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Research Article

Purple Non-Sulfur Bacteria can Change the Radioactive Elements in the Contaminated Weeds to Stable One

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Abstract

This research may give a hint deeply to why and how a variety of element on the earth have been generated for a long time resulting in the history of living organs. Especially, cyanobacteria of blue-green algae to generate oxygen with photosynthesis in the early time of the earth. The present research describes the physical function of purple non-sulfur bacteria which is also said to be one of photosynthetic bacteria although they involve chemical substances such as chlorophyll, carotene and phycobilin (light-harvesting pigment). It is interesting to notice how they can change the different element from an original one. We propose that some mechanism connects to the existing of water and radiation, namely the bacteria changes water by the catabolism from glycogen and disulfide resulting in formation barium from cesium with help radiation. This technology may be applied to other elements such as strontium, tritium, etc. for reducing radioactive wastes.

Keywords: *Purple Non-Sulfur Bacteria; Radioactive Cesium; Stable Barium; Change of Nucleus; Catabolism*

Introduction

It is interested in discussion with functions of bacteria from interdisciplinary views although there have been many published papers in biological view point, of course. Here is one example. The scientists at University of Manchester found and reported that bacteria could be used to 'eat' nuclear waste and organisms that lived on radioactive soil found in contaminated Peak District site, in which bacteria existed in soil in an old lime kiln. The microbes could cope in underground radioactive waste disposal sites. They can use toxic acid produced in chemical reactions as a source of food. Researchers say the tiny organisms could help 'eat' away at nuclear waste. Here is another example. Sasaki., *et al.* [1] reported that one of bacteria of *Rhodobacter sphaeroides* emits the adhesive materials which stick radioactive ones to them like a magnet. This is a characteristics of the photosynthetic bacteria which has ability of heavy metal adhesion. This technology may help with growing problem of nuclear waste disposal in the world. However, they have not discussed what happened in their body of microbes? namely reduction of radioactivity or changing elements, metamorphosis of the microbes after "eating nuclear waste" in the future? etc. It is necessary to discuss how we can change radioactive elements to stable ones with the bacteria including theory. This is not relating to bacteria, but radioactive wastes have been treated to absorb with a special substance such as zeolite to seal with concrete and to dissolve into the potassium ferricyanide solution. However, cesium atom, for instance, is difficult to get into zeolite crystal, because it is formed by sodium and silicon atom which sizes are about 40 percent smaller than cesium. Furthermore, the value of oxidation-reduction potential of cesium is about -2.9 eV which is similar to those atoms resulting in difficult chemical reaction. That is to say, there is very low efficiency and the secondary problems to where we throw away the absorbed materials containing radioactive substances. But this technology is also leading to disposal problem where we should treat separation of radioactive material and heavy metal. Sugihara reported the way to change radioactive cesium (Cs134 and Cs 137) to stable barium (Ba135, Ba138, etc.) with a weak energy from the specially processed water as shown in [2] and [3]. In present study, we report the change from radioactive cesium to the stable barium atoms using purple non-sulphate bacteria which solution naturally contains water. This is a key point.

Experimental Methods

The radioactive cesium was collected from the weeds at 30~40 km from Fukushima nuclear power plant in 2015. The contaminated weeds were carbonized in the electric furnace (Neuron Kogyo corporation) at 573K without oxygen (bake in the roaster). The carbonized samples were 3.2 kg. As shown in figure 1, the starting material was the carbonized one, and the sample atomized with purple non-sulfur bacteria in 2000 ml container, and were kept in seal at a sunny place. Radiation measurements were performed after certain days. The measurements were implemented with the detector of Ge-semiconductor type (SEG-EMS-jr; SEIKO ENG&G Inc., Japan) by Miyagi Prefecture pollution hygiene inspection center. The element (stable barium) were analyzed with ICP-MS (Induction Coupled Plasma-Mass Spectrometer) and ICP-AES (-Atomic Emission Spectrometer) at the center.

Figure 1: *Left: Carbonized sample (2017/10/10), right: 2000ml of atomized sample with purple non-sulfur bacteria.*

Results and Discussion

Although many examinations for reduction of radioactivity have been performed in time-sequence with different places, timing and objects, here is one of results as shown in figure 2, where radiation reduction with the sample of 2000 ml after atomizing purple non-sulfur bacteria following for 93 days and vertical axis indicates Bq/kg (Becquerel) for Cs134 and Cs137, respectively. Blue; carbonized sample (control), brown; after atomizing sample. In carbonized sample of 93 days, which was not shown in blue one because of barium analysis before and after the atomizing the purple non-sulfur bacteria.

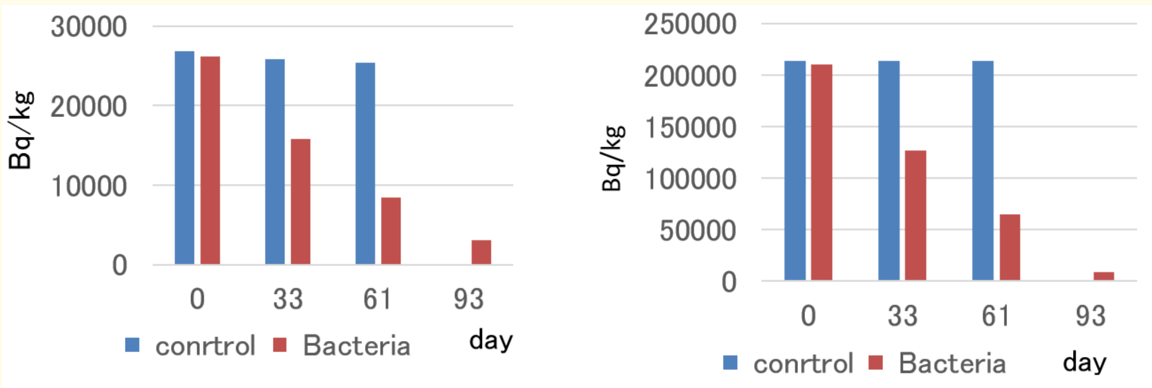

Figure 2: *Radiation reduction of Cs134 (left) and Cs137 (right). Blue; control after carbonizing weeds. Brown; after atomizing purple non-sulfur bacteria onto the weeds.*

As shown in figure 2, radiation was reduced by 40% for 33 days after atomizing the purple non-sulfur bacteria, although it was 10~20% reduction by atomizing only water due to the shielding effect of radiation. Cs137 possesses a half-life of about 30 years, but more than 90% reduction were achieved with the bacteria for 3 months. Meanwhile Cs134 has a half-life of 2 years, the bacteria indicated radiation reduction of 88% for the same period.

There have been no discussions why radioactive substances reduced and to where disappeared. For instances, there is a book of title of "Microbe extinguished radiation!!" [4], but he did not discussed the mechanisms. Furthermore Sasaki., *et al.* [1] reported that *Rhodobacter* spheroid of photosynthesis bacteria releases adhesive substances with minus charges and pulls radioactive substances like a magnet, where the maximum reduction rate was 65% for 14 days adding a lactic acid bacterium. The phrase that bacteria could "eat" nuclear waste has been found sometimes since some bacteria "eat" Isosaccharinic acid (Is) to form uranium compound, like U(OH)4Is.

The USA researcher [5] completed bio-fuel cell leading to electric power generation and clean up wastewater, and reported 20~50 mW/m^2/electrode using electron generated in the process that bacteria decomposes organic compounds in the wastewater. There is a research of fuel cell [6] using purple non-sulfur bacteria from which electron is directly extracted to make electrode, and the bacteria toughed on an anode generates electron which may be pulled on the electrode resulting in smooth reaction of the bacteria. The bacteria may produce proton and electron with -OH radical by anabolic reaction in the carbohydrate metabolism from glucose-1-phosphate (Figure 3) of the product that glycogen is decomposed. Furthermore, the bacteria generate proton and electron from disulfide compound as shown in figure 4. Figure 3 shows that proton and electron may be generated from glucose-1-phosphate which is the initial products from glycogen (glucose).

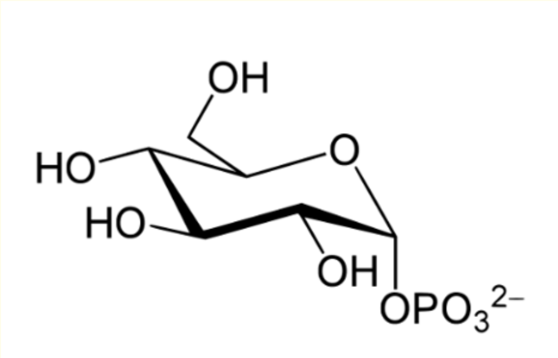

Figure 3: *Glucose-1-phosphate.*

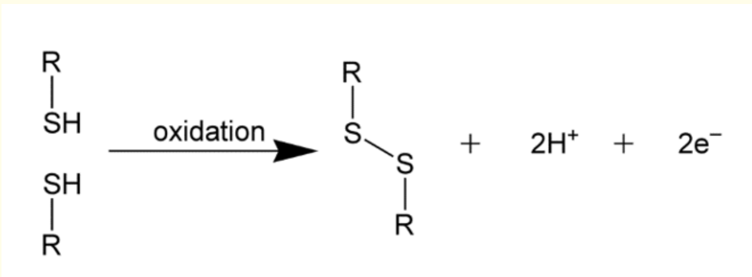

Figure 4: *Proton and electron from disulfide bonds.*

Thus, the purple non-sulfide bacteria produces proton and electron, and these particles obtain the energy ofγ-radiation with 661.6 keV from radioactive cesium 134, and with 563~1365 keV from cesium 137 resulting in enough momentum to access the nucleus. Then, they can get into the nucleus of cesium to conquer the Coulomb barrier of the nucleus. As the results, the stable elements of barium 135, and barium 138 as well as 137 were generated by the purple non-sulfide bacteria in the radioactive-contaminated weeds. This is same scenario which Sugihara reported effective radiation reduction with weak energy of the water itself [2,3]. In these paper, specially-processed water makes <H^+~e^- > (like elementary particle as registered infoton in 2008 by Sugihara) and it happed the reaction such as 137Cs+1H = 138Ba. Furthermore, considering only electron to react with the nucleus, 137Ba might be formed according with the theoretical way of a group theory [2]. These manuscripts indicated the scientific mechanism to extinguish radioactive substances, not just washing them out with water. And we analyzed the treated soils and found barium, lanthanum and cerium more amount rather than usual abundances in the earth. At present experiment, chemical analysis of barium was implemented to result in 8.6 mg/kg in the carbonized weeds and 4100 mg/kg after atomizing purple non-sulfide bacteria.

More theoretical discussion to change of element has been written in terms of nuclear physics to mention with the energy conservation and mass balance during nuclear reaction [7]. Furthermore, changes of other elements will be discussed in connecting with radiation, for instances, just one example is stable sodium (Na-23---100%), but which has radioisotopes (RI), Na-21 (half-life; 23 seconds) emitting β+, Na-25 (59s) and Na-26 (1.1s), emitting β- more than one second of half-life with and more energy than 9 MeV. Namely, if the water contains infoton, < H^+~e^->, they can obtain the energy from those RI and change the elements.

Conclusion

The purple non-sulfide bacteria performed radiation reduction by about 90% from the contaminated weeds for 3 months. And the mechanisms of radiation reduction were discussed by proton and electron from the products due to anabolic reaction relating to the weak energy of water and radiation from radioactive substance. Furthermore, Change of elements will be more discussed with theoretical view in the future, and the present research may play a role for reduction of radioactive wastes basically, and can be expected to be in practice smoothly and in low-cost.

“Newly-discovered waste-eating bacteria could help in nuclear waste disposal” (2014) [8] "Extremophile" bacteria have been found thriving in soil samples from a highly alkaline industrial site in Peak District of England. Although the site is not radioactive, the conditions are similar to the alkaline conditions expected to be found in cement-based radioactive waste sites. The researchers say the capability of the bacteria to thrive in such conditions and feed on isosaccharinic acid (ISA) make it a promising candidate for aiding in nuclear waste disposal.

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Conflict of Interest

There is no conflict of interest.

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