

Heavy Metal Removal

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Efficacy of spirulina extract plus zinc in patients of chronic arsenic poisoning: a randomized placebo-controlled study.

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BACKGROUND: Millions of people in Bangladesh, India, Taiwan, and Chile are consuming high concentration of arsenic through drinking water, and thousands of them have already developed chronic arsenic poisoning. There is no specific treatment. Some authors suggest the use of vitamins and minerals for more than 6 months. The present placebo-controlled double-blind study was conducted to evaluate effectiveness of spirulina extract plus zinc in the treatment of chronic arsenic poisoning. **METHODS:** Forty-one patients of chronic arsenic poisoning were randomly treated orally by either placebo (17 patients) or spirulina extract (250 mg) plus zinc (2 mg) (24 patients) twice daily for 16 weeks. Each patient was supplied with arsenic-safe drinking water by installing a locally made water filter at household level. Effectiveness of spirulina extract plus zinc was evaluated by comparing changes in skin manifestations (clinical scores), arsenic contents in urine and hair, between the placebo- and spirulina extract plus zinc-treated groups. **RESULTS:** The concentrations of total arsenic in water (without filtration) of placebo- and spirulina extract plus zinc-treated groups were 150.1 +/- 18.3 and 161.7 +/- 23.9 microg/l, respectively. Intake of these high concentrations of arsenic lead to increased excretion of arsenic in urine (72.1 +/- 14.5 microg/l in placebo-treated group and 78.4 +/- 19.1 microg/l in spirulina plus zinc-treated group). After 2 weeks of using filtered water, there were significant reduction of both arsenic intake through water and urinary arsenic excretion (8.3 +/- 3.6 microg/l and 18.4 +/- 7.3 microg/l in placebo group; 9.7 +/- 5.4 microg/l and 21.6 +/- 5.8 microg/l) in spirulina extract plus zinc-treated group. There was a sharp increase in urinary excretion of arsenic (138 +/- 43.6 microg/l) at 4 weeks following spirulina plus zinc administration and the effect was continued for another 2 weeks. Spirulina extract plus zinc removed 47.1% arsenic from scalp hair. Spirulina extract had no major adverse effect that required physician's attention. The clinical scores (median) for melanosis before and after treatment with placebo was not statistically significant ($p > 0.05$), whereas in spirulina extract plus zinc-treated group it was statistically significant ($p < 0.01$). In cases of keratosis, the median clinical scores before and after treatment was not statistically significant ($p > 0.05$) in placebo-treated group. In spirulina extract plus zinc-treated group, the clinical scores for keratosis before and after treatment was statistically significant ($p < 0.05$). **CONCLUSIONS:** Results show that spirulina extract (250 mg) plus zinc (2 mg) twice daily for 16 weeks may be useful for the treatment of chronic arsenic poisoning with melanosis and keratosis.

Protective effect of Spirulina on lead induced deleterious changes in the lipid peroxidation and endogenous antioxidants in rats.

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The present study aims to investigate the protective effect of Spirulina on lead-induced changes in the levels of lipid peroxidation and endogenous antioxidants in liver, lung, heart, kidney and brain of rats. Levels of elemental lead were also measured in the organs of rats in all experimental groups. In the liver, lung, heart and kidney of lead-exposed animals, there was a significant ($p < 0.001$) increase in the lipid peroxidation and a decrease in the levels of endogenous antioxidants. Although, Spirulina did not affect the deposition of lead in organs apart from the brain, simultaneous administration of Spirulina to lead exposed animals significantly ($p < 0.001$) inhibited lipid peroxidation and restored the levels of endogenous antioxidants to normal. To conclude, Spirulina had a significant effect on scavenging free radicals, thereby protecting the organs from damage caused by the exposure to lead. Further more, Spirulina showed a significant ($p < 0.05$) decrease in the deposition of lead in the brain. Copyright 2003 John Wiley & Sons, Ltd.

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Effect of hexane extract of spirulina in the removal of arsenic from isolated liver tissues of rat.

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The present study was conducted to investigate whether the active compound(s) of spirulina is present in its -- alcohol extract, hexane extract, DCM extract or in their residues. In phase I the accumulation of arsenic in isolated liver tissues of rat at different incubation period (15, 30, 45 minutes) was seen. In phase II arsenic-loaded liver tissues were incubated in presence and absence of alcohol extract, alcohol extraction residues, hexane extract, hexane extraction residues, DCM extract and DCM extraction residues of spirulina respectively. The percentage removal of arsenic from liver tissues by different extracts and residues of spirulina was estimated by Atomic Absorption Spectrophotometer. In phase III arsenic-loaded liver tissues were incubated in presence and absence of different concentration of hexane extract of spirulina and the percentage removal of arsenic from liver tissues was estimated. This study showed that the accumulation of arsenic in isolated liver tissue was time dependent and highest accumulation found was 0.69 microg/g tissues after 45 minutes incubation, which was highly significant. The percentage removal of arsenic from arsenic loaded liver tissues by alcohol extract, alcohol extraction residues, hexane extract, hexane extraction residues, DCM extract, DCM extraction residues were 33.8%,4.4%,83.0%,10.2%,7.3% and 2.9%, respectively. The percentage removal of arsenic by hexane extract at the concentration of 1, 10, 100 microg were 13.2%, 29.4% and 89.7%, respectively. Among the different extracts and residues of spirulina the hexane extract causes highly significant ($p<0.001$) removal. In conclusion the present study suggests that the active compound(s) of spirulina is present mostly in its hexane extract.

Publication Types:

- In Vitro

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Effect of spirulina and Liv-52 on cadmium induced toxicity in albino rats.

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Oral administration of cadmium (6mg/kg body weight/day) as cadmium chloride (CdCl₂) for 30 days resulted in a significant increase in thiobarbituric acid reactive substances (TBARS) level and a decrease in the levels of copper, zinc, iron, selenium, glutathione, superoxide dismutase, catalase, glutathione peroxidase when compared to normal control. Administration of either Liv-52 alone or in combination with spirulina produced a well pronounced protective effect in respect to these parameters in cadmium intoxicated rats. The protective effect of spirulina and Liv-52 in respect to biochemical changes were also confirmed by histopathological study in the liver and kidney sections.

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Effect of extracts from *Spirulina platensis* bioaccumulating cadmium and zinc on L929 cells.

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The uptake of cadmium and zinc by *Spirulina platensis* was investigated using a laboratory culture of this cyanobacterium. The cells were treated with metal concentrations increasing from 0.5 to 2.0 mg L⁻¹, in order to evaluate their adsorption capacity and survival potential. Afterwards, the cytotoxicity of cell extracts bioaccumulating heavy metals was evaluated on cultured L929 mouse fibroblasts. Cadmium was removed with higher yield (84.0-88.7%) than zinc (54.5-68.0%) and the maximum specific removal of these metals was 1.82 and 2.60 mg g⁻¹, respectively. Cadmium bioaccumulating algal extracts caused higher cell mortality of L929 cells than zinc accumulating ones, with a clear dose-response trend. EC(50) estimated by Trimmed Spearman-Kärber (TSK) method were 7.21 and 9.59 cells mL⁻¹ for cadmium and zinc, respectively. The capability to accumulate heavy metals could have a remarkable importance for the utilization of algal species in human or animal feeding.

Publication Types:

- Research Support, Non-U.S. Gov't

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Effects of spirulina on the number of ovary mast cells in lead-induced toxicity in rats.

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The present study investigated the protective effect of Spirulina against the lead-induced increase in mast cells in the ovary during the oestrous cycle of rats. In the ovary cortex and medulla of lead-exposed animals, there was a significant increase in the number of mast cells; however, when also treated with Spirulina, a decrease was observed. The number of mast cells when Spirulina (300 mg/kg) was used alone was not significantly different from that of the control group. These results indicate that Spirulina decreases the number of mast cells induced by lead in the cortex and medulla of rat ovary.

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Spirulina platensis feeding inhibited the anemia- and leucopenia-induced lead and cadmium in rats.

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In the present investigation, the effect of *Spirulina platensis* (Sp) was undertaken on rats fed with lead and cadmium including diet by using physiological, enzyme histochemical and stereological methods. For this aim, 50 rats were equally divided into five groups as control (C), lead (Pb), *Spirulina*+lead (Sp+Pb), cadmium (Cd), and *Spirulina*+cadmium (Sp+Cd). Red blood cell (RBC) and white blood cell (WBC) counts, packed cell volume (PCV), and haemoglobine (Hb) concentrations were determined by haemocytometric methods in blood samples collected on 30th day. Population of T lymphocyte was counted by the alpha-naphthyl acetate esterase (ANAE) staining method, and reticulocytes were counted by stereological method. The counts of RBC, WBC, and ANAE positive T lymphocyte, and the values of Hb, PCV, and MCHC were decreased in the Pb and Cd groups compared to control group. Also, the number of reticulocytes (polychromatophilic erythrocyte) increased in the Pb groups, whereas it decreased in the Cd group. On the other hand, these values were ceased by *S. platensis* in the treated groups. These results suggest that *S. platensis* supplementation may be useful in adjuvant treatment of leukemia and anemia caused by lead and cadmium toxication.

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The effects of *Panax ginseng* and *Spirulina platensis* on hepatotoxicity induced by cadmium in rats.

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Cadmium is an environmental and industrial cumulative pollutant that affects many organs, specially the liver. The protective effect of *Spirulina platensis* and *Panax ginseng* on cadmium-induced oxidative stress and hepatotoxicity was evaluated in adult female Wistar albino rats. At the end of the 1-month experimental period, all animals were fasted for 12h and liver samples were taken for the determination of malondialdehyde (MDA), reduced glutathione (GSH), superoxide dismutase (SOD) and nitric oxide (NO) levels. *S. platensis* and *P. ginseng* treatments showed marked decrease lipid peroxidation and increase of the endogenous antioxidants levels. The cadmium-induced histopathological changes were also minimized with the tested extracts. These results suggest that *S. platensis* and *P. ginseng* might play a role in reducing the toxic effect of cadmium and its antioxidant properties seem to mediate such a protective effect.

Publication Types:

- Research Support, Non-U.S. Gov't

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