

Chlorella vulgaris is unicellular green algae found in both fresh and marine water and it is widely used as food supplements. Significant attention has recently been drawn to the use of microalgae for developing functional food, as microalgae produce a great variety of nutrients that are essential for human health. The nutritional value of *Chlorella* was initially determined in 1950s-1960s, and first studied as a possible food source in Japan, United States and Germany after World War II. Chlorella contains supreme level of crude protein, carbohydrate, lipid, essential amino acids and minerals.

Chlorella has a green colour due to the chloroplasts it contains. Its shape is spherical with a size that varies from 1 to 10 microns. These microalgae contain, in addition to chlorophyll, a significant amount of intracellular proteins, carbohydrates, lipids, vitamins which is why it is commonly used for the preparation of food supplements, as well as for the production of cosmetics, clinical treatments and even for the detoxification of heavy metals in wastewater.

Among the applications that can be given to the metabolites produced by Chlorella is the production of lipids as well as the synthesis of proteins and some carbohydrates. The *Chlorella vulgaris* strains are species of microalgae that grow easily and quickly. Microalgae has become important in recent years because they are considered as raw materials for chemical compounds that have been affected by their primary and secondary metabolism, such as lipids, whose main application is for the generation of biodiesel.

Nutrients

Chemical composition

The composition of the Chlorella identified some metabolites such as: proteins, lipids carbohydrates, and some pigments. It has generated, a large part of the content is protein, which is why it can give great nutritional value.

Proteins

18-22 amino acids contain 8 essential amino acids that the body is unable to produce. Amino acids play an essential role in the metabolism and function of all cells in the body. Among the amino acids that have been characterized in Chlorella are: aspartic acid, threonine, serine, glutamic acid, glycine, alanine, cysteine, valine, methionine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine, arginine, and proline, Within the composition of the amino acids identified in the biomass of this microalgae are some essentials such as: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine and valine, with the exception of tryptophan. Chlorella contains a large amount of essential amino acids and where aspartic acid together with glutamic acid are those that contain a greater proportion, so it can be given great nutritional value to foods containing this microalgae.

Fatty acids composition in Chlorella

Fatty acids	Carbon number	(%)
Palmitic acid methyl ester	C _{16:0}	17.5
Palmitoleic acid methyl ester	C _{16:1}	3.27
Stearic acid methyl ester	C _{18:0}	15.39
Oleic acid methyl ester	C _{18:1}	13.87
Linoleic acid methyl ester	C _{18:2n6}	9.18
Lignoceric acid methyl ester	C _{24:0}	22.11

Lipids

They constitute from 5 to 40% of the dry weight in the biomass, being mainly glycolipids, waxes, hydrocarbons, phospholipids and fatty acids, which are synthesized in the chloroplasts and once synthesized they are directed to the cell walls and membranes of the different organelles as the chloroplasts themselves and the mitochondria. Regarding the type of fatty acids in Chlorella, it has been identified that 70.18% corresponds to saturated fatty acids (SFA), 16.85% corresponds to monounsaturated fatty acids (MUFA) and finally 8.72% corresponds to polyunsaturated fatty acids (PUFA) so it gives a wide variability in its lipid profile.

Carbohydrates

They are present in the form of starch and cellulose, as well as some reducing sugars. Starch is found in chloroplasts consisting mainly of amylose and amylopectin. Cellulose is part of the cell wall of Chlorella therefore it can be used as an input for the elaboration of functional products that contribute to human health. The composition of the cell walls of Chlorella results from a mixture of rhamnose, galactose, glucose, xylose, arabinose and mannose where the most abundant is rhamnose.

Pigments

Among the most abundant pigments in Chlorella is chlorophyll, which makes up 1 to 2% of the biomass dry weight. In addition to these pigments, there is also the presence of carotenoids which belong to the group of terpenes.

Among the main pigments that have been identified in Chlorella are β -carotenes, astaxanthin, canthaxanthin, lutein, chlorophyll a and b, pheophytin a and b and violoxanthin.

Vitamins

Chlorella also consist of of Beta -carotenes, Vitamins C and B vitamins (B1, B2, B6 and B12), Folic acid, Inositol, Niacin and Pantonic acid

Minerals

It also contains calcium, iron, iodine, magnesium, phosphorus, zinc, manganese, and selenium.

Consumption of Chlorella

In the last two decades, the popularity of Chlorella has been increasing among the American and Japanese people. Its safety has been carefully and extensively studied and the results have not shown any toxic effects on humans.

Chlorella helps maintain balance in body function, boosts the immune system, purifies and detoxifies the body, regulates the pH of internal body fluids, lowers blood sugar in people with diabetes, lowers cholesterol, regulates blood pressure and improves gastrointestinal function. In fact, as a food supplement for humans, poultry and aquatic animals are very suitable and valuable.

Store in a cool dry place away from sunlight and out of reach of children.

Amino acids characterization in Chlorella

Amino acids: concentration (g/100 g protein)

Aspartic acid	10.5
Threonine	5.24
Serine	5.08
Glutamic acid	10.74
Glycine	5.1
Alanine	8.44
Valine	6.44
Methionine	1.5
Isoleucine	5.01
Leucine	6.84
Tyrosine	5.2
Phenylalanine	4.2
Histidin	5.02
Lysine	5.6
Arginine	8.2
Proline	6.4

Nutrient content in Chlorella powder

Nutrients	In 100 grams of Chlorella powder
Total Proteins	50 - 60 g
Total Fats	7 - 12 g
Total Fibers	2 - 6 g
Chlorophyll	206 mg
Ash	6.24 g
Polysaccharide	15 - 25 g
Beta carotene	183 mg
Phosphorus	800 mg
Sodium	42 mg
Calcium	200 mg
Magnesium	300 mg
Potassium	30 mg
Iron	120 mg
Zinc	70 mg
Folic acid	0.26 mg
Vitamin E	10 mg
Vitamin C	22 mg
Vitamin B1	2.3 mg
Vitamin B2	5.8 mg
Vitamin B3	30 mg
Vitamin B6	2.2 mg
Vitamin B12	0.1 mg
Biotin	0.19 mg