

KLAMATH ALGAE

(APHANIZOMENON FLOS AQUAE)

Klamath Algae (Alphanizomenon Flos Aquae or AFA), which is one of the many types of blue-green algae, is found in abundance in Upper Klamath Lake in southern Oregon. It is one of the very few edible microalgae, and it differs from other microalgae such as Spirulina and Chlorella insofar as it is wild and grows in a perfect environment which allows it to develop a truly remarkable nutritional profile.

The constant replenishment of Klamath Lake by snow and water runoff from one of the most highly active volcanic regions in the world provides a unique source of pure mineral rich water. Klamath Lake and its surrounding marshes, forests, and meadows serve as a refuge for hundreds of species of resident and migratory wildlife. Located in a relatively undisturbed, high desert region, the Klamath Basin is home to the largest wintering congregation of bald eagles in the lower forty-eight states, and is the largest stopover for waterfowl in the Pacific flyway. Nestled in the shadow of pristine Crater Lake and fed by more than seventeen natural springs of astonishing beauty, Klamath Lake is the largest freshwater lake (125 square miles) in Oregon, draining a watershed of more than 3,800 square miles. Klamath Lake contains a wealth of minerals resulting from a thick layer of volcanic ash spewed over the Klamath Basin during the eruption of Mount Mazama seven thousand years ago. This bountiful supply of naturally occurring minerals in Klamath Lake, together with a great opportunity for photosynthesis (300 days of sun per year) and cold winters that force the algae to produce truly essential fatty acids, are the main reason for what many scientists consider the most nutrient abundant food source on the planet.

Klamath Algae nutritional profile

- **Proteins.** Approximately 60% to 70% of the algae is made up of high quality proteins, containing 20 amino acids, including all the essential ones. Most of all, it also has the ability to improve the body's own ability to absorb and utilize proteins from food, making it extremely important for athletes and anyone who need a high performance fuel.¹
- **Essential aminoacids.** It contains all the 8-10 essential aminoacids in a proportion which is nearly identical to the one considered ideal for the human body (Food and Nutrition Council, 1980).
- **Minerals.** It contains more than 30 minerals, practically the complete spectrum of macro and micro minerals in an organic form which is best for assimilation.
- **Vitamins.** It contains a complete and balanced spectrum of vitamins, including the vitamin B spectrum and even a high quantity of vitamin K. It is the vegetable source with the highest amount of bioavailable B12 (200% of the RDA in 2 grams of algae).
- **Betacarotene and carotenoids.** It has one of the highest amounts of beta carotene, both in the cis and trans forms, which makes for a high degree of assimilation. Furthermore, it has a wide spectrum of 15 carotenoids, including alpha and gamma, and as science has definitively shown, it is only the natural spectrum of carotenoids, including cis and trans betacarotene, that is capable of truly antioxidant and anti-cancer activity.²

¹ Kushak, R.I., et al., *The Effect of Blue Green Algae Aphanizomenon Flos Aquae on Nutrient Assimilation in Rats*, JANA, Vol.3, n.4, Winter 2001, pp. 35-39.

² As is well known, the famous CARET and PHS studies, promoted by the US National Cancer Institute and published by the New England Journal of Medicine in 1996, were probably the biggest and longest human trials ever to test the anti-tumor activity of synthetic beta-carotene. The studies showed that synthetic betacarotene, and even just beta-carotene by itself, far from performing anti-oxidant functions, acted as oxidative and pro-tumor agents. It has since become clear that in order to achieve a strong anti-

- **Brain aminoacids.** It contains, in the proper proportions, all the aminoacids, such as phenilalanine, triptophan and trypsin, which act as precursors of the most essential neurotransmitters. This seems to be one of the main reasons why the algae has repeatedly shown to have powerful effects on brain and neurological activity.³
- **Phycocyanins.** 10% to 15% of the dry weight of the algae is represented by phycocyanins, molecules that recent studies have shown to have **powerful antiinflammatory effects**, similar to those of non steroidal antiinflammatory drugs, but of course without any of the side effects. In particular, it has been proven that phycocyanins inhibit the formation of leukotriene B4, an inflammatory metabolite of arachidonic acid.⁴
- **Polysaccharides.** Like other blue-green algae, AFA contains also a high percentage of immunomodulating polysaccharides. In particular, AFA seems to contain a novel type of polysaccharide that, when extracted and purified, has shown to be 10 times more potent in stimulating macrophage activity than ordinary LPS (lipopolysaccharides).⁵
- **EFA.** Has an excellent profile of essential fatty acids, and its Omega 6 and Omega 3 are in the ideal proportion of around 1:3. This explains, albeit partially, its ability to normalize the metabolism of fats in the body, as well as cholesterol and tryglicerides. The same study showed that AFA decreases the plasma level of arachidonic acid, thus reinforcing its general antiinflammatory activity.⁶
- **Chlorophyll.** Has a very high percentage of chlorophyll, which contributes to the cleansing and detoxification of the blood. More specifically, recent studies have confirmed that dietary sources of chlorophyll can play a significant antimutagenic and anticarcinogenic role.⁷

oxydant and tumor preventive action, it is necessary to get betacarotene both in the trans and cis form, and most of all in a natural synergy of carotenoids. See Mayne S.T., et al., *Beta-carotene, carotenoids and disease prevention in humans*, in *FASEB J.*, 10(7): 690-701 (1996); Pryor W.A., et al., *Beta-carotene: from biochemistry to clinical trials*, in *Nutr Rev.*, 58(2 Pt 1): 39-53 (2000).

³ The US orthomolecular psychiatrist dr. Gabriel Cousins performed various tests with AFA on Alzheimer patients in the '80s, and reported his remarkable successes in Cousins, G., *Journal of Orthomolecular Medicine*, Vol.VIII, n.1&2, 1985. A more recent study done at the University of New Mexico showed that AFA could cure 95% of mild traumatic brain injury in only 6 weeks, as opposed to the 70% success rate in 6 months of the standard pharmacological therapy. Valencia A., Walker J., *A multi-axial treatment paradigm for mild traumatic brain injury to achieve reparative functional metaplasticity*, 3d World Congress on Brain Injury, IBIA, Quebec City, June 1999.

⁴ Romay, C. et al., *Antioxidant and antiinflammatory properties of C-phycocyanin from blue-green algae*, in *Inflamm Res*, 1998, Jan.; 47(1): 36-41; Romay, C. et al, *Ibid.*; Romay C., et al., *Further studies on anti-inflammatory activity of phycocyanin in some animal models of inflammation*, in *Inflamm Res*, 1998, Aug; 47(8): 334-8; Romay C., et al., *Antioxidant and antiinflammatory properties...*, in *Inflamm Res*, Jan.; 47(1): 36-41; Gonzales R., et al., *Anti-inflammatory activity of phycocyanin extract in acetic acid induced colitis in rats*, in *Pharmacol Res*, 1999, Jan; 39(1): 55-9; Vadiraja BB, et al., *Hepatoprotective effect of C-phycocyanin: protection for carbon tetrachloride and R-(+)-pulegone-mediated hepatotoxicity in rats*, in *Biochem Biophys Res Commun*, 1998 Aug 19; 249(2): 428-31.

⁵ Pugh N., et al., *Isolation of three high molecular weight polysaccharides with potent immunostimulatory activity from Spirulina Platensis, Aphanizomenon Flos Aquae and Chlorella pyrenoidosa*, in *Planta Medica* (in press).

⁶ Kushak, R.I., et al., *Favorable Effects of Blue-Green Algae Aphanizomenon flos-aquae on Rat Plasma Lipids*, *JANA*, vol. 2, n°3, Jan. 2000, pp. 59-65.

⁷ Dashwood R., et al., *Chemopreventive properties of chlorophylls towards aflatoxin B1 : a review of the antimutagenicity and anticarcinogenicity data in rainbow trout*, in *Mutat Res.* 399(2):245-53 (1998); Chernomorsky S., et al., *Effect of dietary chlorophyll derivatives on mutagenesis and tumor cell growth*, in *Teratog Carcinog Mutagen*, 19(5): 313-22 (1999).

Recent studies on AFA

Consumption of *Aphanizomenon flos-aquae* Has Rapid Effects on the Circulation and Function of Immune Cells in Humans

A novel approach to nutritional mobilization of the immune system

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JANA, vol. 2, No. 3, 2000, pp. 50-58.

Objective: To examine the short-term effects of consumption of a moderate amount (1.5 grams) of the blue green algae *Aphanizomenon flos-aquae* (AFA), on the immune system.

Methods: Using a crossover placebo-controlled, randomized, double-blinded design, 21 volunteers were studied, including 5 long-term AFA consumers.

Results: Consumption of a moderate amount (1.5 grams) of the blue-green algae *Aphanizomenon flos-aquae* results in rapid changes in immune cell trafficking. Two hours after AFA consumption, a generalized mobilization of lymphocytes and monocytes, but not polymorph nucleated cells was observed. This included increases in CD3+, CD4+, and CD8+ T cell subsets and CD19+ B cells. In addition, the relative proportions and absolute numbers of natural killer (NK) cells were reduced after AFA consumption. No changes were observed in the relative proportions of n6ve versus memory T cells, neither in the CD4 or the CD8 fractions. A mild, but significant reduction in phagocytic activity was observed for polymorph nucleated cells. When freshly purified lymphocytes were exposed to AFA extract in vitro, direct activation was not induced, as evaluated by tyrosine phosphorylation and proliferative activity.

Discussion: The changes in immune cell trafficking displayed high degree of cell specificity. Long-term consumers responded stronger, with respect to altered immune cell trafficking. In vitro, AFA did not induce a direct activation of lymphocytes. These data support a signaling pathway from gut-to-CNS-to-lymphoid tissue. The signals from CNS may be crucial for the rapid changes in the general distribution and specific recruitment we observed. Moderate anti-inflammatory modulation may account for the modification of phagocytic activity.

Conclusion: Consumption of AFA leads to rapid changes in immune cell trafficking, but not direct activation of lymphocytes. Thus, AFA increases the immune surveillance without directly stimulating the immune system.

NOTE: dr. Gitte Jensen and her team are preparing a new manuscript from a study which shows that some still unknown substance contained in AFA “induces apoptosis in some human tumor cell lines” (quoted from G.Jensen, et al., *Blue-Green Algae as an Immuno-Enhacer and Biomodulator*, in *JANA*, Winter 2001, Vol.3, n°4, pp.24-30.)

Antimutagenic properties of fresh-water blue-green algae

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Folia Microbiol (Praha), 39(4), 1994, pp. 301-3

The antimutagenic properties of whole fresh-water blue-green algae *Aphanisomenon flos-aquae* from Klamath Lake, OR, USA, were tested using the Ames test. Simultaneous addition of both algae and Nitrovin (a mutagen) to the test medium did not reduce the mutagenic activity. On the other hand, addition of freeze-dried blue-green algae to the test medium 2-24 h before the application of mutagen reduced its mutagenic activity.

Favorable Effects of Blue-Green Algae *Aphanizomenon flos-aquae* on Rat Plasma Lipids

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JANA, vol. 2, No. 3, 2000, pp. 59-65

ABSTRACT

Background: Polyunsaturated fatty acids (PUFA) are essential for human health. There are indications that the lipid fraction of blue-green algae *Aphanizomenon flos-aquae* contains about 50% of PUFA and may be a good dietary source of PUFA. The purpose of this study was to investigate the effect of diets supplemented with algae on blood plasma lipids.

Methods: Rats were fed with four different semisynthetic diets: i) standard, with 5% soybean oil; ii) PUFA-free with 5% coconut oil; iii) PUFA-free with 10% algae; iv) PUFA-free with 15% algae. After 32 days the levels of plasma fatty acids, triglycerides and cholesterol were studied.

Results: Rats fed the PUFA-free diet demonstrated an absence of linolenic acid (LNA) in plasma; however, supplementation with algae resulted in the same level of LNA as controls, an increased levels of eicosapentaenoic acid and docosahexaenoic acid, and a decreased level of arachidonic acid. Dietary supplementation with 10% and 15% algae decreased the plasma cholesterol to 54% and 25% of the control level, respectively ($P < 0.0005$). Plasma triglyceride levels decreased significantly ($P < 0.005$) after diet supplementation with 15% algae.

Conclusion: Algae *Aphanizomenon flos-aquae* is a good source of PUFA and because of potential hypocholesterolemic properties should be a valuable nutritional resource.

FURTHER EFFECTS ON METABOLISM

1) Kushak R., et al., The Effect of Blue Green Algae *Aphanizomenon Flos Aquae* on Nutrient Assimilation in Rats, in *Journal of American Nutraceutical Association*, Winter 2001, Vol.3, n.4, pp.35-39.

This study showed that the addition even of a small amount of AFA (equivalent to just 2 grams a day of human consumption) promoted the growth, both organic and muscular, of rats. The group of rats fed the small amount of AFA grew 16% more than the control group. This result is remarkable especially if confronted with similar studies done with *Spirulina*, where even diets containing up to 73% of the alga did not produce any difference in relation to the control group. Further findings of this study have been: a) the AFA stimulates the production of the enzyme alpha-amylase in the pancreas. This is an important finding, especially for people with glycemic problems such as diabetes and obesity, as it is known that higher quantities of amylase not only promote better digestion of carbohydrates, but also help reducing the level of glucose in the blood; b) AFA favors a better biosynthesis of proteins, leading to a higher accumulation of proteins in tissues and organs. It seems to do that also by lowering the level of aminopeptidase-N, the enzyme responsible for protein hydrolysis.

The findings of this study are very relevant in general, but more specifically for growing children and kids, and for athletes who always need to consume more protein than average.

2) Kushak R., et al., Effect of Algae *Aphanizomenon Flos Aquae* on digestive enzyme activity and polyunsaturated fatty acids level in blood plasma, in *Gastroenterology*, 1999; 116: A559.

This study confirmed the results of fatty acids metabolism obtained in the study published in *JANA* and whose abstract is reported above. But this study adds a very important element to the picture, which further reinforces the idea that AFA is capable of normalizing sugar metabolism and all the widespread pathologies related to it (Hypoglycemia, diabetes, weight problems and obesity, etc.): AFA has shown to inhibit in a dose dependent manner the activity of the enzymes maltase and sucrase in the intestine, thus contributing to a reduction of blood glucose.