

1.2 PIXE

Geochemical characteristics of river water of Taihei River, Akita City

Hiroshi Kawaraya¹, Daizo Ishiyama¹ and Koichiro Sera²

¹Faculty of Engineering and Resource Science, Akita University

1-1 Gakuen-Machi, Tegata, Akita 010-8502, Japan

²Cyclotron Research Center, Iwate Medical University

348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

The purpose of this study was to clarify the formation process of chemical composition of river water of Taihei River flowing through Akita Plain. Concentrations of major elements and heavy metal components in the water were measured using ion chromatography and the PIXE method. Concentrations of major elements and iron in the river water increase from the headwater to the lower reach of the river. As for the suspended materials over 0.45 μm of the river water form Si, Fe, Al, Ca, K, S and Ti, and the concentrations of Si, Fe and Al are $10\sim 10^2$ -time higher than those of other elements. The suspended materials in the river water are thought to be clay minerals or amorphous substances. The iron component of suspended materials in the river water is thought to be Fe colloid derived from the decomposition of pyrite in mudstone. Based on the results of principal component analysis for river water quality formation, component one (67%) is contribution of sea salt and sulfate in winter, and component two (26%) is contribution of sulfate in early spring of the middle ~ downstream region. Compared to the chemistry of river water of Asahi River, the influence of sulfate is large in early spring of the middle ~ downstream region of Taihei River.

Characteristics of flow rate and chemical concentrations of mine drainage water

Daizo Ishiyama¹, Hinako Sato¹, Toshio Mizuta¹ and Koichiro Sera²

¹Faculty of Engineering and Resource Science, Akita University

1-1 Gakuen-Machi, Tegata, Akita 010-8502, Japan

²Cyclotron Research Center, Iwate Medical University

348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

Flow rate and chemical compositions of mine drainage water from galleries and a dump of waste of an abandoned mine were examined on the basis of data obtained by a field survey and chemical analyses using ion chromatography and PIXE analyses. It was founded that the flow rate of mine drainage water from galleries and the dump of waste increases in snow melting season and rainy season and that iron and zinc contents of mine drainage water increase with increase in flow rate. Dilution of mine drainage water caused by melting snow and by increase in the amount of precipitation during rainy season was not observed. Amounts of iron and zinc discharged with mine drainage water are controlled by the rate of discharge of mine drainage water. The fact that dilution of mine drainage water was not observed suggests that the reservoir of the mine drainage is large. Thus, the dump of waste should be isolated from percolating water of precipitation and snow melting to prevent environmental problems. The same care is needed for dumps of waste containing heavy metals from civil engineering works such as tunnel construction and for dumps of industrial waste at a storage sites.

Elemental composition in water treatment medium and zeolite

Katsumi Saitoh¹, Yasuji Kurimoto² and Koichiro Sera³

¹Akita Prefectural Research Center for Public Health and Environment

6-6 Sensyu-Kubota, Akita 010-0874, Japan

Present affiliation: Center Laboratory of Technology, NS Environmental Science Consultant Corporation

4-3-33 Mitake, Morioka 020-0122, Japan

²Institute of Wood Technology, Akita Prefectural University

11-1 Kaieisaka, Noshiro 016-0876, Japan

³Cyclotron Research Center, Iwate Medical University

348-58 Tomegamori, Takizawa 020-0173, Japan

Abstract

To confirm the use possibility (safety) as the soil conditioner of the water treatment medium, this and zeolite (major ingredient) elemental compositions were analyzed by PIXE method. As a result, safety as the soil conditioner was confirmed. Therefore, it is thought that the water treatment medium can be used as a soil conditioner.

Quantitative analysis of minimal aqueous sample by PIXE

S. Goto¹, C. Takahashi¹, K. Terasaki² and K. Sera²

¹Nishina Memorial Cyclotron Center, Japan Radioisotope Association
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

²Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

For quantitative analysis of liquid sample by PIXE, internal standard method is commonly used by adding a standard solution to the sample to an optimal concentration usually at 5-10 ppm. In order to add the standard accurately with a micropipette, the amount of the sample is favorably more than 1 mL. But some kind of liquid, such as [¹⁸O]H₂O, the material of F-18 labeled PET pharmaceutical, is too scarce or precious to get enough amount of sample for analysis by the ordinal internal standard method. With the aim of developing techniques for quantitative analysis applicable to minimal sample of such liquid, we have tested the following four methods by analyzing two multi-element standard solutions and examined their accuracy and reproducibility.

1. External standard method for a spot target: the whole target is irradiated with a uniformly adjusted beam and a specific element in the target is firstly quantified by comparing the spectrum with that of equally irradiated standard target. The remaining elements are quantified by taking the element's value as the internal standard.
2. Two-step method: a portion of the minimal sample is firstly analyzed by adding the internal standard of the ordinal amount (usually 10 µL to a 1 mL sample, so it is too much for the minimal portion) to identify the highest element in the sample and obtain its value. Taking the value as the internal standard, the rest sample is analyzed.
3. Standard dilution: the standard solution is diluted by 10 or 100 times to be added accurately to the minimal sample.
4. Standard covering: after drying 5-10 µL of the sample on the backing film, the appropriate amount of the standard solution is dropped to cover the whole residue.

The results were mostly satisfactory with 10-15 per cent accuracy except two-step method where the self absorption of indium, the excessively added internal standard, affects the measurement. For external standard method and covering method, correct adjustment and positioning of the beam, and precise location of the standard dropping are found to be crucial respectively. As both the methods require no sample conditioning, they are expected to be applicable even to a sample of less than 10µL. Standard dilution method with a 100 times diluted solution is shown to be most stable in accuracy and reproducibility. The ordinal internal standard procedure using optimally diluted solution is supposed to be most advantageous though it takes more amount of sample than the former two methods.

Comparison of data analyzed by PIXE with XRF in chemical composition for beech forest soil samples collected in Mt. Iwaki (II)

M.Tsurumi, T.Kurihashi, N.Takahashi and K.Taneichi

Graduate School of Science and Technology, Hirosaki University
3 Bunkyocho, Hirosaki, Aomori 036-8561, Japan

Abstract

Chemical contents of soil samples were analyzed by Particle Induced X-ray Emission analysis (PIXE) and X-ray fluorescence spectrometry (XRF). An analytical comparison of PIXE with XRF is discussed in composition for soil samples collected at Kyoboku-no-mori in Mt. Iwaki, Japan. There were differences between raw data with these two analytical methods. The content values of major elements show wider variations in PIXE than in XRF. For Ti, Fe, Mn, Ca, and K, PIXE data were agreed well with XRF data. For the other elements, however, data correction were needed. Correction processes were discussed.

Aerosol environment in accelerator rooms of electron linac facilities

Y. Oki, N. Osada¹, T. Mori², S. Shibata and K. Sera³

Research Reactor Institute, Kyoto University
Kumatori, Osaka 590-0494, Japan

¹Graduate School of Engineering, Kyoto University
Kyoto daigaku-Katsura, Nishikyo-ku, Kyoto 615-8530, Japan

²Faculty of Engineering, Kyoto University
Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501, Japan

³Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

In accelerator facilities, there are two kinds of aerosols in air of accelerator rooms during machine operation. One is aerosols (dusts) brought from outside, the other is nano-particles produced through radiation-induced chemical reactions from air in high radiation areas in the accelerator rooms. Their particle size and concentration are basic information on evaluation of airborne radioactivity and internal radiation exposure. In this report, the particle size and concentration were measured for both of the two kinds of aerosols in an electron linear accelerator (Linac) facility.

Chemical characterization of atmospheric aerosols measured at Phimai, Thailand

H. Tsuruta¹, J. Chotpitayasunon², B. Thana², P. Khatri³, T. Takamura³, S. Sudo⁴
S. Yonemura⁴, K. Sera⁵, Y. Saitoh⁶, Y. Shirasuna⁷, K. Hirano⁷, T. Hayasaka⁸ and T. Nakajima¹

¹Center for Climate System Research, The University of Tokyo
5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8568, Japan

²Department of Geology, Faculty of Science, Chulalongkorn University
Phayathai Road, Bangkok, 10330 Thailand

³Center for Environmental Remote Sensing, Chiba University
1-33 Yayoicho, Inage, Chiba, Chiba 263-8522, Japan

⁴National Institute for Agro-Environmental Sciences
3-1-3 Kannondai, Tsukuba, Ibaraki 305-8604, Japan

⁵Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

⁶Takizawa Institute, Japan Radioisotope Association
348-1 Tomegamori, Takizawa, Iwate 020-0173, Japan

⁷Yokohama City Institute of Environmental Sciences
1-2-15 Takigashira, Yokohama 235-0012, Japan

⁸Center for Atmospheric and Oceanic Studies, Tohoku University
6-3 Aoba, Aramaki, Aoba-ku, Sendai 980-8579, Japan

Abstract

An intensive field program was performed to measure atmospheric aerosols at the Observatory for Atmospheric Research, in Phimai, Thailand, every six days per month during July 2007-June 2008, under a collaborative study with Chulalongkorn University. Chemical analysis of the collected aerosols with the four size ranges was made for elemental and organic carbons (EC/OC) by improved method, water soluble ions by ion chromatography, and trace elements by PIXE. Chemical composition was estimated for sea-salt particles, soil mineral dusts, and biomass burning. According to a backward trajectory analysis, the surface wind pattern in the dry season was northeasterly from middle October 2007 to middle March 2008, and then shifted southerly from middle March to early May. For the other period, southwesterly monsoon was

prevailed in the wet season. From the hotspot analysis by a satellite dataset, active biomass burning of the residue of agricultural wastes was detected in south China and Indochina from Dec. 2007 to March 2008. A relationship between EC and non sea-salt sulfate in fine particles revealed that the polluted air masses rich in $(\text{NH}_4)_2\text{SO}_4$ emitted from east Asia was transported to Phimai, while in the latter period of dry season, aerosols rich in EC emitted from biomass burning in Indochina was dominant. During the wet season, however, nitrate was higher in coarse particles, due to the emission from automobiles in Bangkok. Sea salt particles and soil dust particles were also detected in coarse particles.

Chemical composition and source of diesel exhaust nanoparticles (<0.030 μm)

Akihiro Fushimi, Katsumi Saitoh¹, Yuji Fujitani, Shuichi Hasegawa, Katsuyuki Takahashi²
Koichiro Sera³, Kiyoshi Tanabe and Shinji Kobayashi

National Institute for Environmental Studies,
16-2 Onogawa, Tsukuba 305-8506, Japan

¹Division of Environmental Science, Akita Prefectural Research Center for Public Health and Environment
191-42 Yabase-Shimoyabase, Akita 010-8975, Japan

²Japan Environmental Sanitation Center
10-6 Yotsuyakami-cho, Kawasaki-ku, Kawasaki 210-0828, Japan

³Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa 020-0173, Japan

Abstract

The size distribution of particle number and comprehensive chemical composition (elemental and organic carbon, elements, ions) by particle size (D_p : 0.010–10 μm) were measured in the exhausts from an 8-L diesel engine equipped with no exhaust aftertreatment system under a no-load and a transient conditions. High concentrations of nanoparticles were emitted under the no-load condition even using the low-sulfur (8 ppm) fuel. In the nanoparticles ($D_p < 0.032 \mu\text{m}$), organic carbon comprised a major part ($\approx 80\%$) of the measured components, and elemental carbon comprised only 8–15% of them, and elements and ions including sulfate occupied only small percentages of them. Elements contained in lubricating oil (Ca, Zn, S, P, Si, and Cl) in high level were also observed in high concentrations in the nanoparticles. Furthermore, hopane concentrations per particle mass were higher in smaller particles, and chromatogram pattern of nanoparticles obtained by gas chromatography/mass spectrometry were similar to those for lubricating oil. These results indicate that lubricating oil was the primary components of the nanoparticles under the no-load condition. It is suggested that organics in lubricating oil condensed and formed nanoparticles.

Engine lubricating oil analysis using in-air PIXE

Katsumi Saitoh and Koichiro Sera*

Akita Prefectural Research Center for Public Health and Environment
6-6 Sensyu-Kubota, Akita 010-0874, Japan

Present affiliation: Center Laboratory of Technology, NS Environmental Science Consultant Corporation
4-3-33 Mitake, Morioka 020-0122, Japan

*Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa 020-0173, Japan

Abstract

Elemental particles contained in automobile exhaust particles stem from the elements in the automobile engine lubricating oil, and may become a nucleus of atmospheric particles. Therefore, investigation of elements in automobile engine lubricating oil became our major consideration relating to chemical speciation of particles in the atmosphere. Detection of elements in automobile engine lubricating oil is one of the challenging subjects in environmental research. Consequently, we tried to elemental quantitative analysis by in-air PIXE for an engine lubricating oil. As a result, the problem for the quantitative analysis was able to be clarified.

Standard-free method for hoof samples taken from domestic animals such as cow, calf, pony and sheep

K. Sera, K. Suzuki¹, K. Taguchi¹, J. Itoh², S. Goto³, C. Takahashi³ and Y. Saitoh³

Cyclotron Research Center, Iwate Med. University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

¹Department of Veterinary Medicine, Rakuno Gakuen University
582 Bunkyou dai Midorichou, Ebetsu, Hokkaido 069-8501, Japan

²Training section, Japan Radioisotope Association
2-28-45 Honkomagome, Bunkyo, Tokyo 113-8941, Japan

³Nishina Memorial Cyclotron Center, Japan Radioisotope Association
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

A standard-free method for hoof samples taken from cattle such as cow, calf, pony and sheep has been developed in order to estimate the state of health of these animals. The standard-free method developed for human nails was confirmed to be applicable to quantitative analysis of hoof samples since the shape of continuous X-rays is almost the same for nail and hoof taken from these ungulate animals. Accuracy and sensitivity of the present standard method were examined by comparing the results with those obtained by an internal-standard method combined with a chemical-ashing method, and it is confirmed that the method is applicable to hoof samples taken from domestic animals of many species. The method allows us to quantitatively analyze untreated hoof samples and to prepare the targets without complicated preparation technique which often brings ambiguous factors such as elemental loss from the sample and contamination of the sample during preparation procedure. It is also confirmed that halogens, which are important elements for estimating the state of health and are mostly lost during chemical-ashing, can be analyzed without problem by the present method. It is found that elemental concentration of more than twenty elements can be constantly analyzed and it is expected to be quite useful in order to estimate the state of health and to make diagnosis of domestic animals. It is also confirmed that elemental concentration of essential elements in hoof is not so changed depending on the positions in the sliced sample along both horizontal and vertical axis.

Keywords : PIXE, hoof, Standard-free, Cattle, Domestic animals, Untreated, Veterinary medicine, State of health

Quantitative analysis of feather samples taken from wild birds such as swan, waxwing, osprey, heron and crow

K. Sera, K. Suzuki¹, K. Taguchi¹, K. Chiba², J. Itoh³, S. Goto⁴, C. Takahashi⁴ and Y. Saitoh⁴

Cyclotron Research Center, Iwate Med. University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

¹Department of Veterinary Medicine, Rakuno Gakuen University
582 Bunkyou dai Midorichou, Ebetsu, Hokkaido 069-8501, Japan

²Science of Living Department, Morioka Junior College, Iwate Prefectural University
152-52 Sugo, Takizawa, Iwate 020-0193, Japan

³Training section, Japan Radioisotope Association
2-28-45 Honkomagome, Bunkyo, Tokyo 113-8941, Japan

⁴Nishina Memorial Cyclotron Center, Japan Radioisotope Association
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

The standard-free method developed by ourselves 13 years ago has been widely applied to quantitative analyses of hairs such as human head hair and body hair taken from companion and domestic animals. In the present work, the standard-free method for feather and down samples taken from wild birds such as swan, waxwing, osprey, heron and crow was developed. It is found that the standard-free method developed for human hairs can be successfully applied to feather samples without essential modification since the main constituents of feather are almost the same as those for human and animal hairs and, consequently, the shape of continuous X-rays is also the same. The method allows us to quantitatively analyze untreated feather samples of very small quantities and to prepare the target without complicated preparation technique. Accuracy and sensitivity of the present method were examined by comparing the results with those obtained by an internal-standard method combined with a chemical-ashing method, and it is confirmed that the method is applicable to feather and down samples taken from birds of various species. It is expected that the method will become a powerful tool for the studies not only on the mode of life of wild birds but also on environmental contamination by toxic elements.

Keywords : PIXE, Feather, Down, Standard-free, Wild bird, Untreated, Elemental concentration, Quantitative analysis, Environmental contamination

Determination of trace elements in pancreases of Zn-deficient mice

Makoto Yanaga, Hirotaka Shimoyama¹, Michiko Terashima¹, Susumu Yamamoto
Wataru Muramatsu¹, Hideo Suganuma and Kouichiro Sera²

Radioscience Research Laboratory, Faculty of Science, Shizuoka University
836 Ohya, Suruga-ku, Shizuoka 422-8529, Japan

¹Graduate School of Science and Engineering, Shizuoka University
836 Ohya, Suruga-ku, Shizuoka 422-8529, Japan

²Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa 020-0173, Japan

Abstract

Eight-week-old male mice of ICR strain were divided into two groups; one was fed with zinc deficient diet (<1 µg/g Zn), the other with control diet (30 µg/g Zn). After 1 week of treatment periods, their pancreases were removed. Sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE) and two-dimensional electrophoresis (2-DE) were performed for cytosolic fraction. After electrophoresis, the gel was cut into protein spots and subjected to PIXE analysis.

Comparison of absorption of trace elements on liquid and partially solidified enteral nutrition consist of the same elements

- Examination about receipt and disbursement balance of trace elements after partially solidified enteral nutrition administration to rats -

Yoshinori Miura¹, Ryujin Endo², Kenichiro Ikeda³, Koichiro Sera⁴ and Akira Suwabe¹

¹Department of Laboratory Medicine, School of Medicine, Iwate Medical University
19-1 Uchimaru, Morioka 020-8505, Japan

²Department of Internal Medicine, School of Medicine, Iwate Medical University
19-1 Uchimaru, Morioka 020-8505, Japan

³Department of Surgery, School of Medicine, Iwate Medical University
19-1 Uchimaru, Morioka 020-8505, Japan

⁴Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa 020-0173, Japan

Abstract

[Aim] With the expanding use of enteral nutrition, aspiration pneumonia due to gastroesophageal reflux is an increasing concern in patients receiving tube feeding. To avoid this complication, partially solidified enteral nutrition formulations are used in hospital and home based care. However, examination about nutritive absorptivity by a difference of properties of matter is hardly done. We investigated the influence that partially solidified gave absorptivity of trace element.

[Method] We administer orallied enteral nutrition which are liquid and partially solidified enteral nutrition consist of the same elements for two weeks in rats. Afterwards, we obtained urine and feces and blood in rats, then we measured trace element level in these samples by PIXE method.

[Result] As for the serum zinc level of a group of administered half partially solidified enteral nutrition, significant degradation was observed in comparison with a group of administered fluid enteral nutrition. In elemental receipt and disbursement balance of partially solidified enteral nutrition administrated group, zinc and copper and iron and calcium and magnesium and sulfur and potassium compared it with fluid and were low. It was suggested that a difference occurred for elemental absorption in a difference of properties of matter by this study.

PIXE analysis of mothers' and infants' hairs collected at medical checkups held in Fukuoka city

Y. Yoshida³, N. Kinukawa¹, S. Goto², T. Maeda³,
T. Takatsuji³, T. Nakamura³, K. Sera⁴ and Y. Nose¹

¹Department of Medical Information Science, Kyushu University Graduate School
3-1-1 Maidashi Higashi-ku Fukuoka 812-8582 Japan

²Nishina Memorial Cyclotron Center, Japan Radioisotope Association
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

³Graduate School of Science and Engineering, Nagasaki University
1-14 Bunkyo-machi, Nagasaki 852-8521, Japan

⁴Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

This is the second report on the study to explore possible relationships between atopic dermatitis and hair minerals of infants and mothers. The hair minerals are measured using the proton-induced x-ray emission (PIXE). The first report published last year describes the background, objective and method of the study and the distribution of the concentration of each mineral in hairs sampled from 842 mothers at one month after birth and 408 mothers at 10 month after birth. In April 2009, the PIXE measurements were completed for all of the hair samples collected from 1035 pairs of mother and child at one month after birth and 842 pairs of mother and child at ten months after birth. We compared the histograms of the concentrations of each mineral by month. Since the original histograms were extremely skewed, either log or power transformation was performed for normalization. The results indicate that the distribution of S shows approximately the same normal distribution regardless of mother or child and one month or ten months. Further more, since the coefficient of variation, that is the ratio of SD to mean, was only 0.01, indicating S is approximately constant for all samples. Elements that remarkably decreased at ten months were Ca, Cu, Se, Sr and those that increased were Al, Cl, Fe, Co, As, Br, and Rb. However, we do not have any explanation or even hypothesis to explain the remarkable changes as child grew. The present study is at the stage of a double-checking of clinical information now. The double -checking indicates that we input the same information twice independently and check if they agree with each other by software and correct the wrongly input one. In this way we may reduce the input error rate from 7/100 to 7/10,000. The study is expected to proceed as follows:

1) The results of the PIXE measurements will be reported to the participation doctors.

- 2) Association analysis of the amount of minerals, dining habit, and clinical performance.
- 3) Statistical analysis for causal relationships between mineral deficiency/excess and atopy/allergy conditions.
- 4) Redefine the participating mother/child population as a new cohort to study the effects of environment, dining and minerals on their health conditions.
- 5) Cooperation with the “Birth cohort project” by the Ministry of Environment.
- 6) Cooperation of the birth cohort study by Norway

The analyses of bystander effect induced by low-dose radiation in glioma cell

A. Baden¹, S. Tamura¹, S. Wada¹, T. Kakizaki¹, S. Goto², K. Sera³ and N. Ito¹

¹School of Veterinary Medicine, Kitasato university
35-1 Higashi23banyo, Towada, Aomori 034-8628, Japan

²Takizawa Institute, Japan Radioisotope Association
348-1 Tomegamori, Takizawa, Iwate 020-0173, Japan

³Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

Recently, the effects of low dose radiation have only been estimated by extrapolation from the data obtained by the higher dose radiation. Low dose radiation effects such as bystander effect cannot be explained by extrapolation from the data obtained by higher dose radiation. So far, we suggested that radiation induced bystander effect is closely relative with sphingomyelinase. To analyze mechanism between activation of sphingomyelinase and induction of bystander effect, in this study we investigated the relationship sphingomyelinase activity and divalent metal that are necessary for sphingomyelinase activation using PIXE analysis. Activation of sphingomyelinase induced by radiation (0.1Gy) was observed in glioma cell (A172 cell). The activity increased for 5 min and decreased for 15 min after irradiation inside the cell. On the other hand, the activity increased for 15 min after irradiation outside the cell. When fluctuation of intracellular and extracellular metal element was analyzed after irradiation, concentration of intracellular zinc element increased for 5 min and decreased for 15 min after irradiation and that of extracellular zinc element increase for 15 min after irradiation. These results indicate sphingomyelinase activation and fluctuation of zinc element was corresponding. It is considered that activation of sphingomyelinase induced by radiation was due to zinc element and sphingomyelinase itself is one of bystander factor.

Antitumor effect of radiosensitive microcapsules under subcutaneous injection

S. Harada, S. Ehara, K. Sera¹, K Ishii², Y. Saitoh³ and J. Ito⁴

Department of Radiology, Iwate Medical University
Morioka, Iwate 020-8505, Japan

¹Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

²Department of Quantum Science and Energy Engineering, Tohoku University
Aramaki, Aoba-ku, Sendai, Miyagi 980-8579, Japan.

³Nishina Memorial Cyclotron Center (NMCC), Japan Radioisotope Association
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

⁴Japan Radioisotope Association
2-28-45 Honkomagome, Bunkyo-ku, Tokyo 113-8941, Japan

Abstract

Since 2004, we reported the use of liquid-core microcapsules for anticancer drug targeting. However, we did not test their increasing of antitumor effect and decreasing adverse effect. In this study we observed antitumor effect and adverse effect of subcutaneously injected microcapsules in combination with radiation, in meth-A-fibrosarcoma in VIVO in BALB/c mice.

The capsules were generated by spraying a mixture of 2.0% hyaluronic acid, 2.0% alginate, supplemented with 0.2 mmol carboplatin on mixture of 0.5 mol/L CaCl₂ and FeCl₂. Resulting microcapsules were irradiated by ⁶⁰Co γ -ray at doses ranging from 0.5 to 2.5 Gy. The released carboplatin was detected and quantified by particle-induced X-ray emission.

The antitumor effect was measured by growth delay. The strength of adverse effect was measured basing on fuzzy hair, loss of body weight and death.

There were no significant difference in the concentration of carboplatin between encapsulated carboplatin and uncapsulated one in combination with radiation.

There were no significant differences in antitumor effect between combined therapy of encapsulated carboplatin with radiation and uncapsulated carboplatin with radiation. However, their adverse effect was drastically decreased by encapsulating carboplatin.

Our microcapsules were considered effective in decreasing the adverse effect of carboplatin.

Species differences in renal platinum (Pt) concentrations in mice, rats and rabbits given a single intravenous injection of cisplatin

R.Katayama¹, S.Nagata¹, S.Kawai², T.Yamashita², K.Sera³, K.Furuhama¹

¹Department of Veterinary Medicine, Iwate University
3-18-8 Ueda, Morioka, Iwate 020-8550, Japan

²Department of Agro-Bioscience, Faculty of Agriculture, Iwate University
3-18-8 Ueda, Morioka, Iwate 020-8550, Japan

³Cyclotron Research Center, Iwate Medical University
348-58, Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

To better understand a species difference in cisplatin nephrotoxicity, we measured the renal platinum (Pt) concentrations in mice, rats and rabbits given a bolus injection of cisplatin, a platinum chemotherapeutic agent. The renal Pt concentrations were determined by a particle induced X-ray emission (PIXE) method. The ranking order of renal Pt concentrations was rabbits > rats > mice, unlike that of the nephrotoxic potentials (rats > mice > rabbits). These results demonstrate that the species difference in cisplatin nephrotoxicity may be attributed to a reactive metabolite yielded presumably by a certain enzyme such as cysteine-S-conjugate β -lyase.

Improvement in taking out of sample for PIXE from living body

A. Fujimura, S. Kogi¹, C. Kounoki¹, Y. Ando², M. Onodera, Y. Nozaka
C. Takahashi³, S. Goto³ and K. Sera⁴

First Department of Oral Anatomy, ¹First Department of Maxillo-Facial Surgery and
²Department of Periodontology, Iwate Medical University
1-3-27 Chuo-dori, Morioka, Iwate 020-8505, Japan

³Nishina Memorial Cyclotron Center, Japan Radioisotope Association
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

⁴Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

We have investigated the dynamics of the anti-tumor agent(Cisplatin) injected in the tongue in the last 6 years. However, the data of these samples varied widely and we consequently worried about the interpretation for these data. We have thought the cause of these varies was the protocol for sample preparations and have attempted the change of the container size or the measurement method. But we could not get the good result. In this experiment, we have improved the extraction method of lymph node. After injection of anti-tumor agent, we knot the afferent and efferent lymph vessels of the lymph node before extraction. We can get the good result thorough using this method. We can get by-product in this experiment. The agent flows into the lymph node of the same side in which we injected the agent, and the half volume of agent flows into the lymph node of the opposite side. From now on, we will increase the sample number and determine the inflow quantity in each side of the deep cervical lymph node.

Quantitative analysis of very small quantity of organs taken from patients and experimental animals
– Standard-free method for organ samples –

K. Sera¹, S. Goto², Y. Saitoh², J. Itoh³, S. Futatsugawa⁴, A. Fujimura⁵, Y. Nozaka⁵
Y. Noda⁶, S. Nishizuka⁶, G. Wakabayashi⁶

¹Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, 020-0173, Japan

²Nishina Memorial Cyclotron Center, Japan Radioisotope Association
348-58 Tomegamori, Takizawa, 020-0173, Japan

³Training Section, Japan Radioisotope Association
2-28-45 Honkomagome, Bunkyo, Tokyo 113-8941, Japan

⁴Department of Administration, Japan Radioisotope Association
2-28-45 Honkomagome, Bunkyo, Tokyo 113-8941, Japan

⁵First Department of Oral Anatomy, School of dentistry, Iwate Medical University
1-3-27 Chuo-dori, Morioka, Iwate 020-8505, Japan

⁶Department of surgery, School of medicine, Iwate Medical University
19-1 Uchimaru, Morioka, Iwate 020-8505, Japan

Abstract

A standard-free method for small lymph node and spleen samples taken from rats, and lymph node, esophagus, colon etc. taken from real patients has been developed in order to take measure to meet increasing demands for quantitative analyses of small amount of organs. It becomes possible to quantitatively analyze organ samples of less than 1 mg collected from small experimental animals and also from patients by biopsy, and accuracy and sensitivity of the method were examined by comparing the results with those obtained by a powdered-internal-standard method and a chemical-ashing method. It is found that the method is quite effective for estimating therapeutic effect of CDDP (Cisplatin) since it allows us to quantitatively evaluate uptake of CDDP into organs by analyzing small quantity of samples taken from actual patients by biopsy. It is expected that the method will become a powerful tool for studies not only in fundamental and clinical medicines but also on practical diagnosis and treatment.

Keywords : PIXE, Organ, Standard-free, Quantitative analysis, Small quantity, Clinical samples, Experimental animals, Anticancer agent

Elemental analysis of Chinese and Japanese peanuts by PIXE

A. Terakawa¹, K. Ishii¹, H. Yamazaki¹, S. Matsuyama¹, Y. Kikuchi¹, Y. Kawamura¹
J. Arikawa¹, M. Watanabe¹, M. Fujikawa¹, H. Akiyama¹, Y. Ito¹
K.Sera² and H. Sasaki³

¹Department of Quantum Science and Energy Engineering, Tohoku University
Aza-Aoba 6-6-01-2, Aramaki, Aoba-ku Sendai, Miyagi 980-8579, Japan

²Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

³Sasaki Taro Memorial PIXE center
5-3 Asano-chou, Hakodate, Hokkaido 040-0076, Japan

Abstract

Elemental concentration in Chinese peanuts was analyzed and compared with that in Japanese peanuts by means of a PIXE (Particle Induced X-ray Emission) technique with an internal standard method to investigate toxic elements in them because frequent detection of contamination of toxic elements or excessive agrochemical residues in food imported from China has posed serious health concerns to Japanese people. The authors prepared the samples by separating the peanut seed into two cotyledons (seed leaves) and an embryo. The present result showed that there were not significant differences in concentration for major elements between Chinese and Japanese peanuts, while higher concentration of Ni and Sr was observed in the Chinese peanut sample. It is suggested that the high concentration of these elements is related to pollution of the soil.

Uptake and transport of Cadmium in soybean plants

(3) The relationship between Cd and elemental concentrations in leaves

S. Yada¹, T. Arao², A. Kawasaki², H. Oda³ and K. Sera⁴

¹Research Fellow of the Japan Society for the Promotion of Science
National Institute for Agro-Environmental Sciences
3-1-3 Kannondai, Tsukuba, Ibaraki 305-8604, Japan

²National Institute for Agro-Environmental Sciences
3-1-3 Kannondai, Tsukuba, Ibaraki 305-8604, Japan

³National Institute for Agro-Environmental Sciences
(Present address: Eisai Seikaken Co., Ltd.
312-4 Toriko, Nishihara, Aso, Kumamoto 861-2401, Japan)

⁴Iwate Medical University, Cyclotron Research Center
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

A pot (1/5,000a) soil culture experiment with soybean plant (*Glycine max*) was performed. Soybean plants were sampled at the full maturity (R8) growth stage, and concentrations of elements in leaves were determined by PIXE. The concentration of Cd in soybean plant was determined by ICP-MS.

The analysis result of 82 elements from Na to U by PIXE, Mg, Si, P, S, Cl, K, Ca, Mn, Fe, Cu, Zn, Br, Sr were determined. The concentrations of these elements in soybean leaves did not affected by the addition of rice stubble (40 g pot⁻¹). The addition of rice stubble resulted in the specifically increase in the Cd concentrations in soybean leaves.

Quantitative analysis of phosphorus, iron, and arsenic in the roots or root apoplast of barley grown on water medium with arsenic and iron

M. R. Shaibur, S. Kawai and K. Sera *

Faculty of Agriculture, Iwate University
3-18-8 Ueda, Morioka, iwate 020-8550, Japan

*Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

An experiment with arsenic (As) and barley (*Hordeum vulgare* L. cv. Minorimugi) grown hydroponically was conducted to observe the effects of phosphorus (P) status on the formation of iron (Fe)-plaque. Plants were grown for 16 days treated with 10 μM As in presence or in absence of P. A set of treatment was without As and P. Phosphorus was used as ammonium phosphate ($\text{NH}_4\text{H}_2\text{PO}_4$) and As was used as sodium meta-arsenite (NaAsO_2). The $\frac{1}{2}$ -strength nutrient solution was used at pH 5.5. Plants were treated with 10 μM As + 500 μM P, 10 μM As + 250 μM P, 10 μM As + 50 μM P, 10 μM As + 0 μM P and 0 μM As + 0 μM P for 16 days. Iron-plaque with root reddish color was clearly visible in barley roots grown in As-treated and P-depleted condition. However, Fe-plaque with reddish color was not found in P-depleted and As containing medium, suggesting that As played a vital role in the formation of Fe-plaque in P-depleted condition. Intensity of reddish color intensity increased with decreasing P concentration in the medium. Apoplastic-Fe together with other elements were extracted by the method of Bienfait et al.. Contents of macro and microelements occurred as Fe^{3+} -complex in apoplast and in roots were determined. Particular emphasis was given on the concentration of P, Fe and As. Arsenic decreased root dry weight (DW) with decreasing P concentration in the medium. Detectable amount of P was not found in apoplastic portion in all treatments, indicating that P might not be complexed with apoplastic-Fe. Phosphorus may be present inside of roots as organic or inorganic phosphate. Iron was mostly concentrated in apoplast. However, As was mostly concentrated in roots and a little portion was found to be complexed with Fe^{3+} in the apoplast. Our result suggested that P might repress the formation of As-Fe complex in the apoplast, somehow.

PIXE analysis of mineral content in food waste samples

Keiko Chiba, Maki Abe, Yuriko Kawano, Ruiko Hori
Keiko Matsuhashi, Sakino Yamauchi and Kouichiro Sera*

Science of Living Department, Morioka Junior College, Iwate Prefectural University
152-52 Sugo, Takizawa, Iwate 020-0193, Japan

*Cyclotron Research Center, Iwate Medical University
348-58 Tamegamori, Takizawa, Iwate 020-0173, Japan

Abstract

In this study, we demonstrated that food waste was possible to change the delicious food menu with devised cooking arrangements, therefore we can reduce food waste rate.

Mineral content of waste food samples were analyzed using PIXE at NMCC. Many inorganic elements were detected in waste food samples. The main components of mineral in waste samples were K, Ca, Mg, P, Fe and Cu. Those components were essential nutrients for human body. In some case, Ca and Fe showed higher value in waste parts of food than edible parts.

These results also suggested that eco-cooking is a near ecological action in daily life and play an important role of environmental protection.

PIXE analysis of trace elements in blood cells and serum

F.Akiha, F.Akiha¹, S.Goto² and K.Sera³

3-4-9 Shigemori-Shincho, Hirosaki, Aomori 036-8261, Japan

¹Division of Technical Support, Iwate University
3-18-8 Ueda, Morioka, Iwate 020-8550, Japan

²Takizawa Institute, Japan Radioisotope Association
348-1 Tomegamori, Takizawa, Iwate 020-0173, Japan

³Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0173, Japan

Abstract

In this paper we would like to describe the results of our study. The original test samples were picked out from surgical sufferers (mainly cancer) at Hirosaki University Hospital. We have detected K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Y, Nb, Mo, I, Hg, Pt, Pb, Na, Mg, Al, Si, P, S and Cl.