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Evaluation of Nickel in Paints Scrapings Obtained from Selected Rural Areas in Lagos, Nigeria.

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Research Article

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ABSTRACT

The primary aim of this study was to evaluate the occurrence and concentrations of nickel in painted walls of selected rural residential buildings in Lagos, Nigeria with a view to determine the health risk of the occupants. Microorganisms isolated were *Bacillus subtilis, B. brevis, B. megaterium, B. circulans* and *Enterobacter gergoviae* with population density ranging from 1.0 - 2.1 and 0.5 -1.9 x 10^5 cfu/g in the outdoor and indoor samples respectively. Nickel concentration was determined by the atomic absorption spectrometry (AAS). Here we reported the detection of nickel in all samples obtained from thirteen rural locations with concentrations ranging from 2.240 to 11.353 and from 1.241 to 13.309 mg/l in outdoor and indoor samples respectively. Nickel concentrations showed the levels were above the maximum permissible limits recommended by USEPA. The rural populace in these areas may be at risk.

INTRODUCTION

Nickel (atomic number 28, atomic mass 58.71) is a common group III transition metal that comprises 0.0099% of the Earth's crust, making it the seventh most abundant transition metal and 22nd most abundant element [1]. Nickel is hard, strong, silvery-white metal that resists corrosion and is used for electroplating and making of alloys. Principal exposure is through costume jewelry (usually the inexpensive type) and other metal objects. Nickel is used as pigments for paints and ceramics. It is naturally present in the environment and is also known as *Niccolum sulfuricums*. Metallic nickel can have lethality and sublethal effects[2]. Other products which contain nickel include rechargeable (NiCd) batteries, coins, welding rods and wires, electronic or computer equipment, and pigments for paints and ceramics. Exposure to Nickel could be through food and water. Inhalation of paint odour is another major route of exposure.

Exposure to nickel can cause several health effects. How nickel enters the body and its form will determine the effect on health. Inhalation is the most hazardous route of exposure. If soluble nickel is inhaled from painted walls, it dissolves and moves through the body going mostly to the kidneys and liver. Insoluble and metallic nickel remains in the lungs. A number of studies have examined the potential of nickel and nickel compounds to induce respiratory effects. Therefore the use of nickel as pigments in paints is deadly both for paint workers who are constantly exposed and also occupants of such painted homes. Most of these studies were cohort mortality studies in nickel-exposed workers. A significant excess of deaths from nonmalignant respiratory system disease was found among workers that were associated with the exposure to nickel [3]. Inhalation of soluble nickel can cause irritation of the nose and sinuses, and could also lead to loss of the sense of smell (anosmia) or perforation of the nasal septum (the wall between the nostrils). Long-term exposure may lead to asthma, bronchitis or other respiratory diseases[4]. Inhalation of nickel carbonyl from painted walls in the home is extremely hazardous to human health as inhalation can cause headaches, nausea, vomiting, chest pain and breathing problems. Symptoms may not start until 12 to 36 hours after exposure. High exposure can cause pneumonia and death.

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EXPERIMENTAL

Sample Collection

Samples of paint scrapings were obtained from thirteen different rural areas in Lagos State, Nigeria viz: Mushin (MU) Oshodi (OS), Iyana Ipaja (IP), Iwaya (IW), Alapere (AL), Festac (FE), Orile (OR), Ojuelegba (OJ), Alagomeji (AG), Bariga (BA), Ajegunle (AJ), Oworo (OW) and Ketu (KT). From each location, indoors and outdoors samples were aseptically collected in sterile universal bottles. The samples were immediately taken to the laboratory for analyses.

Cultural Conditions of Microorganism

The samples were crushed and homogenized by blending. One gram of each sample was deposited in 9 ml sterile water and mixed thoroughly. Then 1 ml suspension was taken into a 9 ml sterile water to obtain the 10^{-2} dilution. In the same procedure, different concentrations of bacteria (10^{-3}, 10^{-4}, 10^{-5}, 10^{-6} and 10^{-7}) were obtained [5]. Isolation of bacteria was performed by using nutrient agar [Peptone (5.0g) Beef Extract (3.0g) Agar (20g) Distilled water (1000 ml)]. 15 ml of the medium was poured into culture plates and allowed to solidify by cooling. Aliquots of 0.1 ml diluents of 10^{-3} and 10^{-5} concentrations were inoculated into plates by a sterile pipette. Each of these dilutions was inoculated in duplicates and a sterile glass rod was used to spread inoculum evenly. The spreading of the inoculum was carried out under aseptic conditions. Lastly, the culture plates were incubated at 37^{o}C for 24-48hrs.

Enumeration and Purification of the Isolates

At the end of incubation, the developed colonies which displayed variable colonial characteristics were counted. The morphology of colonies was preliminarily observed with light microscope. Pure colonies were then obtained by repeated streaking of each colony on fresh agar plates and finally stored on slants[6].

Morphological Identification

After culturing was done at 37°C for 24 h, the colonies were picked from the slants for the Gram's staining experiment [7]. Then, the cells of the strains were observed with the light microscope after the staining procedure.

Physiological and biochemical identification

The isolated microorganisms were identified on the basis of physiological and biochemical characteristics of the bacteria [8]. Subsequently, the isolates were subjected to further confirmation of identification with the analytical profile index (API)

Determination of Nickel Concentration with AAS

Five (5g) of the paint scraping sample was placed in the refluxing flask. The scraping was then digested for 2 h with 5 ml HNO_3 at a temperature of 130 ± 1°C with a heating mantle. After cooling, the digested scraping was poured into a 25 ml volumetric flask. The solution in the volumetric flask was made up to the 25 ml mark with distilled water. A working standard was also prepared alongside [9].

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RESULT AND DISCUSSION

The study showed the concentration of nickel in the sampled paint scrapings to range from 2.240 to 11.353 and from 1.241 to 13.309 in outdoor and indoor samples respectively presented as shown in Fig. 1. The data showed that all the samples had high levels of nickel in paint scrapings. Currently the recommended safe value of nickel for wildlife, approved in a directive from the EU parliament, is set at 20 mg/l [10]. Nickel values in Bariga and Alagomeji outdoor samples were particularly high (12-13.5mg/l). The microbial population density in these nickel contaminated paint scrapings suggested the resistance of these organisms to nickel contamination. The microbial population density ranged from 1.0 - 2.1 and 0.5 -1.9 x 10^5 cfu/g in the outdoor and indoor samples respectively (Fig. 2). The isolated microorganisms were identified to be *Bacillus subtilis, B. brevis, B. megaterium, B. circulans* and *Enterobacter gergoviae* respectively. Nickel occurs naturally in the environment at low levels. Nickel dermatitis, consisting of itching of the fingers, hands, and forearms, is the most common effect in humans from chronic (long-term) skin contact with nickel. Respiratory effects have also been reported in humans from inhalation exposure to nickel. Human and animal studies have reported an increased risk of lung and nasal cancers from exposure to nickel refinery dusts and nickel subsulfide. Animal studies of soluble nickel compounds (i.e., nickel carbonyl) have reported lung tumors [11].

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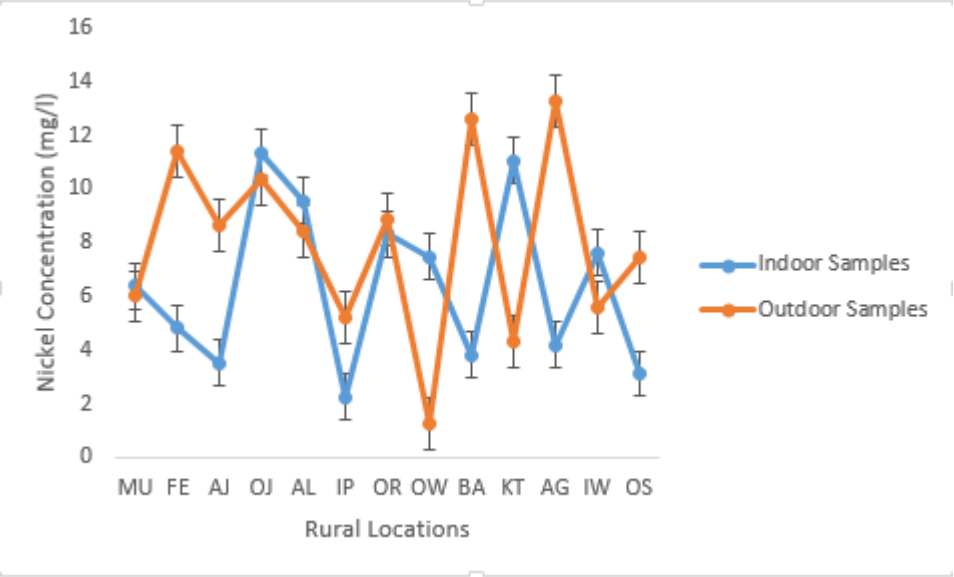

Figure 1: Nickel Concentration in Rural Locations

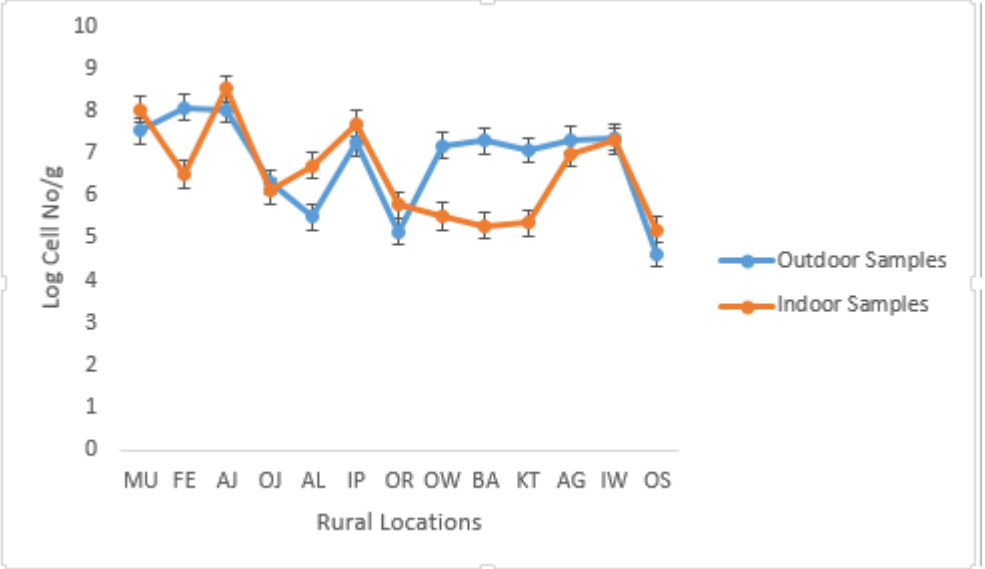

Figure 2: Microbial Population Density in Rural Locations

CONCLUSION

The EPA has classified nickel refinery dust and nickel subsulfide as Group A, human carcinogens, and nickel carbonyl as a Group B2, probable human carcinogen. Previous studies have also shown that increase in nickel concentration in fish led to increased mortality rate [12, 13, 14]. Long term bioaccumulation in humans can also be deadly. The use on nickel as paint pigment is highly discouraged.

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