URANIUM POISONING IN GROUNDWATER AND AGRICULTURE LANDS OF PUNJAB

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Uranium is a naturally occurring element, which is widespread in nature. It is found in low levels within all rock, soil, and water. This is the heaviest element to be found naturally in significant quantities on earth. According to the United Nations Scientific Committee on the Effects of Atomic Radiation the normal concentration of uranium in soil is 300 µg/kg (micro gram per kg) to 11.7 mg/kg (milli gram per kg). Higher concentrations of uranium are present in certain types of soils and rocks, especially granite and the ocean. Some important uranium ores found include pitchblende, uraninite, carnotite, autunite and torbenite. It has exceptionally low radioactivity of the major isotopes, U-234 (abundance = 0.0055 %), U-235 (abundance = 0.72 %) and U-238 (abundance = 99.27 %) and their daughter products.

Keywords: element, radiation, concentration, ores, isotopes, abundance

EFFECTS OF URANIUM EXPOSURE

Exposure to uranium can result in both chemical and radiological toxicity. The main chemical effect associated with exposure to uranium and its compounds is kidney toxicity. This toxicity can be caused by breathing air containing uranium dusts or by eating substances containing uranium, which then enters the bloodstream. Once in the bloodstream, the uranium compounds are filtered by the kidneys, where they can cause damage to the kidney cells. Very high uranium intakes (ranging from about 50 to 150 mg depending on the individual) can cause acute kidney failure and death. At lower intake levels (around 25 to 40 mg), damage can be detected by the presence of protein and dead cells in the urine.

Uranium is a carcinogen, mutagen, teratogen and neurotoxin which means it can possibly cause cancer as well as lead to birth defects in newborn babies and also results in retarded mental health.

URANIUM POISONING

Uranium poisoning in Punjab first made news in March 2009 when a South African Board Certified Candidate Clinical Metal Toxicologist, Carin Smit, visited Faridkot city in Punjab, India and tested hair and urine samples taken from149 children respectively. These samples were shipped to Microtrace Mineral Lab, Germany. High levels of uranium were found in 88% of the samples, and in the case of one child, the levels were more than 60 times the maximum safe limit. A study, carried out amongst mentally retarded children in the Malwa region of Punjab revealed 87% of children below 12 years and 82% beyond that age having uranium levels high enough to cause diseases. Since 2009, Micro Trace Minerals of Germany has continued testing cancer patients, living in the Malwa Region of Punjab which is the area known for having the highest cancer rate in India. High uranium was found in nearly all individuals tested, the work was published in the British Journal of Medicine and Medical Research in 2015.

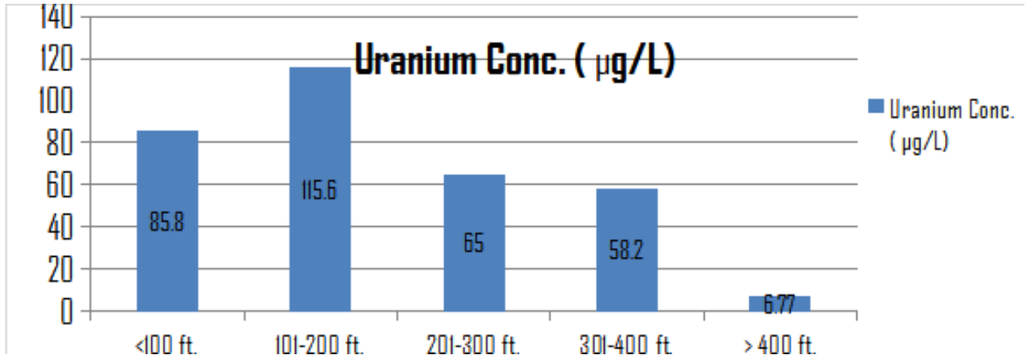
URANIUM CONCENTRATION TESTING

One hundred and forty one (141) groundwater samples from different locations of Mansa, Bathinda and Faridkot districts of Punjab had been collected. The source of sample comprises hand pumps, tube wells and borewells. For 5-10 minutes, water source was kept running and fresh water was taken in polyethylene bottles and then filtered using 0.45 micron Whatman filter paper for removal of suspended particles.

RESULT

District (No. of samples)	Mansa (47)	Bathinda (46)	Faridkot (48)
Area covered (km^2)	2174	3344	1472
Average uranium concentration (µg/l)	96.4	69.3	87.8
Maximum uranium concentration (µg/l)	645.2	323.9	375.8
Minimum uranium concentration (µg/l)	5.9	7.9	7.6

VARIATION OF URANIUM CONCENTRATION WITH DEPTH



SOURCE: Pelagia Research library

MAXIMUM CONTAMINANT LEVEL (MCL) FOR URANIUM IN DRINKING WATER

- MCL for uranium in the community water systems has been set at 30 µg/L by the United States Environmental Protection Agency.
- The Atomic Energy Regulatory Board, India has set a limit for uranium in drinking water of 60 µg/L.
- The World Health Organisation (WHO) set a provisional guideline of 15 µg/L.

CAUSES OF HIGH URANIUM CONCENTRATIONS

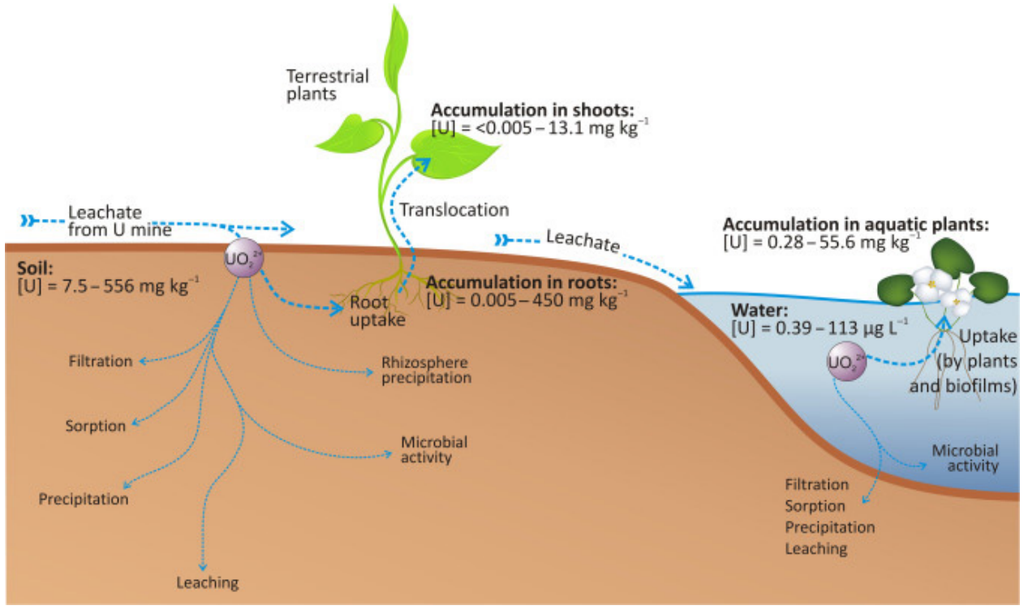
An investigation carried out by The Observer newspaper, in 2009 revealed that the possible cause of contamination of soil and ground water in Malwa region of Punjab, to be the fly ash from coal burnt at thermal power plants which contains high levels of uranium and ash, as the region has state's two biggest coal-fired power stations, which are Guru Nanak Dev Thermal Plant and Guru Hargobind thermal Plant. The highest average concentration of uranium 56.95 µg/l, in the town of Bhucho Mandi in Bathinda district a short distance from the ash pond of Lehra Mohabat thermal power plant. Soils in the Malwa region are waterlogged and calcerous. Irrigation water percolating through soil dissolves carbon dioxide gas produced at high pressures from the plant root respiration and the microbial oxidation of the agricultural matter. The resulting carbonic acid reacts with the insoluble calcium carbonate to produce soluble bicarbonate, which leaches uranium from soils and adds it to the ground water.

SAFETY MEASURES AND POSSIBLE SOLUTIONS

- The state government needs to establish community filtered water supplies in order to limit the usage of uranium contaminated ground water for drinking purpose.
- As in this area the canal system is well developed and chemical contaminants are also under safe limit in canal water so in households only canal water must be supplied.
- It is recommended that the use of ground water for building construction and other huge consumption activities must be made compulsory to limit the usage of canal water.
- Consume natural powerful metal chelating agents such as citrus fruits, cilantro and garlic.
- In emergency cases bore well at depth more than 200 ft. should be preferred in this region for safe drinking and irrigation purposes because of comparatively lower level of uranium.

URANIUM TRANSFER IN THE FOOD CHAIN FROM SOIL TO PLANTS TO ANIMALS

The uranium transfer to the food chain of humans is significantly affected by the geological origin of the soils and the groundwater basin as well as the living area of the flora and the drinking water reservoir. In accordance with its occurrence in the soil, uranium gets into the flora and is comprehensively stored in young plants. The uranium content/kg dry matter is diluted by assimilates with increasing age. Compared to vegetable foods, animal foodstuffs contribute less uranium to human nutrition, although hen's eggs, kidneys and livers can accumulate relatively much uranium. On average, the uranium intake of omnivorous amounted to about 2 µg/day. It is determined by regional (geological) influences, primarily the uranium content in drinking water.



PHYTOEXTRACTION OF URANIUM

The majority of uranium was found to accumulate in the roots. Uranium concentrations in the leaves, regardless of the type of plants were presented below standard of drinking water (30µg/l) by U.S EPA. All the cultivation processes were conducted in a growth chamber at 25 degrees celsius, 70% relative humidity, 4000 Lux illumination (16 hours/day) and CO2 concentration of 600 ppm. Four times at intervals of 2 weeks leaves and roots collected were analyzed for uranium concentration. Ranges of uranium concentration of the roots and leaves from the five plants were measured to 206.81-721.22µg/kg and 3.45-10.21µg/kg respectively. Five plants such as Lettuce (*Lactuca sativa* L.), Chinese cabbage (*Brassica campestris* L.), Sweet potato (*Ipomoea batatas* (L.) Lam), Radish (*Raphanus sativus*) and Sesame (*Perilla frutescens* var. *japonica*) were cultivated during 56 days in phytotron.

Phytoextraction pot experiments with citric acid were conducted. Citric acid as chelating agent was applied to soil to enhance uranium accumulation in five crop plants. 6 days before harvest crops, each citric acid 25ml and 50ml was injected into the soil. After injecting citric acid 25ml , pH of the soil was reduced to 4.95. Uranium concentration of leaves and roots collected from five plants was increased to 2-4 times and 7-30 times compare to control soil. Injected with citric acid 50 ml, pH of the soil was reduced to 4.79. Uranium concentration of leaves and roots collected from five plants was increased to 3-10 times and 10-50 times compare to control soil. The results of TOC (Total Organic Carbon content), CEC (Cation Exchange Capacity), T-N and T-P analysis of the soil with citric acid 25 ml and 50 ml were similar to control soil.