Minutes of the FNCA Workshop on Radiation Processing of Natural Polymers"

October 29 – November 1, 2013
Kajang, Malaysia

1) Outline of Workshop

ⅰ) **Date**	October 29 – November 1, 2013
ⅱ) **Venue**	Kajang, Malaysia
ⅲ) **Host Organizations**	Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT), Malaysian Nuclear Agency (Nuclear Malaysia)
ⅳ) **Participants**	Twenty five (25) from nine (9) FNCA member countries, Bangladesh, China, Indonesia, Japan, Malaysia, Mongolia, The Philippines, Thailand, and Vietnam and two (2) IAEA/RCA countries, Myanmar and Pakistan.
ⅴ) **Program**	**Annex 1**

2) Workshop Programme

Open Seminar on "Application of Radiation Processing for Sustainable Development"

An open seminar on application of radiation processing for sustainable development was held at Malaysian Nuclear Agency in Kajang, Malaysia. About forty people from research institutes, agricultural and industrial sector participated in the seminar.

Ms. Moe Aoki, Special Staff, International Nuclear Cooperation Division, Research and Development Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT) gave opening remarks expressing her deep appreciation to Malaysia, and particularly Malaysian Nuclear Agency for generously hosting the open seminar and workshop. Dr. Sueo Machi, FNCA Coordinator of Japan also gave his opening remarks and emphasized that the good collaboration experienced between the scientists and business sectors of FNCA countries can contribute much to the commercialization of the radiation processed products. He also expected that all the participants would actively participate in the seminar through questions and comments during presentations and panel discussion.

Dr. Muhd Noor Muhd Yunus, Deputy Director General of Malaysian Nuclear Agency gave his welcoming remarks and extended a hearty greetings to all the participants. He wished this open seminar would be a good opportunity to acquire new knowledge on the application of radiation processing for sustainable development. He also wished that all FNCA and IAEA/RCA participants would have an enjoyable stay in Malaysia. Seven presentations and a

panel discussion on Future Prospect and Challenges of Radiation Processing Application for Sustainable Development were then conducted. The summary of open seminar is attached as **Annex 3**.

Opening Session

The workshop was attended by experts on applications of electron accelerator and radiation processing of natural polymer from FNCA participating countries namely Bangladesh, China, Indonesia, Japan, Malaysia, Mongolia, the Philippines, Thailand and Vietnam. In addition, two experts representing IAEA/RCA member countries namely Myanmar and Pakistan, which are not FNCA member countries, also participated in the workshop. The list of participants of the workshop is attached in **Annex 2.**

Ms. Moe Aoki and Dr. Sueo Machi each gave a welcoming speech and hoped for a fruitful discussion during the workshop. Dr. Muhd Noor Muhd Yunus, Deputy Director General of Malaysian Nuclear Agency welcomed all the participants and formally declared the opening of the workshop.The participants then briefly introduced themselves.

Session 1: Overview of FNCA

Dr. Sueo Machi reported on the progress of FNCA projects during the 13th Ministerial Meeting in 2012. In addition to the major decisions made during that meeting, the highlights and achievements of on-going FNCA projects were enumerated. It was recommended at the FNCA Coordinators Meeting last March 2013 that the FNCA coordinator of each country organize an annual meeting of Project Leaders where the Coordinator shares the policy and direction of FNCA with PLs, and PLs share information of outcomes of their respective projects.

Dr. Masao Tamada, Director General of Takasaki Advanced Radiation Research Institute, Japan Atomic Energy Agency (JAEA) introduced the current activities and the implementation plans of "Radiation Processing of Natural Polymers" for the FNCA Electron Accelerator Application Project (2012 – 2014, Phase 4). The project would focus on technology transfer of plant growth promoter (PGP) and super water absorbent (SWA) to end-users with collaborative R&D with agricultural sector.

Session 2: Country Report on Production and Field Test of Plant Growth Promoter (PGP) or Elicitor Produced by Radiation Processing

Nine (9) FNCA member countries presented reports, detailing their activities for 2013 on oligochitosan PGP obtained by radiation processing. Member counties shared the results of PGP from chitosan and carrageenan in terms of weight gain, disease reduction of plants, and control of infection in aqua culture. PGPs have been beneficial in quite a number of crops. Elicitor effect of PGP especially on disease suppression could be a great advantage for commercialization.

The summaries of the reports are attached as **Annex 4 Part A.**

Session 3: Review of Performance Field Test Results of PGP

Dr. Kamaruddin Bin Hashim, Director, Radiation Processing Technology Division, Malaysian Nuclear Agency (Nuclear Malaysia) and Dr. Nguyen Quoc Hien, Scientific Researcher, Research and Development Department, Research and Development Center for Radiation Technology, Vietnam Atomic Energy Institute (VINATOM) gave a lead speech for this session. The focus for discussion were on the following topics: 1) guideline of production process of PGP, 2) development and field test of PGP in each country in terms of disease resistance for different plants, and 3) work plan of the field test in 2013 to 2015. Comments raised during the discussion were as follows:

- Cost of final product is still expensive. Therefore, it is necessary to conduct cost benefit analyses In the case of Vietnam, the cost for PGP product (3% of oligachitosan) is only about 2$/l because the chitosan are available at around 15-20 USD/kg.
- It was learned from experience of member countries that degradation process by irradiation in liquid state is more effective compared to that in solid state though the concentration of oligocchitosan is low. In case of the irradiation in solid state, the irradiation dose will increase to around 200kGy due to the low production rate. Dr. Wu Guozhong (China) suggested irradiating the product in solid state. For the field tests, one should differentiate oligomer from low molecular weight polymers. It is necessary to investigate further the effect of each.
- Member states should consider the effect of PGP on high value crops of each country.
- PGP effect should be demonstrated clearly to private companies and government sector in order to promote commercialization.

Session 4: Preparation of guideline PGP application for different crops including rice and chili

All the participants agreed that a guideline on PGP application for different crops is very important and useful for all member states. Application method can be modified by member countries according to their situation. Many parameters, such as soil condition, crop variety, growing stage, molecular weight of chitosan, concentration of chitosan, frequency of spraying will have an impact on the final test result of PGP. However, it is difficult to cover all these factors in detail in the guideline. There was an agreement that a general guideline for the use of PGP should be compiled, including molecular weight, concentration of chitosan for spraying (40-100 ppm) and seedling (50-200 ppm) and frequency of spraying. Other member countries can make their own decision according to the guideline. Effects of plant growth and elicitor of other crops aside from rice and chili will be also compiled. These data will be attached as appendix in the guideline. Malaysia and Vietnam will provide guideline for PGP on rice, while Indonesia and Thailand will provide information on chili. The documents should be submitted to Dr. Nagasawa (Japan) by the end of 2013. The format will be sent to member countries in a

few weeks.

Session 5: Strategy for Commercial Application of PGP and Plan for 2013-2015

Dr. Kamaruddin presented a comprehensive strategy for commercial application of PGP as summarized in the diagram shown in **Annex 5**.

The following points were discussed:

- The strategy for the production of PGP in large scale has to be considered. The volume has to meet the demand required by private companies.
- The importance of the reproducibility of production of oligosaccharides has to be stressed.
- In the commercialization process, the institute's vital role is to assist business partners in producing the necessary documents needed for the registration of the products
- Legal registration of PGP is difficult though it is a necessary step for commercialization. Strategically, the first step is to register its application in the most valuable crop after confirming its PGP effect in field test. Business partner may assist in the process of registration.

The following R & D Work Plan for 2013-2015 on PGP has been adopted:

- Determine MW of oligochitosan as growth promoter and elicitor effect for specific plant of interest.
- Develop a comprehensive data and protocol on the application of oligochitosan on various plants based on FNCA Member State's interest. So far only rice and chili have been developed and shared to FNCA Member State.
- Determine socio- economic impact of oligo-chitosan on plant of interest for each FNCA Member.
- Collect data on results of field test on plants of interest and share with other member states.
- Develop data on LMwt chitosan in terms of function and application as food additive in animal feed stock to diversify use of chitosan in agricultural business
- Do a strategic planning on how to produce PGP in a commercial scale
- Indonesia will compare the active components causing PGP effect of their oligochitosan samples and compare it with the oligochitosan samples using Vietnam's protocol

Session 6: Country Report on Production and Application of Hydrogel Super Water Absorbent by Radiation Cross-linking and Grafting of Natural Polymers

Nine (9) member countries and two (2) IAEA/RCA countries presented their reports on research activities on SWA. It was concluded that SWA is effective to accelerate germination

and growth of plants. Value-added SWA with the incorporation of slow release function of PGP, chemical/bio fertilizer, nutrients etc. is can increase its prospect for commercialization. The summary of the reports is attached as **Annex 4 Part B.**

Session 7: Results of Field Tests and Strategy for Commercial Application of SWA, and Work Plan in 2013-15

Dr. Phiriyatorn Suwanmala, Nuclear Scientist, Nuclear Research and Development Group, Thailand Institute of Nuclear Technology (TINT) and Ms. Tita Puspitasari, Researcher, Center for Application of Isotopes and Radiation Technology, National Nuclear Energy Agency (BATAN) delivered a lead speech for this session.

Challenges and tasks to approach commercial application include the following:

- Low-cost and indigenous ingredients like coir dust can be selected as starting material for SWA preparation
- Leap frog from the procedure for SWA production already achieved by other member states, such as Vietnam or Thailand.
- Approach the government for political and financial support

The following points were suggested for Project work plans in 2013-2015,:

- Make collaboration with other institute such as agriculture research institute or farmer community in the arid area
- Combine treatment of SWA with biofertilizers and/or PGP to have value added SWA
- Study possible slow release of chemical fertilizer or biofertilizer with SWA

Other points for discussion were as follows:

- Dissemination through mass media will attract end-users.
- Preparation process of SWA is much different when upscaling from laboratory scale to bench scales. Open air is enough for drying of SWA using laboratory scale. However, drying process in bench scale needs special equipment like drying oven. New guideline of SWA should contain the protocol for formulation; dose; methods for drying, cutting, and grinding; gel fraction; swelling degree, etc.

Session 8: Coordination of the FNCA Project with RCA/IAEA Project on Radiation Processing

Dr. Lucille V.ABAD, Supervising Science Research Specialist, Philippine Nuclear Research Institute (PNRI) made a report on RAS1014: Supporting Radiation Processing for the Development of Advanced Grafted Materials for Industrial Applications and environmental Preservation. RAS 1014 started in January 2013 for a duration of 3 years which will end in December 2015. The objective of this project is to produce advanced grafted products for

industrial applications and for mitigating environmental pollution by using radiation processing. Outcome of this project is to produce advanced radiation grafted products in the form of membrane, gel, fiber and hybrid coating to use in industrial application and for removal of toxic elements and harmful compounds in environmental application. First regional training course on the topic of "Basic Radiation Processing of Polymer Focusing on Radiation Grafting" has been carried out in Manila, Philippines from 15 to 19 April 2013. Objective of the training is to expose participants with knowledge and information to carry out activity on radiation grafting through lecture, case study and discussion. Next activity will be held in Korea on the "Regional Executive Meeting for End-user and Policy Makers on Radiation Grafting for Industrial Applications and Environmental Preservation" from 11 to 15 November 2013.

There was an agreement that FNCA will continue the cooperation with IAEA/RCA, since both groups are composed only of one team and the experienced linkages of both were found to be beneficial to FNCA and IAEA/RCA . It was also suggested to coincide the meeting of FNCA with IAEA/RCA.

Session 9: Conclusion and Summary Report

The workshop minutes were reviewed and approved after discussion.

Closing Session

The workshop was officially closed by Dr. Dahlan Bin Hj Mohd, Senior Director, Management Programme, Malaysian Nuclear Agency, Ms.Moe Aoki, and Dr. Sueo Machi.

Technical Visit

The participants visited some irradiation facilities at the Malaysian Nuclear Agency, namely: a) SINAGAMA (gamma irradiation) and observed its services being offered to industry such as spice, cocoa etc.; b) Alutron (Electron Beam Irradiation) which is used to produce hydrogel for facemask and crosslinking of cables; and c) Raymintex which is used for the gamma irradiation of liquids and has been used for the irradiation of oligochitosan in big volume.

3) Conclusion and Recommendation

Major Conclusion of the meeting:

1. The work plans of PGP/Elicitor and SWA have been agreed as attached in Annex 5 and 6, respectively.
2. The guide line of PGP/elicitor for rice and chilly should be edited by Dr. Nagawasa after submission by member countries (Rice: Malaysia, Vietnam Chili: Indonesia, Thailand) The deadline of submission is at the end of 2013. Format will be sent by Dr. Nagasawa in 2 weeks.
3. Collaboration with agricultural sector including research institutes and relevant

government department has to be strengthened.

4. A national group headed by PLs has to be set up to strengthen the project implementation. The group may consist of soil scientists, plant growers, agriculture marketing experts, potential end-users, agriculture policy makers, and radiation processing experts.
5. Some basic researches still need to be done for better application of PGP and SWA.

Meeting noted following points:

1. Vietnam and Japan have achieved commercialization of PGP/Elicitor
2. Malaysia, Indonesia, and Thailand have achieved semi-commercialization of PGP and elicitor
3. Further effort of field tests on specific crops for PGP/elicitor is needed in some countries
4. Cost reduction of SWA is desirable by using agricultural waste materials
5. Enhanced information dissemination to farmers on PGP/elicitor and SWA is essential for extension.
6. Each country will do strategic planning on how to produce PGP/Elicitor in a commercial scale considering some limitations with regards to irradiation facilities
7. Collaboration between FNCA and IAEA/RCA should be continued.
8. It is proposed to have a joint seminar between IAEA/RCA Project Review Meeting and FNCA workshop to share information

4) Attachments

Annex 1: Program
Annex 2: List of Participants
Annex 3: Summary of Open Seminar
Annex 4: Part A: Summary of Country Reports on Production and Field/Pot Test of Plant Growth Promoter (PGP) from Chitosan by Radiation Processing
Part B: Summary of Country Reports on Production of Super Water Absorbent (SWA) by Radiation Processing
Annex 5: PGP & SWA Work Plan for 2013-2015
Annex 6: Table of PGP and SWA Progress