Executive Summary of UGC Sponsored Minor Research Project

A STUDY ON RADON CONCENTRATION IN DRINKING WATERS AND SPA WATER IN PUTTUR & SURROUNDING REGION

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Introduction Radiation in the environment has mainly two components - one is originating from extraterrestrial sources such as cosmic rays and the other one having terrestrial origin - radioactive nuclides that exist in earth's crust. The dose rates at the sea level due to cosmic rays is estimated to be 28nGy h^{-1}. Terrestrial sources of radiation are primordial radionuclide produced during the birth of the universe whose half lives are sufficiently long to have survived the interval since the creation. Secondary radionuclide are derived from the radioactive decay of primordial radionuclide. These radio nuclides can be divided into those that occur singly and those that are components of three radioactive series Th - 232 series, U - 238 series and U - 235 series, in addition to the other natural radionuclide K- 40 present in the earth' crust. One of the main source of radiation is Radon gas *(UNSCEAR, 2000) .* The short lived Radon is also a major source of radiation exposure. It is estimated that the contribution to the effective annual radiation dose due to the exposure to radon and its progeny is about 50% of the total effective annual radiation dose from natural sources. The world average value is 2.4 mSv for the annual effective dose equivalent from natural background radiation of which 1.4 mSv comes from radon, thoron and their daughter products.

The water in rivers, lakes and streams can be expected to contain radon in small amounts in view of the solubility of radon in water to the extent of almost 0.251 kg-' under standard conditions and the wide distribution of uranium and thorium and their decay products in the soil and rocks of the Earth's crust Rn -222 can reach the food chain through water which is the ingredient of life. We use water from open well, bore well, pond, stream or river also contain radon. Spa waters are considered as natural resources of countries and are widely popular for medical therapy, tourism (Using of these waters may lead to higher degree of radiation exposure and even trace element concentration *(Tomislav Bituh etal., 2009, Eisenbud and Gessel 1997).*In Himalayan ranges and also in Deccan Plateau, hot water spa are found to be in large numbers. But in southern coastal area, spa is rare. One such spa is found in Bettampady village near Puttur town in the west coast of Karnataka, 70Km from Mangalore. This spa is called "*Bendre Theertha*" located on the banks of a small stream known as *Irdhe Hole*

Objective:

Main objectives of the present research project are

- *Gamma Dose rate measurements in Puttur and spa region*
- *Measurement of Uranium and Radon -222 in water samples.*
- *Measurement of Ra-226 in soil samples*

Materials and Methods

Systematic measurement of ambient radiation level were carried out using hand held GM-tube based RDS-31 (Mirion, France) radiation survey meter. It was calibrated and the calibration accuracy is $\pm$ 5% with ^{137}Cs source. The energy response of the instrument was from 48 keV to 3 MeV. The ambient gamma absorbed dose rates were measured, in-situ, in the identified locations.

Concentration of Rn-222 was determined in water samples by emenometry. Water samples were collected in rinsed and dried bottles of 200ml. They were transferred to radiation bubbler by vacuum technique using vacuum pump connected to water degassing system. Rn gas in water made to transfer to the evacuated background counted scintillation cell. After de emanation of of Rn-222 into the scintillation cell, the cell was allowed to stand for minimum of 3 hrs or 180minutes, so that short lived radon progeny reached equilibrium with Rn - 222. Then the scintillation cell was connected to the photomultipler tube and the alpha counter assembly of 30% efficiency. From the measured counts Rn-222 activity was calculated *(Raghavayya, 1977).*

A microprocessor based laser fluorimeter was used for the measurement of uranium concentration in the water samples. The method was based on the luminescence of the uranyl ion in the solution and fluorescence measurement technique. The instrument contain a LED laser as the excitation source lasing at 337.1 nm. The output of the laser was focused onto the sample cell that excites the uranium complex compounds, formed when the buffer of sodium pyrophosphate and phosphoric acid (fluorescence enhancing

agent) was added to the sample solution along with the organic matter present in the samples. The fluorescence of uranyl ion was measured by a photomultiplier tube (PMT).

To measure uranium, about 100 ml of water samples wer collected in polythene bottles from different water sources, filtered through Whatmann 42 filter paper and made pH neutral (pH-7) by adding sodium pyrophosphate buffer. Then about 6 ml of the sample was transferred into the analyzing cell, fluron (sodium pyrophosphate buffer) was added and analyzed for uranium concentration using the laser fluorimeter.

The instrument provides uranium concentration in ppb (part per billion or μg L^{-1}), then the uranium concentration was converted into Bq L^{-1} by using the specific activity of uranium.

Soil samples wer collected near spa region to determine concentration of some of the natural radionuclide. Sampling where done by following the standard procedure. Activities of ^{226}Ra, ^{232}Th and ^{40}K in soil samples were determined by gamma spectrometry *(Siddappa etal., 1990).*

The gamma spectrometry system contain a 42% relative efficiency n-type low background HPGe detector. The detector was enclosed in a 10 cm thick graded lead shield in order to reduce the radiation background. The resolution of the detector was 2.0 keV at 1.33 MeV. The spectrum was acquired and analysed by employing a PC based 16K multichannel analyser (DSA-1000, CANBERRA) and Genie-2000 software. The detector efficiency calibration was performed by using the IAEA quality assurance reference materials and the details of measurement technique are presented elsewhere (Siddappa etal., 1990).The minimum detection levels (MDL) for ^{226}Ra, ^{232}Th and ^{40}K in soil were 0.41, 0.22 and 2.71 Bq kg^{-1} respectively.

Results and Discussion :

The ambient gamma radiation dose was measured in different places. The observed gamma dose rates in Puttur town area is in the 70 - 85 nGy h^{-1} with geometric mean 74.9 and standard deviation of ± 4.2. Measurements are also made in Darbe area, Sampya, Kallarpe, Santyar, Chellyadka, Bettampady, Irde. In thse defferent areas the observed gamma dose rate was found to be 56 - 89 nGy h^{-1}. In hot water spa region, the gamma dose rate is 65 - 78 nGy h^{-1} with a geometric mean value 71.5 nGy h^{-1}No conspicuous values observed in spa area.

Soil samples are analyzed from spa area and the values are reported in Table 2 & 3. Samples have exhibited 32.07 ± 2.9 Bqkg $^{-1}$ and $48.05 \pm .3$ Bqkg $^{-1}$ of ^{226}Ra concentration. However, concentration of ^{40}K in same samples are 153.4 ± 0.48 and 143.8 ± 0.46 Bqkg $^{-1}$ respectively. These values are comparable with the reported values in the literature for other normal background area (Radhakrishna etal., 1996, Ulbhak & Klindr 1982., Tayyeb etal., 1998, Ramola etal., 1997)

The measured activity of Ra -226 in in number of soil samples and they are in the range is 32.07 - 48. 05 Bqkg^{-1}. Ac -2228 is 65.56 – 131.1 Bqkg^{-1}, Tl – 208 is 68.38 – 143. Bqkg^{-1}, Cs – 137 is 0.41 - 1.03 BqKg $^{-1}$ and K -40 is in the range 143.8 - 153.4 Bqkg^{-1}

The water samples collected in normal area and also from spa are invesitigated for Rn - 222 and Uranium concentration. Concentration of Uranium is BDL- 0.33 µg l^{-1}. Except in one sample, in all cases uranium concentration found to be less than detection limit.

Rn - 222 concentration in five water samples (A1–A5) found to be in the range 0.68–1.57 Bq l^{-1} with the geometric mean value 1 Bq l^{-1}. Samples collected from well water (B1 and B2) show slightly higher concentration. This may be attributed to the fact that spa is an open pond, the well is narrow and deeper situated in a near by farm yard. Hence the concentration of ^{222} Rn is found to be higher. C_1 , C_2 and C_3 are samples from normal area of Puttur town show normal values of Rn-222 concentration.

CONCLUSION

Results of the studies indicate that

- Gamma dose rate in the study region is found to be in normal range. No conspicuous increase in spa region is observed. This indicate that spa is more due to sulpher or other chemical rather than radioactive uranium.
- Ra-226 concentration in soil samples found to be in normal range reported in the literature for other environs.
- The measured Rn-222 concentration in water samples in normal and spa is within permissible level. Hence Rn-222 concentration and exposure due to Rn-222 is not having much significance.
- Uranium concentration in water samples are found to be less than detection limit. Hence it can be inferred that the Irde Spa - Bendre Theertha may not be due to uranium or its progeny.
- The same thing has been observed in case of the concentration of Rn-222. Its concentration value found to be on lower side compared to that observed in other environs reported in the literature.

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