Measurement of radon concentration in soil and Verification of radiation hormesis effect in radon radioactivity environment

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Introduction
Introduction

- Occurrence and influence of radon

**Occurrence of radon**

- Radon is generally emitted in building materials such as concrete and gypsum board, but most of the radon is released in the earth's crust by about 85%.

**Characterization of radon**

- When uranium in natural materials such as soil or rocks continuously collapses, it becomes radium.
- Finally radon is the radioactive gas that is generated when radium collapses.

**Influence of radon**

- When the radon enters the lungs by breathing, it can mutate the chromosomes in the cells that cause lung cancer.
Introduction
- Radiation Hormesis effect

Radiation hormesis effect

- It is the hypothesis that **low doses of ionizing radiation are beneficial**.
- It stimulate the activation of repair mechanisms that protect against disease.
Introduction
- Purpose

Purpose of study

- Confirming the radiation hormesis effect of soil microorganisms.
- Proving the radon concentration and exposure time at which the hormesis effect appears.
Sampling
Sampling - Materials and Methods

- Soil samples were collected from radon contaminated sites and three control groups in one mountain in Goesan-gun, Chungcheongbuk-do, South Korea.
- All four points spaced each other 2m apart.
- Soils were collected at 0cm, 15cm, 30cm depth at each site using a sterile shovel.
Analysis the characteristics of Goesan soil - Materials and Methods
Analysis the characteristics of Goesan soil Materials and Methods

- Materials and Methods

1. Radon concentration in Goesan soil

Soil samples from Goesan were placed in a plastic container, sealed well and measured for 1 hour using FRD 400.
Analysis the characteristics of Goesan soil
- Materials and Methods

2. The number of plate culture count (Dilution plate method)

- Analysis for counting the number of microorganisms cultured on a solid medium of a flat plate
Analysis the characteristics of Goesan soil
- Materials and Methods

3. The value of Dehydrogenase measurement

- Put 0.5mL of cell
- + 0.02mL of 2% TTC solution
- + 0.1mL of 1% glucose
- + 0.5mL of distilled water
- Incubate for 6hr in a 30 ℃ incubator
- 1mL of methanol
- Measure the absorbance of the supernatant at 490nm

- Indicator of the overall activity of soil microorganism
Analysis the characteristics of Goesan soil - Results
Results and discussion
- Radon Concentration Measurement and characteristics of Goesan soil

1. Radon concentration

- Radon contamination sites have the highest radon concentrations in the soil.

- The higher the depth of the soil, the higher the radon concentration.

- Radon concentration in the soil decreases as it moves away from the radon contamination point.
Results and discussion
- Radon Concentration Measurement and characteristics of Goesan soil

2. The number of plate culture count

- The number of plate culture count was the highest in the radon contaminated soil. Also, the number of growing colonies was higher in deep soils.

- These results confirmed the survival of microorganisms can be improved even if the radon concentration is high.
Results and discussion
- Radon Concentration Measurement and characteristics of Goesan soil

3. The value of Dehydrogenase measurement

- The value of dehydrogenase measurement was the highest at the point where the radon concentration was high.

- From these results, it was confirmed that the activity of microorganisms was increased when exposed to radon.
Experiment of radon exposure to Goesan soil by time and concentration

-Materials and Methods
Experimental of Radon exposure by time and concentration
- Materials and Methods

1. Experiment condition

<Experiment Condition>

- Concentration: 14,000bq/m$^3$, 1,400 bq/m$^3$, 185bq/m$^3$
- Exposure time: 1, 3, 5 hours
Experimental of Radon exposure by time and concentration
- Materials and Methods

2. Experiment setting

Adjust the radon concentration in the chamber
- 14,000 bq/m³
- 1,400 bq/m³
- 185 bq/m³

The liquid medium containing the soil microorganisms extracted from each sample
Experimental of Radon exposure by time and concentration
- Materials and Methods

3. OD 600

- Analysis for measuring the concentration of bacteria or other cells in a liquid
Experimental of Radon exposure by time and concentration
- Materials and Methods

4. COD

- Put 150mL of culture solution + 5mL of Microbial Suspension
- Cultured in a 30°C incubator
- Sampling at 0, 6, 12, 16, and 20 hours
- Filter through a 0.45µm acetate filter
- Measure the COD

- Used to measure the degradation ability of the microorganisms exposed to radon
Experiment of radon exposure to Goesan soil by time and concentration

-Results
Results and discussion
- Radon exposure experiment results by concentration and time

1. The number of plate culture count & The value of Dehydrogenase measurement – 185bq/ m³

- When exposure concentration is 185bq/m³, the number of plate culture count and the value of dehydrogenase measurement increase by increasing exposure time.
- These results show that as radon exposure increase, the number and activity of microorganism increase.
Results and discussion
- Radon exposure experiment results by concentration and time

1. The number of plate culture count & The value of Dehydrogenase measurement – 1,400bq/m³

(a) 1,400bq/m³, 1hr exposure

(b) 1,400bq/m³, 3hr exposure

(c) 1,400bq/m³, 5hr exposure

- When exposure concentration is 1,400bq/m³, the number of plate culture count and the value of dehydrogenase measurement increase by increasing exposure time from 1hr to 3hr.
- But increasing exposure time from 3hr to 5hr, the number of plate culture count and the value of dehydrogenase measurement decrease.
Results and discussion
- Radon exposure experiment results by concentration and time

1. The number of plate culture count & The value of Dehydrogenase measurement – 14,000bq/m$^3$

(a) 14,000bq/m$^3$, 1hr exposure

(b) 14,000bq/m$^3$, 3hr exposure

(c) 14,000bq/m$^3$, 5hr exposure

- When exposure concentration is 14,000bq/m$^3$, the number of plate culture count and the value of dehydrogenase measurement decrease by increasing exposure time.
- The maximum value was shown at 1 hour exposure, and the longer the exposure time, it did not grow well due to adverse effects on microorganism growth.
Results and discussion

- Radon exposure experiment results by concentration and time

1. The number of plate culture count & The value of Dehydrogenase measurement – 3hr exposure

- As compare all results of experiment, the value of the all radon contamination point is the maximum when exposure time is 3hr.
- As a result, when radon concentration is 1,400bq/m$^3$ and exposure time is 3hr, results show the highest growth of microorganism.
Results and discussion
- Radon exposure experiment results by concentration and time

2. The value of OD 600 – 3hr exposure

- The value of OD 600 at all experiment conditions shows almost same increase/decrease trends as the number of plate culture count and the value of dehydrogenase measurement.
- Compared all the value of OD 600 of 3hr exposure time experiment.
- As a result, when radon concentration is 1,400bq/m$^3$, the value of OD 600 also shows the highest growth of microorganism.
3. The value of COD

(a) 185bq/m³ exposure  
(b) 1,400bq/m³ exposure  
(c) 14,000bq/m³ exposure

Results and discussion

- Radon exposure experiment results by concentration and time

When radon concentration is 1,400bq/m³ and exposure time is 3hr, the rate of carbon decomposition was highest for 83%.

As a result, it confirm that the carbon decomposition ability was improved due to the promotion of microbial activity when exposed to a slightly high concentration of radon.
Results and discussion  
- Discussion

Total results – $1,400\text{bq/m}^3$, 3hr

(a) Dilution plate method & Dehydrogenase analysis

(b) OD 600 measurement

(c) COD

- Three results prove that the conditions of radon concentration $1,400\text{bq/m}^3$ and exposure time 3hr appears highest growth of microorganism and highest carbon decomposition.
Conclusions
Conclusions

• In this study, all of the experimental results were confirmed that when exposed to 1,400bq/m$^3$ of radon concentration makes the better physiological activities of microorganisms compared to exposure to low concentration of 185bq/m$^3$ and high concentration of 14,000bq/m$^3$.

• Based on these results, it was verified that when exposed to a proper concentration of radiation, a beneficial effect can be obtained such as promoted growth reaction or physiological activity of the microorganism.

• In conclusion, this study demonstrated the radiation hormesis effect of radon on soil microorganisms.
Thank you