

Blinkova LP, Gorobets OB, Baturo AP.

Biological activity of Spirulina

Zh Mikrobiol Epidemiol Immunobiol. 2001 Mar-Apr;(2):114-8. Review.

In this review information of ***Spirulina platensis* (SP)**, a blue-green alga (photosynthesizing cyanobacterium) having diverse biological activity is presented. Due to high content of highly valuable proteins, indispensable amino acids, vitamins, beta-carotene and other pigments, mineral substances, indispensable fatty acids and polysaccharides, PS has been found suitable for use as bioactive additive. SP produces an immunostimulating effect by enhancing the resistance of humans, mammals, chickens and fish to infections, the capacity of influencing hemopoiesis, stimulating the production of antibodies and cytokines. Under the influence of SP macrophages, T and B cells are activated. SP sulfolipids **have proved to be effective against HIV**. Preparations obtained from SP biomass have also **been found active against herpesvirus, cytomegalovirus, influenza virus**, etc. SP extracts are capable in inhibiting cancerogenesis. SP preparations are regarded as functional products contributing to the preservation of the resident intestinal microflora, especially lactic acid bacilli and bifidobacteria, and to a decrease in the level of *Candida albicans*. The biological activity of SP with respect to microorganisms holds good promise for using these microalgae as components of culture media.

Hayashi K, Hayashi T, Kojima I.

A natural sulfated polysaccharide, calcium spirulan, isolated from *Spirulina platensis*: in vitro and ex vivo evaluation of anti-herpes simplex virus and anti-human immunodeficiency virus activities.

AIDS Res Hum Retroviruses. 1996 Oct 10;12(15):1463-71.

Abstract:

A sulfated polysaccharide named calcium spirulan (Ca-SP) has been isolated from a sea alga, *Spirulina platensis*, as an antiviral component. The anti-human immunodeficiency virus type 1 (HIV-1) and **anti-herpes simplex virus type 1 (HSV-1)** activities of Ca-SP were compared with those of dextran sulfate (DS) as a representative sulfated polysaccharide. Anti-HIV-1 activities of these agents were measured by three different assays: viability of acutely infected CD4-positive cells, or a cytopathology assay; determination of HIV-1 p24 antigen released into culture supernatants; and inhibition of HIV induced syncytium formation. Anti-HSV-1 activity was assessed by plaque yield reduction. In addition, their effects on the blood coagulation processes and stability in the blood were evaluated. These data indicate that Ca-SP **is a potent antiviral agent against both HIV-1 and HSV-1**. Furthermore, Ca-SP is quite promising as an anti-HIV agent because even at low concentrations of Ca-SP an enhancement of virus-induced syncytium formation was not observed, as was observed in DS-treated cultures, Ca-SP had very low anticoagulant activity, and showed a much longer half-life in the blood of mice when compared with that of DS. Thus, Ca-SP can be a candidate agent for an anti-HIV therapeutic drug that might overcome the disadvantages observed in many sulfated polysaccharides. When the role of chelation of calcium ion with sulfate groups was examined by removing calcium or its replacement by sodium, the presence of calcium ion in the molecule was shown to be essential for the dose-dependent inhibition of cytopathic effect and syncytium formation induced by HIV-1.

Hernandez-Corona A, Nieves I, Meckes M, Chamorro G, Barron BL.  
Antiviral activity of *Spirulina maxima* against herpes simplex virus type 2.  
*Antiviral Res.* 2002 Dec;56(3):279-85.

Abstract:

*Spirulina* has been used in a variety of practical applications in biotechnology and medical sciences. This paper presents the antiviral activity found in a hot water extract (HWE) of a commercial preparation of *Spirulina maxima*, studied by a microplate inhibition assay, using several viruses. The HWE **inhibited the infection for: herpes simplex virus type 2 (HSV-2)**, pseudorabies virus (PRV), human cytomegalovirus (HCMV), and HSV-1, and the 50% effective inhibition doses (ED50) were 0.069, 0.103, 0.142, and 0.333 mg/ml for each virus, respectively. For adenovirus the inhibition was less than 20%, and no inhibition was found for measles virus, subacute sclerosing panencephalitis virus (SSPE), vesicular stomatitis virus (VSV), poliovirus 1 and rotavirus SA-11, at concentrations of 2 mg/ml of the HWE. **The highest antiviral activity was for HSV-2**, with a selectivity index of 128. The antiviral activity was not due to a virucidal effect. Herpesvirus infection was inhibited at the initial events (adsorption and penetration) of the viral cycle. To initiate the isolation and identification of the compound that exhibits the antiviral activity of *S. maxima*, some extracts made by using several solvents with different polarity were evaluated by microplate inhibition assay using HSV-2. The highest antiviral activity was detected in the methanol–water 3:1, which suggests that the antiviral activity is probably due to highly polar compounds.

Rechter S, König T, Auerochs S, Thulke S, Walter H, Dornenburg H, Walter C, Marschall M.  
Antiviral activity of Arthrospira-derived spirulan-like substances.  
Antiviral Res. 72, No 3 (2006) 197-206.

Abstract:

Natural substances offer interesting pharmacological perspectives for antiviral drug development in regard to broad-spectrum antiviral properties and novel modes of action. In this study we analyzed polysaccharide fractions isolated from *Arthrospira platensis*. Fractions containing intracellular or extracellular spirulan-like molecules showed a pronounced antiviral activity in the absence of cytotoxic effects. Using specific assays for the quantification of viral replication in vitro, these substances exhibited **strong inhibition of human cytomegalovirus, herpes simplex virus type 1, human herpesvirus type 6 and human immunodeficiency virus type 1**, while only weak or no inhibition was noted for Epstein-Barr virus and influenza A virus. Considering herpesviruses, antiviral effects were most pronounced when the cells were preincubated with the substances prior to the addition of virus, indicating that antiviral action may be primarily targeted to virus entry. However, an inspection of the inhibition of human cytomegalovirus protein synthesis clearly demonstrated that intracellular steps also contributed to the antiviral effect. In the case of human immunodeficiency virus, inhibition occurred at a stage later than viral entry. Thus, spirulan-like substances possess a marked antiherpesviral and anti-HIV activity based on different modes of action. Further development of these substances might yield novel candidates of broad-spectrum antiviral drugs.

**Khan Z, Bhadouria P, Bisen PS.**

**Nutritional and therapeutic potential of Spirulina.**

Curr Pharm Biotechnol. 2005 Oct;6(5):373-9.

Department of Biotechnology, J.C. Bose Institute of Life Sciences, Bundelkhand University, Jhansi 284128, U.P., India.

Abstract

Spirulina, a filamentous cyanobacterium, possesses diverse biological activities and nutritional significance due to high concentration of natural nutrients, having bio-modulatory and immunomodulatory functions. Different Spirulina preparations influence immune system viz. increase phagocytic activity of macrophages, stimulating the production of antibodies and cytokines, increase accumulation of NK cells into tissue and activation and mobilization of T and B cells.

**Spirulina** have also shown to perform regulatory role on lipid and carbohydrate metabolism by exhibiting glucose and lipid profile correcting activity in experimental animals and in diabetic patients. Preparations have been found to be **active against several enveloped viruses including herpes virus, cytomegalovirus, influenza virus and HIV**. They are capable to inhibit carcinogenesis due to anti-oxidant properties that protect tissues and also reduce toxicity of liver, kidney and testes.

**Hayashi T, Hayashi K, Maeda M, Kojima I.**

**Calcium spirulan, an inhibitor of enveloped virus replication, from a blue-green alga *Spirulina platensis*.**

J Nat Prod. 1996 Jan;59(1):83-7.

Faculty of Pharmaceutical Sciences and School of Medicine, Toyama Medical and Pharmaceutical University, Toyama, Japan.

Abstract

Bioactivity-directed fractionation of a hot H<sub>2</sub>O **extract from** a blue-green alga ***Spirulina platensis*** led to the isolation of a novel sulfated polysaccharide named calcium spirulan (Ca-SP) as an antiviral principle. This polysaccharide was composed of rhamnose, ribose, mannose, fructose, galactose, xylose, glucose, glucuronic acid, galacturonic acid, sulfate, and calcium. Ca-SP **was found to inhibit the replication of several enveloped viruses, including Herpes simplex virus type 1**, human cytomegalovirus, measles virus, mumps virus, influenza A virus, and HIV-1. It was revealed that Ca-SP selectively inhibited the penetration of virus into host cells. Retention of molecular conformation by chelation of calcium ion with sulfate groups was suggested to be indispensable to its antiviral effect.

Maddaly R, Sai LD, Syed A, Solomon F D P

**The beneficial effects of spirulina focusing on its immunomodulatory and antioxidant properties**

Nutrition and Dietary Supplements 2010;2:73–83

Study was carried out by preparing a hot water extract of spirulina and subjecting it to fractionation. A part of the fractionated product was found to inhibit the replication of several viruses, especially those with an envelope such as the measles virus, and the HIV-1 virus, in human T cells, peripheral blood mononuclear cells and Langerhans cells. This component was found to be a sulfated polysaccharide, calcium spirulan. In order to find out the chelating property of calcium in the inhibition of replication of virus, the calcium was replaced by sodium. As a result the antiviral property was inhibited. Therefore calcium was seen to play an essential role in a dose-dependent manner for inhibiting the cytopathic role of such viruses. In addition, in undernourished children spirulina has been found to improve weight gain and correct anemia in both HIV-infected and HIV-negative cases.

Capelli B, Cysewski G.R.

**Potential health benefits of spirulina microalgae**

Nutra Foods, 2010, 9 (2) 19-26

The benefits of Spirulina in building immunity and improving resistance to viral infections are well documented. For decades, users have anecdotally reported a decrease in colds and flu from Spirulina use. Several pre-clinical animal studies have shown good immunostimulatory effects in a variety of species. In humans, mammals, chicken and fish Spirulina produces an immunostimulating effect by enhancing the resistance to infections, the capacity of influencing hemopoieses, and stimulating the production of antibodies and cytokines. Spirulina has also been shown to activate macrophages, T and B cells. Sulfolipids derived from **Spirulina have proved effective against HIV. Extracts from Spirulina biomass have also been found active against herpes virus, cytomegalovirus, influenza virus**, etc. Spirulina extracts have also been shown capable of inhibiting carcinogenesis.



Lindmark L, Schøring-Thyssen M

**Effect of microalgae supplementation (Immolina) on recurrent Herpes simplex (HSV-1) cold sores**

Kasima Medical Development AB

Cold sores, around the mouth, with painful blisters are very common condition caused by the herpes simplex virus (HSV-1). Weakness of immune system due to severe cold infection, stress, UV exposure and/or fever is believed to play an important role in the reactivation of the virus and return of blisters. No good treatment is available.

Immolina is a unique commercial microalgae extract from *Arthrospira platensis* with proven immunostimulatory and modulatory properties. Anecdotal evidence suggest that this microalgae extract could be a valuable supplement to alleviate symptoms of cold sore.

A double-blind placebo controlled, trial of an oral microalgae extract for the prevention and treatment of recurrent herpes simplex (HSV-1) infection was conducted to evaluate usefulness and efficacy. The critical inclusion criterion was more than 6 episodes of cold sores (oral herpes) during past 12 months. The active group was given Immolina capsules (400 mg per day) for 16 weeks. The placebo capsules contained microcrystalline cellulose. The study was conducted as consumer study, where the participants kept continuous daily diary of symptoms. A total number of 148 participants (age 18 - 65) entered the trial of which 84 (22 males and 62 females) subjects on active treatment and 64 (18 males and 46 females) subjects on placebo completed the trial.

The Spirulina Extract treatment group had an average of 40% less HSV infections during the whole testing period. Number of total symptom free participants during the whole study was 34/84 (40%) for Spirulina Extract compared 4/64 (6%) with the placebo ( $p < 0.02$ ). During last 8 weeks of the study the non-recurrence evidence was 51/84 and 16/64 for the active and placebo group respectively. This means that in the active Spirulina Extract group 58% more cases were without cold sores as compared to the placebo group.

The statistical analysis (Fisher's Exact Test) show a significance with  $p < 0.02$ . No side effects were reported. There is also a tendency that males might respond better than females.