ISSN No. : 0972-1266

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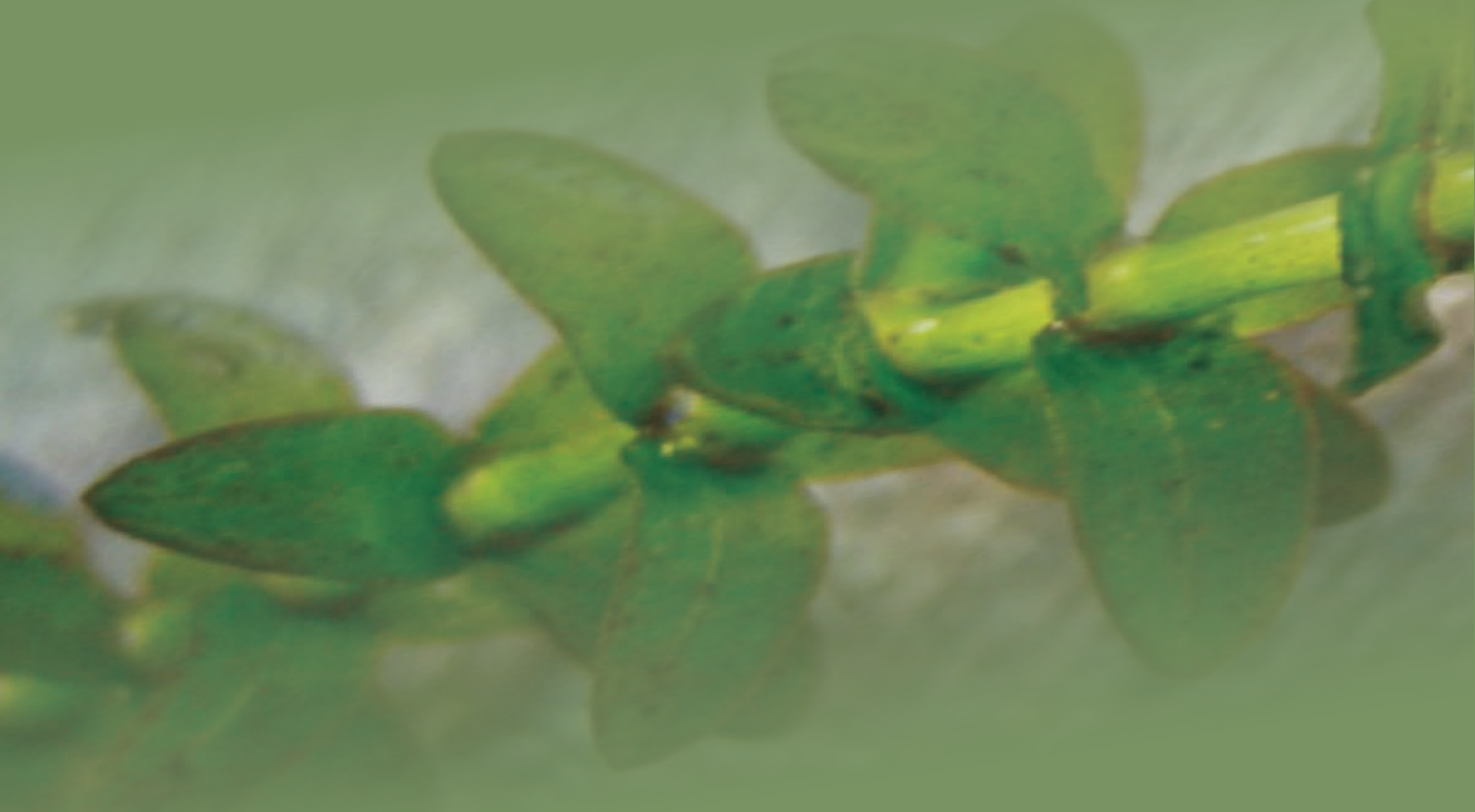
ENVIS Newsletter

Vol. 16 No. 4 November 2009

Nickel



CSIR-INDIA

Indian Institute of Toxicology Research

IN THIS ISSUE

EDITORIAL

In the continuation of series of newsletter on heavy metals (previous issues were on chromium, cadmium & lead), this time we are bringing information on “Nickel” (Ni) which triggers more hypersensitive reactions than any other metal. Nickel is an element with silvery-white lustrous appearance & a slight golden tinge. Enzymes of certain life-forms contain nickel as an active center making the metal essential for them. It may be found in different compartments of environment including rivers, lakes, oceans, soil, air, drinking water, plants, and animals. The metal is corrosion-resistant, finding many uses in alloys, as a plating, in the manufacture of coins, magnets and common household utensils, as a catalyst for hydrogenation, and in a variety of other applications like dental restorations, prostheses (hip, knee, cochlear and cardiac implants), colour pigments, cosmetics, in cigarettes, jewellery and buttons.

Nickel is released into the atmosphere by industries that make or use nickel, nickel alloys, or nickel compounds. It is also released into the atmosphere by oil-burning power plants, coal-burning power plants, and trash incinerators. Nickel released in industrial waste-water ends up in soil or sediment where it strongly attaches to particles containing iron or manganese. Recalcitrant and persistency properties keep it on special concern. Ni contaminated drinking water may cause severe damage to lungs, kidneys & gastrointestinal distress.

People can become sensitive to nickel when jewellery and other items come into contact with the skin. Itching, redness, rashes, blisters & dry patches on skin are major symptoms of nickel allergy. Once allergy is developed, people will always be sensitive to it and should avoid contact. Exposure to nickel metal and soluble compounds should not exceed 0.05 mg/cm^3 in nickel equivalents per 40-hour work week. Nickel sulfide fumes and dust are believed to be carcinogenic. Cancers of the lung and nasal sinus have resulted when workers breathed dust containing high levels of nickel compounds. The International Agency for Research on Cancer (IARC) has determined that some nickel compounds are carcinogenic to humans and that metallic nickel is a probable carcinogen for humans. The Environmental Protection Agency (EPA) has reported that nickel refinery dust and nickel subsulfide are human carcinogens. Besides being explosive in air nickel carbonyl, [$Ni(CO)_4$], is an extremely toxic gas as a result of metal toxicity combined with carbonyl's ability to give off highly toxic carbon monoxide.

Guidelines have been set by different agencies i.e. World Health Organization (WHO), Agency for Toxic Substances & Disease Registry (ATSDR), EPA & Bureau of Indian Standards (BIS) in order to limit its exposure. Despite this, several cases of Ni toxicity come to light due to lack of awareness towards its toxic potential.

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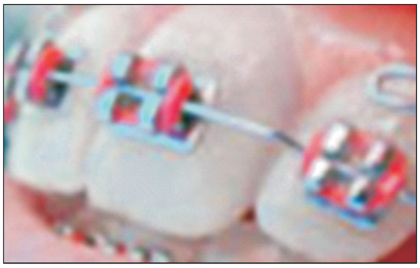
ODDS & ENDS

Air-borne heavy metal contamination to dietary vegetables: a case study from India

Continuously increasing demand for food by burgeoning human population and food chain associated health hazards due to environmental release of toxic chemicals have become the subject of global concern. Heavy metal contamination of vegetables through soil, water, and air-borne sources may pose a serious threat to human health in longrun. Accumulation of heavy metals in vegetables has been well linked with soil heavy metal and irrigation water from long back. Atmospheric deposition has now been identified as the principal source of heavy metals entering into plants and soil especially around urban-industrial areas. The metal aerosols deposited onto the soil can be absorbed through root or deposited on leaves and fruits and absorbed directly. Contamination of edible parts of three dietary vegetables, Spinach (*Spinacia oleracea L.*), Radish (*Raphanus sativus L.*), and Tomato (*Lycopersicon esculentum Mill.*) by air-borne cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), and lead (Pb) was determined using pot culture experiments at three sites in the city of Varanasi, India. The data revealed that although Cr and Cu in vegetables remained below their safe limits, about 68% of the total samples contained Cd, Ni, and Pb above their respective safe limits of 1.5, 1.5, and 2.5 $\mu g\ g^{-1}$. Site wise synchrony and air accumulation factor (AAF) indicated that atmospheric deposition was the main contributor of metal contamination to vegetables. The study suggests that if the present trends of atmospheric deposition are continued, air-borne heavy metals will contaminate the agricultural produce with long-term health implications.

Bulletin of Environmental Contamination and Toxicology 2009, doi 10.1007/s00128-009-9879-1

Nickel-based (Ni-Cr and Ni-Cr-Be) alloys used in dental restorations may be a potential cause for immune-mediated hypersensitivity



Nickel-based alloys like Ni–Cr and Ni–Cr–Be are used for preparation of dental prosthesis, base plates, anchoring clamps and clamping systems of removable dental prostheses because it is corrosion and wear-resistant, cold-formable, colorfast and has good castability. Although it is widely used in orthodontics, its potential biologic hazards, hypersensitivity in particular, are still uncertain as yet and only a few studies *in vivo* have considered the biocompatibility. However, several case reports show adverse effects of immunologic alterations, such as urticaria, respiratory disease, nickel contact dermatitis, microscopic hematuria and proteinuria, and even exacerbated to hepatocyte injury and renal injury. So nickel-based alloy used in dental restorations may be a potential cause for immune-mediated hypersensitivity. The metal surface would occur electrochemical corrosion as metal edge of porcelain-fused-to-nichrome crown exposed to oral cavity rich in electrolytes after restoration, and metal ion would release to oral cavity then come into contact with cells and tissues in the immediate environment, or be distributed throughout the body, mainly to the intestine canal. Once these ions are not biocompatible, the human system may be injured (toxicity and risk of sensitization) if they are absorbed in sufficient quantity. Thus, it is necessary to determine the long-term biocompatibility properties of nickel-based alloy, reduce sensitization, and grasp the information of individual differences in the appearance of adverse reactions in further research.

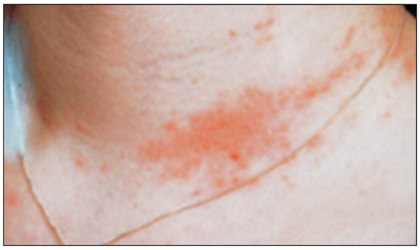
Medical Hypotheses 2009, doi:10.1016/j.mehy.2009.04.04.1

Effects of nickel on eosinophil survival

Accessories, watches, coins and other items containing metal sometimes cause contact dermatitis and metal allergy. Among metals, nickel in alloys is ionized by sweat on the surface of the skin and exhibits particularly marked irritancy and allergenicity. Eosinophils play important roles in allergy so the effect of nickel on eosinophils was studied. It was prepared from the peritoneal cavity in rats immunized with *Ascaris suum* extract. Purified rat eosinophils were incubated in the presence of various kinds of metals including nickel. The viability of eosinophils was analyzed using a flow cytometer. When rat eosinophils were incubated for 3 days in the presence of nickel chloride at 30-1,000 µM, the viability of eosinophils was decreased in a concentration-dependent manner. Nickel chloride at 300 µM significantly increased the percentage of annexin V+ PI- eosinophils. The population of annexin V+ PI- eosinophils was also increased by nickel sulfate, cobalt chloride and zinc sulfate. The binding of nickel ions to eosinophils was detected by flow cytometer. Nickel ions bind to eosinophils and decrease the viability of eosinophils through the induction of apoptosis. Nickel ions may exhibit activity which modifies the function of eosinophils in allergy.

International Archives of Allergy and Immunology 2009, 149/1, 57-60

Contact sensitization in venous eczema: Preliminary results of patch testing with Indian standard series and topical medicaments



Sensitization to metals like potassium dichromate, nickel sulfate and cobalt chloride from day to day exposure is frequent. Nickel has been the most notorious sensitizer, perhaps due to its widespread use in imitation jewellery, watches, buttons, zippers, rings, doorknobs, batteries, metal-cutting fluids, coins, orthopedic plates, keys, spectacle frames and kitchenware. Similarly, cobalt chloride is a component of paints, jewellery, zippers, buttons, utensils, hair dyes and cosmetics while potassium dichromate finds use in cement, leather tanning, textile dyes, wood preservatives, photography, welding, shoe polishes, paints, detergents, electroplating and automobile industry. In this study, 3, 9 and 5% of the patients reacted to potassium dichromate, nickel and cobalt respectively and were sensitized probably from articles of daily use. Nickel sensitivity in one female patient could be correlated to the use of trinkets. Patients sensitive to potassium dichromate and cobalt were engaged in masonry while another patient sensitive to thiuram mix was a spare time agriculturist, the occupations well known to predispose for sensitization by these allergens.

Elimination of allergens/topical medications causing contact dermatitis in venous eczema, which poses a significant problem in its chronicity and treatment, provides the basis for better therapeutic outcome. The objective of this study was to determine the pattern of contact sensitization in venous eczema patients in Himachal Pradesh (India). Thirty-four patients (M:F, 31:3) and 10 controls (M:F, 6:4) were patch tested with Indian standard series and 10 commonly used topical medicaments. Positive patch test results were seen in 50% (M:F, 16:1) of the patients. Common allergens were Fragrance mix (15%), p-phenylendiamine (15%), nickel (9%), wool alcohol (9%), chinoform (9%), balsum of Peru (5%), cobalt chloride (5%), potassium dichromate (3%), epoxy resin (3%), thiuram mix (3%) and formaldehyde (3%). Only sisomycin and miconazole among the topical medications elicited a positive patch test reaction in 3 and 5% patients, respectively. Neomycin contact sensitivity was not seen in any of the patients. One patient who had exacerbation of venous eczema following accidental application of topical diclofenac showed a positive patch test reaction to it. Patch test should be used to identify the topical agents that may be responsible for perpetuation or aggravation of eczema, especially in patients who do not improve despite adequate treatment of other underlying causes.

Indian Journal of Dermatology Venereology and Leprology 2009, 75/2, 136-141

Dietary intake of nickel and zinc by young children

The daily dietary intake of nickel (Ni) and zinc (Zn) by 42 young children, 21 boys and 21 girls, from 4 to 7 years of age, living in urban and rural areas of Germany and having different food consumption behaviour, was determined by the duplicate method with a 7-day sampling period. Dietary records were also kept by the children's parents for the 7-day sampling period. Individual reported food items were identified, assigned to food groups and, together with known Ni and Zn concentrations of foodstuffs, daily intake rates were calculated. The same method was used for calculations of the energy, fat, protein and carbohydrate intake rates.

The levels in the food duplicates, determined by atomic absorption spectrometry, were in the range of 69–2000 ì g Ni/kg dry weight (geometric mean (GM): 348) and 7.1–43 mg Zn/kg dry weight (GM: 17.5). Daily intake rates based on the 294 individual food duplicate analyses were 12–560 ì g Ni/d (GM: 92.3) and 1.5–11 mg Zn/d (GM: 4.63). The results from the dietary records were 35–1050 ì g Ni/d (GM: 123) and 1.7–15 mg Zn/d (GM: 5.35).

The results of the daily intake rates from both methods showed a correlation with regard to Zn (r=0.56), but no correlation was found between either the Ni intake rates determined with both methods or between the Ni intake rates measured by the duplicate method and calculated intake rates from the dietary records of energy, fat, protein, carbohydrates or drinking water. In the case of nickel, the discrepancies between the methods lead one to suppose that the main factors influencing Ni intake by food are not directly caused by easily assessable food ingredients themselves. It is possible that other factors, such as contaminated drinking water or the transition of Ni from kettles or other household utensils made from stainless steel into the food, may be more relevant. In addition there are some foodstuffs with great variations in concentrations, often influenced by the growing area and environmental factors. Further, some food groups naturally high in Nickel like nuts, cocoa or teas might not have been kept sufficient within the records. In summary, the dietary record method gave sufficient results for Zn, but is insufficient for Ni.

Based on the food duplicate analysis, children living in urban areas with consumption of food products from a family-owned garden or the surrounding area and/or products from domestic animals of the surrounding area had about one-third higher Ni levels in their food than children either living in an urban area or children consuming products exclusively from the supermarket. Only slight differences were found with regard to Zn.

Compared to the recommendations of the German Society of Nutrition (DGE) (25–30 ì g Ni/d and 5.0 mg Zn/d), the participants of the study had a clearly increased Ni and, in view of the geometric mean value, a nearly adequate Zn intake. Health risks are especially given with regard to the influence of nickel intake by food on dermatitis for nickel-sensitive individuals.

Journal of Trace Elements in Medicine and Biology 2009, 23/ 3, 183-194

Nickel allergy, how deep?

A 41-year-old woman was referred to Cardiology Unit to evaluate the feasibility of a percutaneous closure of her 20-mm atrial septal defect. During the last few months she had increasing dyspnoea and an echocardiographic study had disclosed an atrial septal defect with significant right ventricular enlargement. Her past medical history was silent, except for Nickel Ni^{2+} allergy confirmed by a skin patch test. Ni^{2+} allergy is a problematic issue in patients scheduled for Ni^{2+}-containing devices. The atrial septal occluder device generally used consists of a metallic alloy composed of 55% nickel and 45% titanium.

Acta Cardiologica 2009, 64/1, 104-106

Assessment of ground water quality for drinking purpose, District Nainital, Uttarakhand, India

Nickel at trace level is essential to human nutrition and no systemic poisoning from nickel is known in this range. The level of nickel usually found in food and water is not considered a serious health hazard. Some of the important nickel minerals include garnierite, nickeliferous limonite and pentiandite. Certain nickel compounds have carcinogenic effects on animals; however, soluble compounds are not currently regarded as human or animal carcinogens.

The ground water quality of District Nainital (Uttarakhand, India) has been assessed to see the suitability of ground water for drinking and irrigation applications. This study examines the suitability of ground water including spring water for drinking purposes. Forty ground water samples (including 28 spring samples) were collected during pre- and post-monsoon seasons and analyzed for various water quality constituents. The hydrochemical and bacteriological data was analyzed with reference to Bureau of Indian Standards (BIS) and World Health Organization (WHO) standards and their hydrochemical facies were determined. The concentration of total dissolved solids (TDS) exceeds the desirable limit of 500 mg/L in about 10% of the samples, alkalinity values exceed the desirable limit of 200 mg/L in about 30% of the samples, and total hardness values exceed the desirable limit of 300 mg/L in 15% of the samples. However, no sample crosses the maximum permissible limit for TDS, alkalinity, hardness, calcium, magnesium, chloride, sulfate, nitrate, and fluoride. The concentration of chloride, sulfate, nitrate, and fluoride are well within the desirable limit at all the locations. The bacteriological analysis of the samples does not show any sign of bacterial contamination in hand pump and tube-well water samples. However, in the case of spring water samples, six samples exceed the permissible limit of ten coliforms per 100 ml of sample. It is recommended that water drawn from such sources should be properly disinfected before being used for drinking and other domestic applications. Among the metal ions, the concentration of iron and lead exceeds the permissible limit at one location whereas the concentration of nickel exceeds the permissible limit in 60 and 32.5% of the samples during pre- and post-monsoon seasons, respectively. The grouping of samples according to their hydrochemical facies indicates that majority of the samples fall in Ca–Mg–HCO_3 hydrochemical facies.

Environmental Monitoring and Assessment 2009, doi 10.1007/s10661-009-1031-5

Heterochromatinization as a potential mechanism of nickel-induced carcinogenesis

Nickel compounds have demonstrated carcinogenicity without any associated mutagenesis, suggesting that its mechanism of carcinogenesis is epigenetic in nature. Epigenetics refers to heritable patterns of gene expression that do not depend on alterations of the genomic DNA sequence. One such potential mechanism is the heterochromatinization of chromatin within a region of the genome containing a gene sequence, inhibiting any further molecular interactions with that underlying gene sequence and effectively inactivating that gene. Nickel ion (Ni^{2+}) condenses chromatin to a greater extent than the natural divalent cation of the cell, magnesium ion (Mg^{2+}) observed by atomic force microscopy and circular dichroism spectropolarimetry. In addition, Model experimental system that incorporates a transgene was used, the bacterial xanthine guanine phosphoribosyl transferase gene (gpt), differentially near, and far from, a heterochromatic region of the genome, in two cell lines, the Chinese hamster V79-derived G12 and G10 cells, respectively, to demonstrate by a DNase I protection assay that nickel treatement protects the gpt gene sequence from DNase I exonuclease digestion in the G12 cells, but not in the G10 cells. Conclude that condensation of chromatin by nickel is a potential mechanism of nickel-mediated gene regulation.

Biochemistry 2009, 48(21), 4626-4632

Protective role of vitamin E on nickel and/or chromium induced oxidative stress in the mouse ovary

Chromium and nickel individually are considered potential health hazards. These are major components of various steels and their salts are used extensively in plating. Thus, both these metals are important materials in many industries and it is not possible to stop exposure to them.

Vitamin E is a proven antioxidant and has been shown to have protective effect against metal induced toxicity. In this study, *in vivo* effects of nickel chloride ($NiCl_2$; 8 and 16 mg/kg body weight) and/or potassium dichromate ($K_2Cr_2O_7$; 5 and 10 mg/kg body weight) in the ovary of adult mice were investigated. The protective role of vitamin E (2 mg/kg body weight) along with their combination was also studied. Nickel and/or chromium to mice enhanced the levels of lipid peroxides in the ovary, which was accompanied by a significant decline in the levels of protein, glutathione, total ascorbic acid and activities of superoxide dismutase and catalase. Supplementation of vitamin E along with $NiCl_2$ + $K_2Cr_2O_7$ significantly lowered the levels of lipid peroxidation and enhanced the antioxidant status. Findings of the present study suggest that vitamin E exerts its protective effect against nickel and/or chromium induced toxicity by preventing lipid peroxidation and protecting antioxidant system in the mouse ovary.

Food and Chemical Toxicology 2009, 47/ 6, 1368-1371

Nickel-induced oxidative stress and the role of antioxidant defence in rice seedlings

Nickel (Ni) is essential for many plant species to complete their life cycle however, when present at high concentrations in the soil environment, Ni becomes phytotoxic. Soils contaminated by industrial waste and mine waste also frequently contain toxic concentrations of heavy metals. Rice is a staple food crop for the majority of the world population and production of this crop is limited in many parts of the world due to a variety of abiotic stresses including toxic levels of Ni. It is readily taken up by rice roots and therefore, Ni toxicity is a problem for rice crop in many areas of the world that have high soil Ni contents. Ni-induced generation of reactive oxygen species (ROS), induction of oxidative stress, redox status of antioxidant molecules, and alterations in the activities of antioxidant enzymes in rice plants growing under increasing levels of Ni toxicity.

Seedlings of rice (*Oryza sativa L.*) cv. Pant-12 grown in sand cultures containing 200 and 400 ì M $NiSO_4$, showed a decrease in length and fresh weight of roots and shoots. Nickel was readily taken up by rice seedlings and the concentration was higher in roots than shoots. Nickel-treated seedlings showed increased rates of superoxide anion (O^{2-}) production, elevated levels of H_2O_2 and thiobarbituric acid reactive substances (TBARS) demonstrating enhanced lipid peroxidation, and a decline in protein thiol levels indicative of increased protein oxidation compared to controls. With progressively higher Ni concentrations, non-protein thiol and ascorbate (AsA) increased, whereas the level of low-molecular-weight thiols (such as glutathione and hydroxyl-methyl glutathione), the ratio of these thiols to their corresponding disulphides, and the ratio of AsA to dehydroascorbic acid declined in the seedlings. Among the antioxidant enzymes studied, the activities of all isoforms of superoxide dismutase (Cu-Zn SOD, Mn SOD and Fe SOD), guaiacol peroxidases (GPX) and ascorbate peroxidase (APX) increased in Ni-treated seedlings, while no clear alteration in catalase activity was evident. Activity of the ascorbate-glutathione cycle enzymes monodehydroascorbate reductase (MDHAR), dehydroascorbate reductase (DHAR) and glutathione reductase (GR)—significantly increased in Ni-treated seedlings. However such increase was apparently insufficient to maintain the intracellular redox balance. Results suggest that Ni induces oxidative stress in rice plants, resulting in enhanced lipid peroxidation and decline in protein thiol levels, and that (hydroxyl-methyl) glutathione and AsA in conjunction with Cu-Zn SOD, GPX and APX are involved in stress response.

Plant Growth Regulation 2009, 59/1, 37-49

Azadirachta indica leaf powder as a biosorbent for Ni (II) in aqueous medium

Nickel is a common pollutant arising from many electroplating and vegetable fat producing industries, metal mining and processing as well as other industrial, urban and agricultural activities. Even at relatively low concentrations, it could be highly toxic towards plant and animal life and it is necessary to remove or recover the metals from the industrial discharges before being allowed to interact with the natural environment.

In ths study *Azadirachta indica* leaves are converted to a fine powder for use as a biosorbent for the removal of metal ions in aqueous solution. Adsorptive interactions between Ni (II) and the powder were studied under a variety of conditions involving variations in pH, Ni (II) concentration, biosorbent amount, interaction time and temperature, all in single batch processes. The experimental data have been interpreted on the basis of existing mathematical models of equilibrium kinetics and thermodynamics. The biosorption of Ni (II) increased in the pH range of 2.0–5.0 with 92.6% adsorption at pH 5.0 for the highest amount of the biosorbent (4 g/L). The biosorption followed second-order kinetics and intra-particle diffusion was likely to have significant influence in controlling the process. The Langmuir monolayer adsorption capacity varied from 2.4 to 9.1 mg/g and the equilibrium coefficient from 1.09 to 2.78 L/g with strong indication that the Ni (II) ions were held on the biosorbent surface by formation of an adsorption complex. The thermodynamic parameters showed the process to be exothermic in nature supported by appropriate ranges of values of enthalpy change, entropy change and Gibbs energy change.

Journal of Hazardous Materials 2009, 165/ 1-3, 271-278

Ecophysiological tolerance of *Elodea canadensis* to nickel exposure

Aquatic macrophytes have attracted the attention of ecotoxicologists all over the world to address a wide variety of topics such as the cleanup of water bodies, sewage ponds, domestic primary effluent treatment plants, compost and landfill leachate toxicity studies, the biogeochemical cycling of trace elements in fly ash settling ponds, the treatment of coal mining drainage and recalcitrant waste water.

Biological accumulations of nickel and concomitant ecophysiological responses were studied in the leaves of *Elodea canadensis* (Canadian waterweed) treated with different concentrations of Ni (1–50 ì M) for 5 d. In low concentrations nickel was accumulated mainly in the soluble protein fraction, which correlated with its highest observed accumulation coefficient. In higher concentrations, Ni binding in the non-protein soluble fraction was observed. The effects of increasing nickel concentrations on the accumulation of photosynthetic pigments, gas exchange rates, lipid peroxidation, biosynthesis of thiol-containing compounds and the activity of selected enzymes – markers of oxidative stress were investigated. The appearance of several new polypeptides with apparent molecular weights below 20 kDa, was found by SDS–PAGE in Ni-treated Elodea leaves. The results indicate that Ni, in concentrations up to 10 ì M could induce sub-lethal oxidative stress in Elodea leaves. In response, plants developed detoxification mechanisms including an enhanced biosynthesis of thiol-containing compounds which facilitated Ni accumulation and sequestration in plant tissues effectively. Hence, *E. canadensis* could be used in the biological removal of Ni from polluted water up to 10 ì M concentration.

Chemosphere 2009, 77/3, 392-398

A severe reaction to Ni-containing orthodontic appliances

In daily orthodontic practice, a variety of metallic alloys, such as stainless steel, cobalt-chromium, nickel-titanium and beta-titanium, are used. The percentage of nickel in the appliances, auxiliaries, and utilities used in orthodontics ranges from 8% to > 50%. Leaching of these metallic components may be a potential trigger to an allergic reaction.

Nickel is a strong immunologic sensitizer and may result in contact hypersensitivity. The hypersensitivity reaction to nickel is due to a direct relationship with the presence of this metal in the environment and may be caused by ingestion or direct contact with the skin and/or mucosa. Nickel-induced contact dermatitis is a Type IV delayed hypersensitivity immune response occurring at least 24 hours after exposure. This study reports a severe reaction to nickel-containing orthodontic appliances in an adult female patient, which occurred after the surgical exposure of her impacted teeth. Exposure to nickel-containing orthodontic appliances may cause intra- or extraoral allergic reactions. Nickel is the most typical antigen implicated in causing allergic contact dermatitis, which is a Type IV delayed hypersensitivity immune response. This report presents an unusual reaction to nickel during the orthodontic treatment of an adult female patient. The patient had no previous history of allergy and had been wearing fixed metal upper appliances while in orthodontic treatment to assist the eruption of her impacted teeth. The adverse hypersensitivity reactions appeared only after the surgical exposure and included severe signs of eczematic and urticarial reactions of the face with redness, irritation, itching, eczema, soreness, fissuring, and desquamation as well as intraoral diffuse red zones. Diagnostic patch testing performed by the allergist revealed sensitization to nickel (++++ score). Treatment was achieved with nickel-free appliances.

The Angle Orthodontist, 2008, 79/1, 186–192

Biosorption of nickel from aqueous solutions by *Acacia leucocephala* bark: Kinetics and equilibrium studies

The biosorption of nickel (II) ions from aqueous solution by *Acacia leucocephala* bark was studied in a batch adsorption system as a function of pH, initial metal ion concentration, adsorbent dosage, contact time and temperature. The maximum Ni (II) adsorption was obtained at pH 5. Further, the biosorbents were characterized by Fourier Transformer Infrared Spectroscopy (FTIR). The experimental data were analysed

using three sorption kinetic models viz., the pseudo-first- and second-order equations and the intraparticle diffusion model. Results show that the pseudo-second-order equation provides the best correlation for the biosorption process. The equilibrium nature of Ni (II) adsorption at different temperatures of 30, 40 and 50 °C have been described by the Langmuir and Freundlich isotherm models. The equilibrium data fit well Langmuir isotherm. The monolayer adsorption capacity of *Acacia leucocephala* bark as obtained from Langmuir isotherm at 30 °C was found to be 294.1 mg/g. The Chi-square (÷2) and Sum of the square errors (SSE) tests were also carried out to find the best fit adsorption isotherm and kinetic model. Isotherms have been used to determine thermodynamic parameters of the process, viz., free energy change (ÄG°), enthalpy change (ÄH°), and entropy change (ÄS°) were calculated indicating that this system was a spontaneous and endothermic process. This investigation emphasized that *Acacia leucocephala* bark may be utilized as a low cost adsorbent for nickel removal.

Colloids and Surfaces B: Biointerfaces 2009, 74/1, 260-265

Removal of Nickel (II) from aqueous solution by adsorption on agricultural waste biomass using a response surface methodological approach

Agricultural biomasses mainly consist of lignin, cellulose, hemi-cellulose and some proteins which make them effective adsorbent for heavy metal cations. In this study, the combined effect of adsorbent dose, pH and agitation speed on nickel removal from aqueous medium by sugarcane bagasse has been investigated using central composite face-centered experimental design in response surface methodology (RSM) by Design Expert Version 6.0.10. Batch mode experiments were carried out to assess the adsorption equilibrium. The influence of three parameters on the removal of nickel was also examined using a response surface methodological approach. The central composite face-centered experimental design in response surface methodology (RSM) by Design Expert Version 6.0.10 (Stat Ease, USA) was used for designing the experiments as well as for full response surface estimation. The optimum conditions for maximum removal of nickel from an aqueous solution of 50 mg/L were as follows: adsorbent dose (1500 mg/L), pH (7.52) and stirring speed (150 rpm). This was evidenced by the higher value of coefficient of determination (r^2 = 0.9873).

Bioresource Technology 2008, 99/5, 1325-1331

Impact of sewage irrigation on speciation of nickel in soils and its accumulation in crops of industrial towns of Punjab.

Analysis of soil samples collected from sewage and tube well irrigated soils of Ludhiana, Amritsar Jalandhar and Mandi Gobindgarh, revealed that Diethylene triamine penta-acetic acid extractable nickel (DTPA-Ni) was found to be higher in sewage fed soils. Sewage irrigation increased soil DTPA-Ni content by 3.04 times over the tube well irrigated soils. The content of DTPA-Ni showed decreasing trend with depth. Hydrogen concentration (pH) was negatively and significantly correlated with DTPA-Ni nickel whereas, organic carbon and total Ni show positive and significant correlation. Sequential fractionation was carried out to partition Ni into fractions namely exchangeable and water soluble, organic bound, carbonate bound, Mn oxides bound, amorphous Fe oxides, crystalline Fe oxides bound and residual. Plant availability of these fractions is believed to decrease in the above order. Sequential fractionation indicated that every extracted fraction exhibited increase in Ni content with sewage irrigation with most prominent increases occurring in the organic and oxide fractions. The lowest amount of Ni in exchangeable and water soluble and the highest in residual pools testify that plants grown on these soils may not suffer from Ni toxicity. Though all the crops irrigated with sewage water had appreciably higher concentration of Ni as compared to the crops raised with tube-well water yet raya (*Brassica juncea*) and toria (*Brassica campestris*) accumulated higher content of heavy metals as compared to other crops, with higher content in roots than shoots. Transport index suggested that major part of taken up Ni is translocated to top parts of plant. Based on values of transport indices, different crops maybe arranged as toria > raya = maize > bajra > lady finger. As the plants take up nickel readily and there is danger of its excessive accumulation in plant organs and devaluation of the plant products. This is topical issue particularly in crops used for direct consumption.

Journal of Environmental Biology 2008, 29(5), 793-798

DID YOU KNOW ?

- **Smoke of one cigarette contains about 0.04–0.58 µg of nickel.**
- **Nickel is used for the manufacture of stainless steel, which is mostly used to produce food processing equipment and containers.**
- **Food is the major source of nickel exposure for the general population.**
- **Nickel can cause dermatitis, dizziness, headache, nausea and cancer.**
- **Nickel carbonyl is the volatile compound which is known to be a lung carcinogen when inhaled.**

CURRENT CONCERNS

Most of the dietary items and food contain nickel which is considered to be a major source of exposure for the general population. It is a ubiquitous metal so can not be completely avoided from diet but careful selection of food with relatively low nickel concentration can help to control nickel dermatitis. A daily dietary requirement of nickel is 25-35µg but an average diet supplies 300-600 ì g to the human body per day. The presence of sufficient amounts of nickel in the diet of a nickel-sensitive person can stimulate dermatitis. Therefore, knowledge of the presence of nickel in food is helpful for the management of nickel allergy. List of food items containing nickel is given here:

Food with high nickel content (more than 0.5 mg/kg): Whole wheat, whole grain, rye, oat, millet, buckwheat, cocoa, chocolate, tea, gelatin, baking powder, soy products, red kidney beans, legumes: peas, lentils, peanut, soya beans and chickpeas, dried fruits, canned foods, beverages, strong licorice, and certain vitamin supplements.

Food with medium nickel content (0.1-0.5 mg/kg): Mushrooms, oysters, milk chocolate, eggs, raspberries, blackcurrant, cloudberries, kale, parsley, garlic, parsnip, horseradish, corn flour, rye, barley & rice.

Food with Low nickel content (less than 0.1 mg/kg): Meat, ham, sausage, poultry, liver, kidney, cucumber, cheese, milk, yogurt, onion, cabbage, beetroot, spinach, salad, carrots, potatoes, fish, squash, apple, pear & strawberries.

REGULATORY TRENDS

The permissible limits of nickel in various media and commodities should not exceed values which are mentioned below:

Focus	Level	Agency
Ambient air	1-8 hr Time Weighted Average (TWA): 1 mg/m^3	Occupational Safety& Health Administration
Drinking water	0.1 mg/L	Environmental Protection Agency & Agency for Toxic Substances & Disease Registry
	0.5 mg/L	World Health Organization
	0.02 mg/L	The Prevention of Food Adulteration Act & Rules.

GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL POLLUTANTS EFFLUENTS

Metal	Inland Surface water	Public Sewers	Land of irrigation	Marine/Costal areas
Nickel (as Ni), mg/l, max	3.0	3.0	--	50

LIMITS FOR FOOD ITEMS

Metal	Food items	Limits	Source
Nickel	All hydrogenated, partially hydrogenated, interesterified vegetable oils and fats such as vanaspati, table margarine, bakery and industrial margarine, bakery shortening, fat spread and partially hydrogenated soybean oil	1.5 ppm	The Prevention of Food Adulteration Act & Rules.
	Hydrogenated Vegetable Oil	0.5 ppm	Ecomark

ON THE LIGHTER SIDE

Progression

Worried patient: 'Doctor, I'm very worried. I'm still suffering from exhaustion and fatigue when I come home from work every evening.'

Doctor: 'Oh, that's nothing to worry about. Just have a few drinks before your dinner - that will soon wake you up.'

Patient: 'Thanks very much, doctor! But when I consulted you before, you told me to cut out drinking alcohol completely.'

Doctor: 'Yes, so I did. But that was last week, old chap - and medical science has progressed enormously since then.'

ON THE WEB

http://www.inchem.org/documents/ehc/ehc/ehc108.htm

Link provides information on effects of chemicals on human health and environment.

http://www.who.int/entity/water_sanitation_health/gdwqrevision/nickel2005.pdf

Provides information on nickel including identity, physic-chemical properties, major uses, sources in drinking-water, environmental fate, environmental levels, human exposure, kinetics and metabolism in laboratory animals and in humans.

http://www.atsdr.cdc.gov/toxprofiles/tp15.html

Agency for toxic substances and disease registry provides a document entitled “Toxicological Profile for Nickel”.

CONFERENCES

4th International Conference on Nano Science and Technology, Mumbai, India

17-20 February, 2010

Website: http://www.iconsat2010.in

Email: kishorek@gmail.com

Recent Trends in Environmental Toxicology, Beed, India

8-9 February, 2010

Website: http://www.milliyasrcollege.org

Email: e_bareed@yahoo.co.in

4th International Congress of Chemistry and Environment ICCE 2009, Ubonratchathani, Thailand

21-23 January, 2010

Website: http://www.chemenviron.org

Email: conference@chemenviron.org

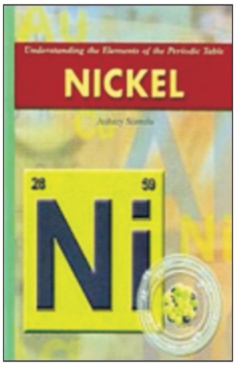
Water Pollution 2010, Bucharest, Romania

9-11 June, 2010

Website: http://www.wessex.ac.uk/10-conferences/water-pollution-2010.html

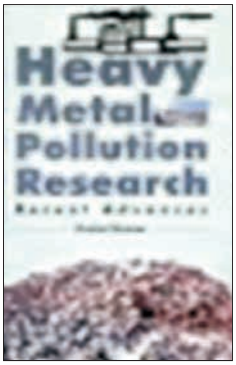
Email: ajones@wessex.ac.uk

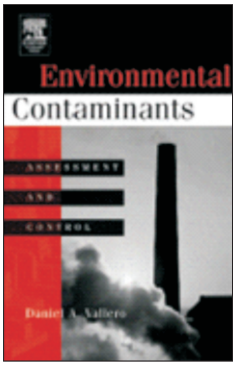
BOOK STOP



Nickel (Understanding the elements of the periodic table)
Author: Aubrey Stimola
Publisher: The Rosen Publishing Group
ISBN-140420704X, 9781404207042

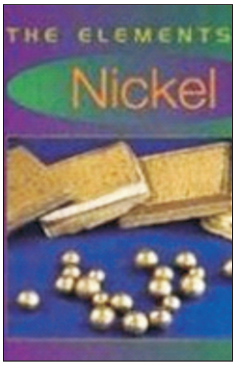
Heavy Metal Pollution Research: Recent Advances
Editor: Arvind Kumar
Publisher: Daya Books
ISBN: 8170353858, 9788170353850





Environmental Contaminants: Assessment and Control
Author: Daniel Vallero
Publisher: Academic Press
ISBN-13: 9780127100579
ISBN-10: 0127100571

Nickel
Author: Giles Sparrow
Publisher: Marshall Cavendish
ISBN: 0761418113, 9780761418115



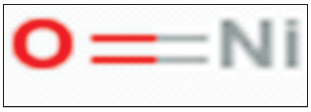
MINI PROFILE OF NICKEL OXIDE

SYNONYMS: Bunsenite, ci-77777, green nickel oxide, mononickel oxide, nickel (II)-oxide, nickelous oxide, nickel- (2+)-oxide, nickel oxide, nickel protoxide.

CAS RN: 1313-99-1

MOLECULAR FORMULA: NiO

MOLECULAR STRUCTURE:



MOLECULAR WEIGHT: 74.69

PROPERTIES: Olive green crystals, green powder, greenish-black cubic crystals, yellow when hot, odorless, m.pt: 1955 °C, specific gravity: 7.45, soluble in acids, potassium cyanide & ammonium hydroxide, insoluble in caustic solutions & water.

USES: It is used in fuel cell electrodes, in production of active nickel catalysts, electroplating, colouring and decolourising glass. It is also used in the manufacture of nickel salts which can be used to make refined nickel oxide. It is used in non-metallic resistance thermometers or thermistors which are temperature-sensitive semiconducting ceramics.

TOXICITY DATA:

Scu-mus LD_{50}: 50 mg/kg

Oral- rat LD_{50}: >5000 mg/kg

Route	Symptoms	First Aid	Target Organ
Inhalation/ Ingestion	Can cause headaches, dizziness, coughing, sore throat, and shortness of breath. May cause irritation to the gastro-intestinal tract. Large oral dose may cause nausea, vomiting, abdominal pain and diarrhea.	Shift the person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.	Respiratory system & gastro-intestinal tract
Contact	Causes irritation, redness, pain & may cause allergic dermatitis.	Remove contaminated clothing and shoes. Immediately flush skin with plenty of soap and water. Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.	Skin & eyes

PERSONAL PROTECTION: Rubber gloves, safety glasses & respirator.

HANDLING AND STORAGE: Store in a tightly sealed container in a cool & dry area. Wash thoroughly after handling.

MAY WE
HELP YOU

To keep you abreast with the effects of chemicals on the environment and health, the ENVIS Centre of Indian Institute of Toxicology Research, deals with:

Maintenance of toxicology information database on chemicals

Information collection, collation and dissemination

Toxic chemical related query response service

Preparation of monograph on specified chemicals of current concern

Publishing Abstract of Current Literature in Toxicology

for further details do write to

Scientist In-Charge

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