need between 6 months and 3 years period is approximately 20 grams. Considering that this level cannot be provided completely by mother's milk, it is essential that this amount should be increased by balanced amino acids from other sources. These amino acids should contain lysine, threonine, and tryptophan. These amino acids are essential, which means that human beings cannot synthesize from food. 4-8 grams of spirulina supplement in addition to ordinary diet is enough to fulfill all protein needs of the metabolism.

Vitamins are also very important for children. For instance; vitamin A is needed for healthy mucosa and skin as it also protects against various infections. It is also very important for the eyes' and cornea's development. Vitamins B1, B2, B6 allow the energy which is in food to be used properly. Vitamins B9 and B12 are responsible for blood cell production. Vitamin C protects from diseases and additionally it protects against scurvy. Vitamin D is essential for bone development. Rickets is observed in case of less vitamin D intake. Spirulina use is enough for prevention of all these vitamin deficiencies.

Minerals like calcium, magnesium, fluorine, zinc, selenium, iodine are important for children nutrition, but besides iron has a special importance than other minerals. The baby can provide iron for its metabolism from mother's milk for the first 6 months after birth. After 6 months iron intake decreases' therefore spirulina use becomes even more important.

Insufficient iron intake leads to anemia. Especially when pregnant women do not consume enough nutrition containing iron, this situation becomes harmful for the baby's development. Depending on iron deficiency, iron deficiency anemia (IDA) occurs especially in areas, where famine is present.

Iron deficiency also damages energy metabolism in hypo-campus at the same time, therefore it causes memory, intelligence, and mind problems.

There are also other problems based on iron deficiency. Iron has an important role in myelin development of the nerves. In other words, iron deficiency also causes the person to react slowly for audio and visual stimulations.

In addition to these, iron has an active role in mono-amine metabolism. Because of this iron deficiency leads to neurotransmitter and neuromediator damages.

Considering one gram spirulina contains approximately 1,8 mg iron, it would be very clear in order to understand how much important it is to use spirulina for healthy development. Considering grain flours have maximum 0,25 mg iron per gram, spirulina contains approximately 7 times more iron than any other grain flour.

Zinc deficiency is also a mineral deficiency which prevents growing up (Zinc deficiency could be easily observed by white marks on the nails). Since zinc use could differentiate depending on traditional feeding habits, this deficiency can easily be cured by mineral additions, which contain zinc to the culture media during production phase.

PEM (Protein-Energy Malnutrition)

PEM, which is directly related with malnutrition, leads to Marasmus and Kwashiorkor diseases, therefore especially for children, protein energy balance is vital. Millions of children are suffering from Marasmus and Kwashiorkor diseases resulting from PEM. Acute PEM situations mostly result in death or in permanent damages for children. Acute PEM affects usually 1-5 year old children.

There are 2 factors causing PEM predisposition. One of reason is deficient diets and the other is repeating infections. As appetite may decrease due to these repeating infections, if fever is also present, the absorption of the food from digestive track also decreases.

More than 25% of 3-5 year old children cannot fulfill 1550 kcal/day energy need, which is metabolism requirement. Average deficiency is 28%. Most of this deficiency results from protein deficiency. This energy and protein deficiency situation also causes iron, vitamin A, vitamin B deficiency at the same time. All of these factors slow down the growth directly.

Deficiency of iron and vitamin B12 leads to anemia, so it is very important to consume enough portions of iron and vitamin B12 at the same time.

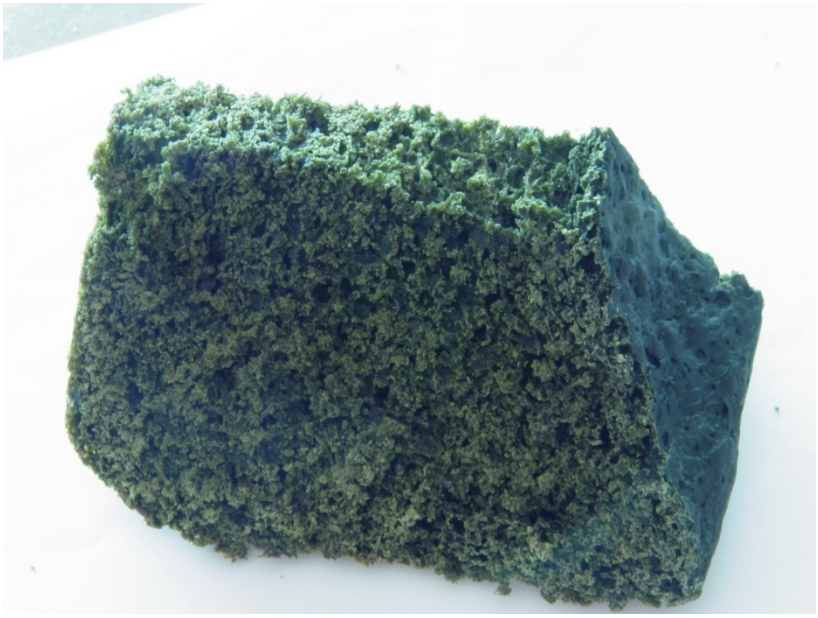
Nutritional Spirulina Use for Children

Spirulina is one of the only food supplements, which could be used at every age and in every situation without risks including pregnancy. However between 1-6 ages, spirulina use is directly beneficial for healthy growth and development.

Growing up process would stop if animal origin protein, that the child should consume, is not enough after mother's milk is decreased. Prevention against this situation can be supplementing with various mash types in addition to the normal diet. Most beneficial mash is made up of rice, spirulina, oil, and water.

For example; 30 g rice or rice flour, 8 g spirulina, 4 ml oil and 100 ml water could be used. First rice, oil, and water are boiled in a pot. After it becomes in mash form and cools down (until it comes to a temperature that could be touched), 8 g spirulina is added to this mixture afterwards. (Corn or corn flour could also be used instead of rice products)

Feeding baby which is 4-7 months old or which is still consuming less mother's milk, with 100 ml of this mash would be enough for providing the needed nutrients to the baby in these periods.



Spirulina Bread

20-24 months old children, who can feed themselves should also be encouraged to consume spirulina. In this period, it is very beneficial and the results are incredible when feeding twice daily with these type of mashes.

”Hunger” is the physiologic feeling of being hungry and reflecting this situation to his/her behaviors.
”Famine” is the situation in a specific area/region which carries on for a long time due to the problems or impossibilities of producing food resources. This situation mostly occurs because of wrong governmental politics, not being scientifically interested in climate change, some specific types of weapons. In addition to these, inefficient use of water resources, and water resources' pollution could also be counted in this list, which affects this situation.

”Malnutrition” is the situation that the food is in low nutritional quality and in fewer amounts. Less available food amount causes that the food cannot be processed by the metabolism enough, as this situation results in metabolic and pathologic disorders. For example, only calcium intake would not be beneficial without vitamin D intake. Or only vitamin B12 intake would not prevent from anemia without iron intake. The amount of protein that must be consumed during the day would not be enough, if only a few of essential amino acids are consumed.

Soley Institute's area of interest is fighting against hunger, malnutrition, and famine but the area that we are mostly focused is malnutrition.

According to WHO, children deaths under 5 years of age are 74% completely related with malnutrition.

Aid politics against malnutrition and famine are not enough for lowering this hunger threat which increases exponentially each year. Extreme efforts of UN and the organizations related with UN are not even enough to lower malnutrition deaths under 5 years of age. It is very clear that the most important thing about this issue is to teach how to cultivate spirulina and produce their own protein and energy resources in areas that famine and hunger are still present.

UN, UNICEF, FAO, WHO, WFP, UNHCR, and additionally NGO's around the world had begun to fight against hunger with educational and more organized works.

Especially production of livestock or production of agricultural products is a big problem for the people, who can't even take care of themselves and also who can't even find food for their families. Since learning growing techniques and use of spirulina are a lot easier issues than producing any other food resources.

Spirulina consists most of the nutrients that could be obtained from animal origins or agricultural products; therefore it is the most important nutrition for fighting against malnutrition.

Excluding body development, malnutrition has lots of harmful effects also for brain development. Malnutrition effects always negatively intelligence and brain development. Children who are mentally and psychologically negatively affected from malnutrition are 60% of the total malnutrition incidences.

Healthy and balanced feeding prevents and protects from malaria which creates cognitive deformations, meningitis, intestinal parasites due to more effective immune system resistance. Malnutrition increases incidence of being infected by these diseases as it also leads to permanent mental disorders.

Is Spirulina Organic Food?

This is about what we consider as “organic”. Of course spirulina is a living organism, therefore it is naturally organic. However, according to the laws of some countries, spirulina products cannot be classified as "organic" due to the chemical based nutrients and fertilizers that are used during production phase, so in these countries spirulina products can only be called "natural".

In order to be able to call a spirulina product as organic, all growth media ingredients have to be completely from organic products. For spirulina production until 2008, mostly chemical based growth media have been used. Chemical originated soda ash, nitrate, sulphate containing compounds are common growth media chemicals. After 2008 some researches and developments have proved us that spirulina can be produced completely by organic based growth media.

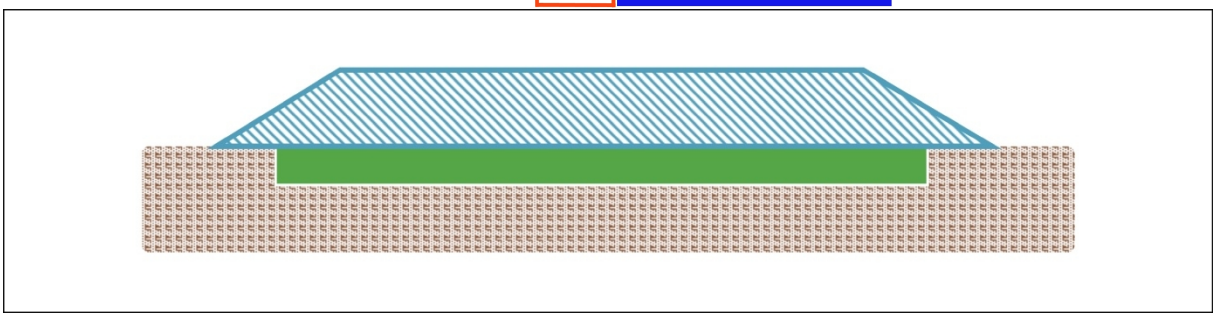
This progress gave famine regions the possibility to make their own spirulina production in an independent, non-out-sourced, no extra aid requiring way in order to prepare their own growth media by themselves.

Therefore, completely organic spirulina production became possible and also chemical dependencies resulting extra out-sourced aid are no longer required with this method.

Which Climate Is Suitable For Spirulina Production?

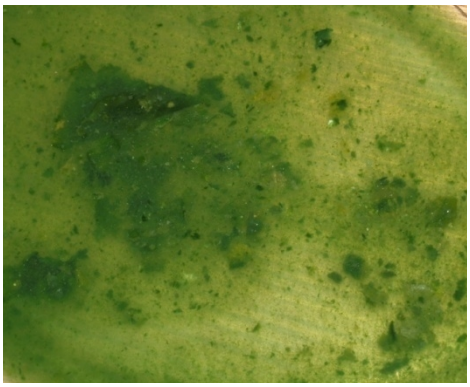
Ideal temperature for spirulina production is 28-30 'C. But spirulina is a living microorganism which can adapt to different environmental conditions. After spirulina culture is adapted in laboratory conditions, this culture can easily be used in mass production area.

It is true that spirulina can only grow in warm climates, but on the other hand this information is as well missing. Spirulina could also be easily produced as well in cold climates.



Covering Open Ponds Like Greenhouse

Spirulina could be produced in systems that the top is covered with nylon based materials like a greenhouse. This brings the easiness for providing right amount of light, and temperature to the culture. Contamination risks are also lowered in this way.



Macroscopic culture media appearance of spirulina produced in bad conditions

Macroscopic culture media appearance of spirulina produced in good conditions

Macroscopic culture media appearance of spirulina produced in bad conditions

Soley Institute experts are ready to provide all needed conditions for spirulina production in any climate and geographic region to people or establishments. Soley Institute experts also provide support and advices for projections, culture and water media preparations.

Culture Medium

Following could be used for culture medium preparations that Soley Institute experts advise.
Ingredients of this media are calculated depending on the water properties and quality and also spirulina culture strain. Although the most ideal mixture is F/2-Si or Zarrouk Medium; for fighting against hunger or for mass open

pond productions, less complicated mediums are used. Here is an example of spirulina medium recipe in the simplest method.

	For 1 Liter	For 2 Liters	For 5 Liters	For 10 Liters	For 50 Liters	For 100 Liters	For 1000 Liters
Sodium Bicarbonate (g)	12	24	60	120	600	1200	12000
Sodium Nitrate (g)	3	6	15	30	150	300	3000
Sea Salt or Lake Salt (g)	2	4	10	20	100	200	2000
Ammonium Phosphate (g)	0,1	0,2	0,5	1	5	10	100
Iron Sulfate (mg)	12	24	60	120	600	1200	12000
Green Tea Solution (ml)	2	4	10	20	100	200	2000
Potassium Sulphate (g)	0,4	0,8	2	4	20	40	400
Magnesium Sulphate (g)	0,1	0,2	0,5	1	5	10	100
Lime (g)	0,1	0,2	0,5	1	5	10	100

Growth media pH value should be between pH 8,5-10. Under pH 8 or over pH 11, spirulina production is affected negatively or in some cases production may even stop.

Additionally, in order to reduce contamination risks, such as other unwanted microalgae or bacteria, pH level needs to be stabilized between pH 9,5-10.

High pH level means that the media is alkaline. Spirulina grows in alkaline type of media. The easiest way to make the media alkaline is to add carbonates or bicarbonates.
The most ideal and cheapest way to increase media alkalinity is “sodium bicarbonate” additions. Carbon needs of spirulina are mostly provided by these carbonates. It is important to prepare this type of water media because in nature spirulina grows only in soda based water media types.

Temperature

Environmental or media temperature directly affects spirulina growth. Most effective production occurs between 28-32 ‘C. If temperature rises 35 ‘C, then production begins decreasing. The maximum temperature that spirulina can survive is 43 ‘C. But however no growth is observed under 16 ‘C and over 37 ‘C.

Lightning

Healthy spirulina culture has dark blue green color if it is dense enough. Because of this, intensive light can easily be converted to heat and therefore direct sunlight can be dangerous for dense cultures due to overheating.
It may be necessary to use shading for basic cultivation techniques during the time that solar rays are received vertically. Modern growing technologies like closed photobioreactor systems do not have this advantage.
The most ideal lighting for spirulina production is 16 hours light and 8 hours dark. Spirulina grows more during dawn and at the end of dark stage.
For regions which have less than 12 hours per day, it may be essential to use extra artificial lighting.

Starter Culture

It is advised to use a healthy spirulina starter culture which has 1 g/lt density. It is necessary to provide this uncontaminated, pure, healthy, culture from microalgae culture banks. Cultures provided from other ponds would result in foreign unwanted microalgae and bacterial contaminations.

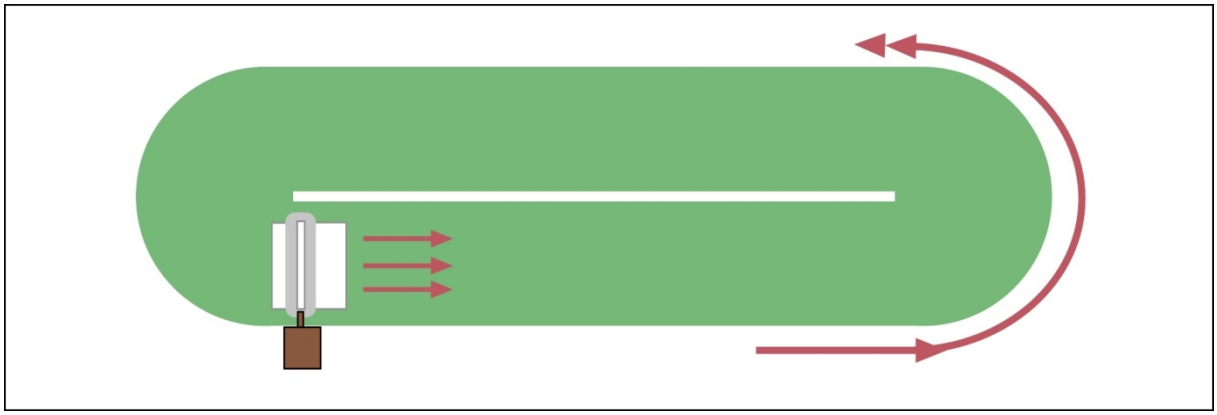
Additionally, when spirulina is cultivated in bad conditions, it loses some of its positive properties. Using this type of bad quality spirulina as starter culture would lead to bad quality, less beneficial and less nutritious spirulina production in time.

Ideal culturing is made by 30 ml spirulina culture for each liter of water media. The density of this starter culture should be 1 g/lt.

Mixing

Spirulina moves depending on the water circulation and it has very low movement ability. Due to this, continuous and frequent mixing is vital in order to; receive nutrients, move to dark and light areas periodically, prevent collections and cluster formations in the bottom and cause mass cell deaths.
Besides, spirulina fixes and utilizes nitrogen and carbon dioxide from the air into the water media where it can be used. Mixing and circulation is essential to let these gasses dissolve in water media.
In basic systems such as pond systems, if there is no electricity source, then shovels are used for mixing the culture. Minimum 4-5 times mixing per day is needed. If there is electricity source, then pedals connected to small motors are used for mixing.

Mixing should be soft and slow in order not to damage microalgae culture cells. In technological photobioreactor systems, the system mixes and circulates automatically.



Depth

Depth is more important than width or length for pond systems. Dense spirulina cultures can penetrate solar rays only until 10-15 cm. When mixing is well made, then this depth could go up till 25 cm. Researches indicated that production is higher if the culture depth is 25 cm.

Isolation

Isolation is essential considering that microorganisms living in soil and other harmful materials contaminating spirulina culture. Also, water which is valuable should not leak in soil due to bad isolation.
Because of these reasons inside of the ponds should be isolated by nylon based materials, so that the possible water leaking is prevented. In this way, water media pollution by construction materials is also prevented. For cement constructed ponds antibacterial and smooth (prevent sticking) paints or resinous materials are used for inside of the ponds in order to prevent sticking of the culture to the sides and bottom.

Clustering

Clustering can often be observed in pond systems which are not mixed or circulated well enough or which have rough walls that spirulina colonies stick together and form plates which are as thick as a paper or different sizes of clusters. If these clusters, which may pollute the water, are not removed from the culture media in time, then they will rotten in the water media, and the spirulina production in the system may stop.

Measuring Spirulina Density

When spirulina becomes very dense in the system; it cannot benefit the nutrients efficiently, dissolved gasses in the culture media and the gasses that the culture uses, become insufficient for production. Because of these, ideal density should be specified and harvesting should be made at the right time.

For basic systems, in optimal conditions spirulina doubles its biomass once in two days. For technological photobioreactor systems, this doubling period is once a day.

Density could easily be measured by dipping a white plate in the culture media. If we can see this plate 6 cm and deeper, then the culture is still not ready for harvesting. On the other hand if we can't see the white plate after 2-3 cm depth, then we can say that it's the right harvest time. It is also not wanted that the visual is below 2 cm. Simple equipments commercially sold in the market, which is called Secchi Disk is ideal for this measurement.

Harvesting

In the modern systems, harvesting is made by electro-mechanical or hydro-mechanical filters. Usually filter equipments operate 30 minutes and stop for 30 minutes. On the other hand in basic pond systems, harvesting is made by cloth stretching. Thin cloth material is stretched between 4 wood sticks and the culture media is poured slowly over this cloth. Filtered spirulina biomass is collected and washed by washing solutions. This biomass is then put in a cloth like bag under something heavy like a rock, so that some of the water content is separated. Then dewatered spirulina biomass is made 4-5 cm thick layer and it is taken to 50 'C drying ovens.

Another way is to spread this biomass as a thin layer in shadow so that it is dried and hardened. After this process, this dry spirulina could be crushed into powder form.

As long as spirulina products do not receive light, air, or moisture; it may be preserved for months as powder form. In other words spirulina dried in this way has a long shelf life.

It is advised that harvesting should not be continued if light penetration becomes more than 5-6 cm.

Washing

Harvested spirulina water media contains residues. Due to these residues, washing and drying processes are important. Dried spirulina cannot be washed; it should be washed directly after the first filtering process.

Washing solution is prepared by one liter of clean water and 4 drops of hydrochloric acid. Harvested spirulina is put in this solution after pre-filtering process and it is mixed slowly. After 5 minutes it should be filtered by cloth. After filtering, pressing is applied in order to make the spirulina into paste form.

Additions After Harvesting

It is important to add some of the chemicals in the water media after harvesting, which are used during spirulina growth. Evaporated water loss should be determined daily and clean water should be added.

Depending on the harvested biomass, the chemical materials are given below which should be added in the water media and which are already consumed by harvested spirulina:

For each gram of harvested dewatered spirulina paste, 400 mg of this chemical mixture should be added. If this calculation is made based on dry spirulina weight, then the mixture that should be added is 1,6 g for each gram of dry spirulina.

Following is the chemical mixture to be added after harvesting.

Sodium Bicarbonate: 500 g
Sea Salt or Lake Salt: 50 g
Sodium Nitrate: 16 Kg
Ammonium Phosphate: 400 g

Potassium Sulphate: 400 g
Magnesium Sulphate: 100 g
Lime: 10 g
Iron Sulfate: 2 g
Green Tea: 20 ml

After this mixture is prepared, it should be kept in a dry place and when needed, then it could be used in needed amounts.

Cleaning

Cleaning process is not used in modern methods or closed photobioreactor systems. However, for basic pond techniques, pond cleaning is very important. It is essential to clean the water for removing dead spirulina residues from the media.

Suggested cleaning method is to change 1/20 of the total pond water media volume every 20 days once and fresh water media should be added.
pH should be checked frequently and regularly in order to keep the level between pH9-10.