R&D area: Degraded chitosan for animal(2024)

Group member: Dr. Tamada Maso (Japan); Dr. Wada Tomoaki (Japan); Dr. Kasinee Hemvichian (Thailand); Maznah Binti Mahmud (Malaysia).

Current status (MALAYSIA/THAILAND)

1. **Storage study** on KitoGama: When stored at room temperature, in an air-conditioned room, and in a warm room, KitoGama exhibited no signs of fungal growth. We have confirmed that KitoGama is safe to store under these three conditions; however, the duration of storage may affect its effectiveness against E. coli.
2. In the aquaponic system, the inclusion of KitoGama in the fishpond resulted **in higher levels of nitrogen (N), phosphorus (P), potassium (K) and EC (electrical conductivity) compared to the hydroponic system** (supplied with AB fertilizer). Aquaponic only depending on waste matter from fish pond and Kitogama.
3. The addition of KitoGama to the tilapia pond in the aquaponic system produced impressive results in the growth of chili, tomato, brinjal, and water spinach. (as at low as 0.05% Kitogama)
4. Thailand has just started the project on "Degraded chitosan for animal feed" in 2024.

Remaining/New Challenges

1. KitoGama has been tested in aquaponics, but trials with other feedstocks still need to be conducted. Unfortunately, we have been unable to secure any collaborators for these trials.
2. Securing and protecting intellectual property is essential to prevent competitors from replicating innovations. It is important to obtain copyright for the operational procedures before launching the product in the market.
3. Building effective collaborations with industry partners, suppliers, and distributors is essential but can be challenging.
4. Securing sufficient funding to support R&D activities and commercialization efforts can be difficult, particularly for high-risk projects.
5. Establishing a reliable supply chain for raw materials and distribution is crucial for successful commercialization. Chitosan powder is not produced locally, so we rely on external sources for our supply. Fluctuations in currency stability may affect both the availability of these sources and the overall cost of the product. However, ongoing demand and industry trust are likely to remain stable despite these challenges.
6. Remaining challenges for Thailand, at this point, are [1] to continue and further the experiments with Tilapia in the first year (2024) [2] to start the experiments with shrimp (prawn) in the second year (2025) and [3] to start the experiments with Sea Bass in the third year (2026)

Gap in basic aspect (MALAYSIA/THAILAND)

- **Limited Testing with Feedstocks**: While KitoGama has been tested in aquaponics, there is a lack of data on its efficacy with various feedstocks.
- **Collaboration Challenges**: The inability to secure collaborators for trials indicates a gap in networking or partnership strategies.
- **Intellectual Property Knowledge**: There may be a gap in understanding the nuances of securing and protecting intellectual property, which could lead to vulnerabilities in innovation.
- **Funding Sources**: The difficulty in securing funding for R&D activities suggests a gap in knowledge about potential funding opportunities or the need for more robust funding proposals.
- **Supply Chain Reliability**: Dependence on external sources for chitosan powder highlights a gap in local sourcing and supply chain management.
- **Impact of Currency Fluctuations**: The potential impact of currency stability on costs and availability points to a gap in financial risk management strategies for sourcing materials.
- **Market Analysis**: There may be a lack of comprehensive market analysis to assess ongoing demand and industry trust, which could inform marketing and sales strategies.
- **Research on Consumer Acceptance**: Understanding consumer acceptance and preferences regarding KitoGama and its applications in aquaponics could be an unexplored area.
- **Long-term Performance Studies**: There may be a gap in long-term studies assessing the sustainability and performance of KitoGama in various applications over time.
- **Regulatory Framework Understanding**: A potential gap exists in understanding the regulatory landscape that affects commercialization, which could impact market entry strategies.

Gap in application aspect (MALAYSIA/THAILAND)

•**Limited Application Range**: KitoGama has been tested in aquaponics, there is a gap in its application with various feedstocks, which could affect its versatility and effectiveness in different agricultural systems.
•**Lack of Field Trials**: The absence of trials in real-world agricultural settings may limit understanding of KitoGama's performance and adaptability outside controlled environments.
•**Scalability Issues**: There may be gaps in knowledge regarding how to scale up KitoGama's application from experimental to commercial levels, including challenges related to production and distribution.
•**Consumer Awareness**: A gap exists in educating potential users about the benefits and applications of KitoGama, which could affect adoption rates in various sectors.
•**Integration with Existing Systems**: There may be a lack of research on how KitoGama can be effectively integrated into existing agricultural and aquaculture systems without disrupting current practices.
•**Performance Metrics**: The absence of standardized metrics to evaluate KitoGama's effectiveness across different applications can hinder comparative studies and widespread acceptance.
•**Environmental Impact Assessment**: There may be a gap in assessing the environmental impact of KitoGama's use in different agricultural settings, which is crucial for sustainable practices.
•**Economic Viability Studies**: Limited research on the economic implications of using KitoGama compared to other products could impede its acceptance in the market.
•**Regulatory Compliance**: There may be gaps in understanding and addressing regulatory requirements specific to the application of KitoGama in various markets.
•**Feedback Mechanisms**: A lack of mechanisms to gather user feedback on KitoGama’s application could limit ongoing improvements and adjustments needed for better performance.

Implementation plan **(MALAYSIA/THAILAND)**

1. Broaden Application Range
- Research and Development: Conduct studies with various feedstocks to assess KitoGama’s effectiveness across different agricultural systems.
- Pilot Programs: Initiate small-scale trials in diverse environments to gather data on versatility.

2. Conduct Field Trials
- Collaboration with Farmers: Partner with local farmers to perform field trials in real-world settings, collecting data on performance and adaptability.
- Monitor and evaluate KitoGama’s effectiveness over multiple growing seasons to establish reliability.

3. Scalability Assessment
- Production Trials: Explore methods for scaling production while maintaining quality.
- Distribution Strategies: Develop a distribution plan that addresses logistics and accessibility in various markets.

4. Enhance Consumer Awareness
- Educational Campaigns: Create informative materials and workshops to educate potential users about KitoGama’s benefits and applications.
- Partnerships with Industry Leaders: Collaborate with agricultural organizations to promote awareness.

5. Integration Research
- Compatibility Studies: Investigate how KitoGama can be integrated into existing systems with minimal disruption.
- Pilot Integration Projects: Test KitoGama within established practices to identify best integration methods.

6. Establish Performance Metrics
- Standardized Metrics Development: Create a set of metrics to evaluate KitoGama’s effectiveness across different applications.
- Comparative Studies: Conduct studies comparing KitoGama with existing solutions to demonstrate benefits.

Implementation plan

7. Conduct Environmental Impact Assessments
- Life Cycle Analysis: Perform assessments to evaluate the environmental impact of KitoGama in various agricultural settings.
- Sustainability Reports: Publish findings to inform stakeholders and promote sustainable practices.

8. Economic Viability Studies
- Cost-Benefit Analysis: Research the economic implications of using KitoGama versus traditional methods to establish value.
- Market Studies: Analyze potential market size and customer segments to identify economic opportunities.

9. Ensure Regulatory Compliance
- Regulatory Research: Investigate relevant regulations in different markets and ensure KitoGama meets all requirements.
- Engagement with Regulatory Bodies: Build relationships with regulatory agencies to facilitate compliance and approval processes.

10. Implement Feedback Mechanisms
- User Surveys: Develop a system for collecting user feedback to identify areas for improvement. (by electronic or by survey form)
- Advisory Groups: Establish groups of users and experts to provide ongoing input on KitoGama’s performance and application. (commercialization division should take this task)
- We are planning to discuss with TINT’s Business Developing Unit (BDU) to make a business plan for the commercialization of the degraded chitosan for fish feed and / technology transfer to private companies

R&D area: Degradation of chitosan for animal feed (2024)

Group member: Dr. Tamada Maso (Japan); Dr. Wada Tomoaki (Japan); Dr. Kasinee Hemvichian (Thailand); Maznah Binti Mahmud (Malaysia).

- ❑ KITOGAMA is chitosan based-food additive

Table 1. Comparison of N, P, K and EC in hydroponic (chemical fertilizer) and aquaponic (KITOGAMA).

	N (ppm)	P (ppm)	K (ppm)	EC (mS/cm)
Hydroponic (AB Fertilizer)	142	260	479	1.80
Aquaponic (Degraded chitosan)	224	329	502	2.23

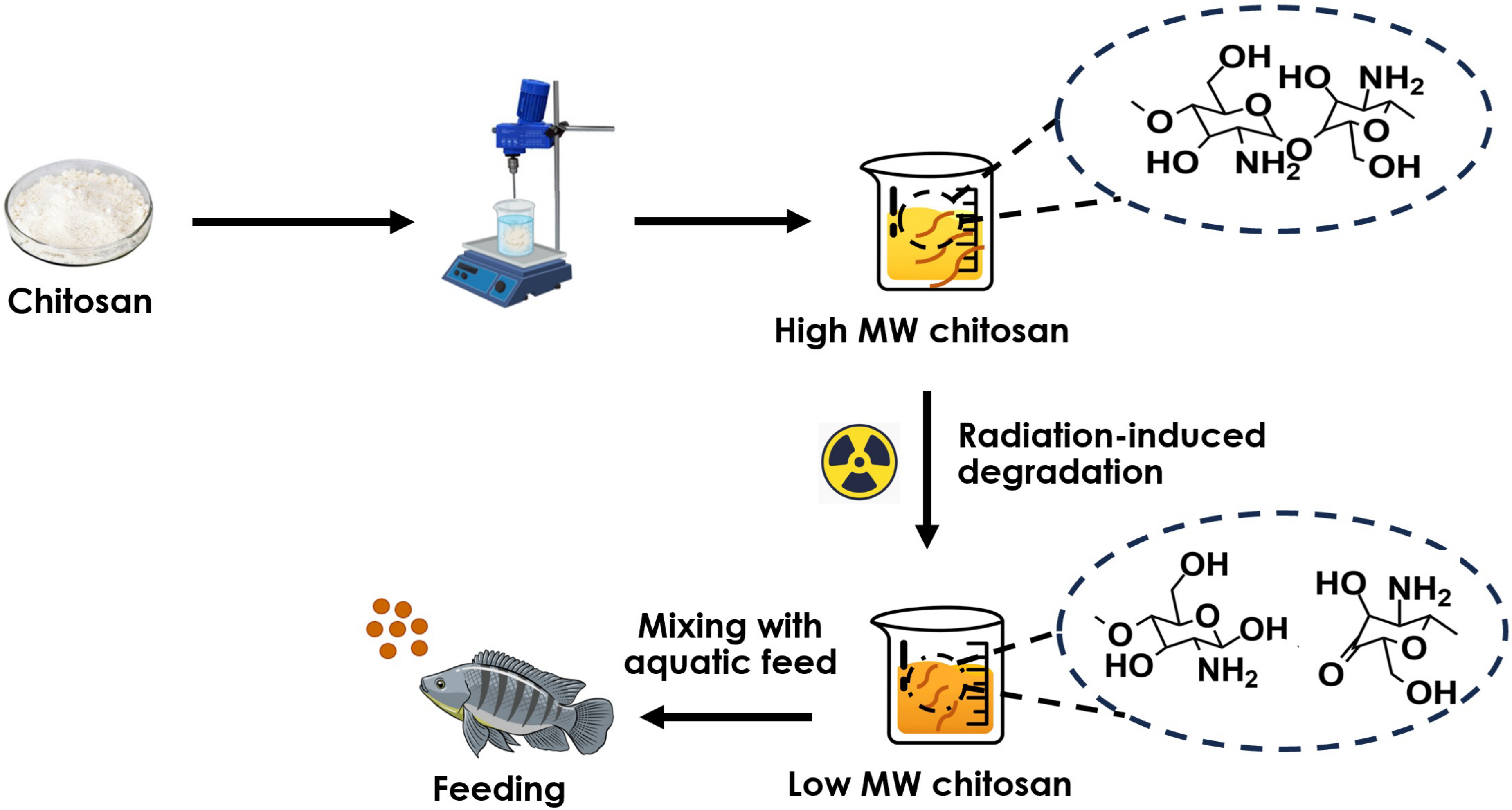
- ❑ KITOGAMA was added in the fish feed and the same water was used as water supply for hydroponic system (plant).

Application of irradiated chitosan (KITOGAMA) in aquaponic system. Various plants (chili, tomato, brinjal, water spinach) and tilapia

R&D area: Degradation of chitosan for animal feed (2024)

Group member: Dr. Tamada Maso (Japan); Dr. Wada Tomoaki (Japan); Dr. Kasinee Hemvichian (Thailand); Maznah Binti Mahmud (Malaysia);.

Thailand's Plan for 2024 – 2026: Lab Tests & Field Tests



R&D area: Hydrogels for Medical Applications (2024)

Group members: Farah Nurlidar (Indonesia), Charito Aranilla (Philippines), Lorna Relleve (Philippines), Mitsumasa TAGUCHI (Japan), Bin Jeremiah Barba (Philippines), Farah Fadzehah (Malaysia)

Current status

<Improvements from 2023>

Indonesia and Malaysia

PEGDA/Alginate hydrogel for ciprofloxacin encapsulation: it showed good potential application for drug release in intestinal target (low drug release in acid condition and high drug release in base pH).

Japan

Nanoparticles sensor: Aqueous gelatin solutions were irradiated with g-rays to produce nanoparticles with average diameters of 5–20 nm and negative surface potentials. The obtained nanoparticles were labeled with 64Cu. The nanoparticles accumulated in the tumors in mice. Therefore, 64Cu-labeled gelatin nanoparticles show promise as a platform for next-generation PET imaging agents for pancreatic cancer.

Philippines

CMC Hemostat: Obtained approved Clinical trial protocol. The clinical trial will involve around 280 subject patients; Translated lab scale production (5 kg/batch) to pilot scale (10 kg/batch and 50 kg/batch).

CMHA: Conducted synthesis, characterization and in vitro drug delivery studies with promising results.

R&D area: Hydrogels for Medical Applications (2024)

Group members: Farah Nurlidar (Indonesia), Charito Aranilla (Philippines), Lorna Relleve (Philippines), Mitsumasa TAGUCHI (Japan), Bin Jeremiah Barba (Philippines), Farah Fadzehah (Malaysia)

Current status

<Remaining/New Challenges>

Gap in basic aspect

Indonesia and Malaysia

Biocompatibility and cytotoxicity assays must be conducted.
No facilities for this aspect and need to collaborate with expertise that have vast knowledge in this area. Fortunately, collaborators has been identified and the cell fibroblast will be arrived in January.

Japan

In vitro and in vivo tests of Cu-loaded nanoparticles for medical applications. Properties of nanoparticles will be improved in order to accumulate in cancer organs.

Philippines

CMC Hemostat: Implementation of clinical trials; Streamlining of pilot scale production (method and equipment)
CMHA: Limited supply of CMHA (not commercially available); Laborious synthesis process

R&D area: Hydrogels for Medical Applications (2024)

Group members: Farah Nurlidar (Indonesia), Charito Aranilla (Philippines), Lorna Relleve (Philippines), Mitsumasa TAGUCHI (Japan), Bin Jeremiah Barba (Philippines), Farah Fadzehah (Malaysia)

Current status

<Remaining/New Challenges>

Gap in application aspect

Indonesia and Malaysia

Requirement legislation, (clinical test, etc.) takes times ,registration of the product – in vivo studies takes a long time and cost a lot of money.

Japan

Need technology takers, or industry and medical partners.

Philippines

CMC Hemostat: Extensive legal requirements (FDA); Feasibility/Cost-Benefit or Effectiveness Analysis studies (in collaboration with Business Development Group)

CMHA: Collaborators, Industry partner

R&D area: Hydrogels for Medical Applications (2024)

Group members: Farah Nurlidar (Indonesia), Charito Aranilla (Philippines), Lorna Relleve (Philippines), Mitsumasa TAGUCHI (Japan), Bin Jeremiah Barba (Philippines), BINTI HILMI Farah Fadzehah (Malaysia)

<u>Current status</u>
<Remaining/New Challenges>
<u>Implementation plan</u>

Indonesia and Malaysia
Market study – need to be conducted extensively so that the funding agency will know the marketability of the product

Japan
Improve nanoparticles properties for diagnostics

Philippines
CMC Hemostat: Involve collaborators in the clinical trial and technology transfer
CMHA Hydrogel: Continue R&D activities; Submitted proposal for funding and awaiting approval.

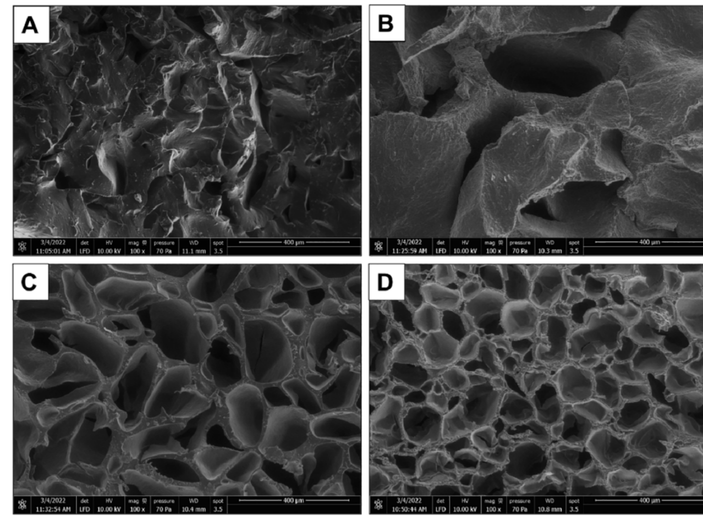
R&D Area: 2. Hydrogel for Medical Application (2024)

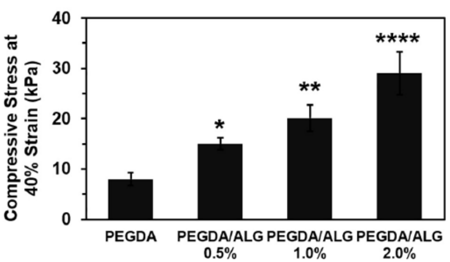
Group member: Farah Nurlidar (Indonesia)

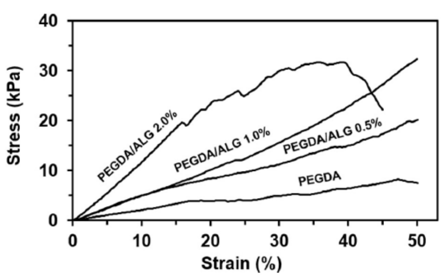
PEGDA/Alginate hydrogel for ciprofloxacin encapsulation

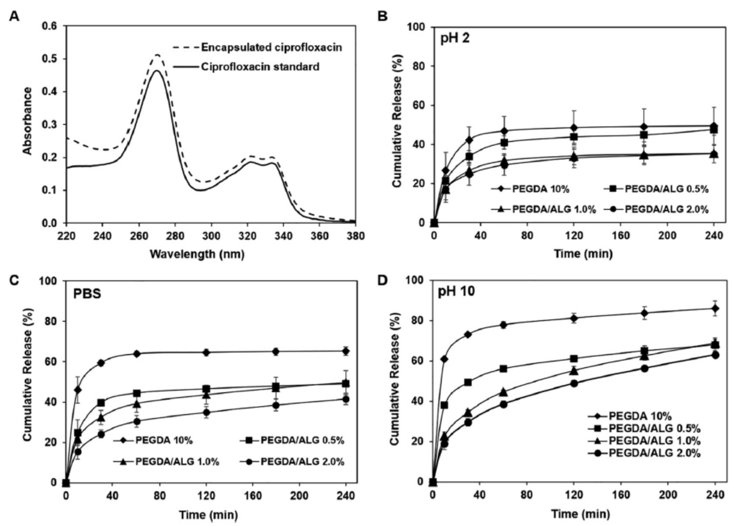
Current status

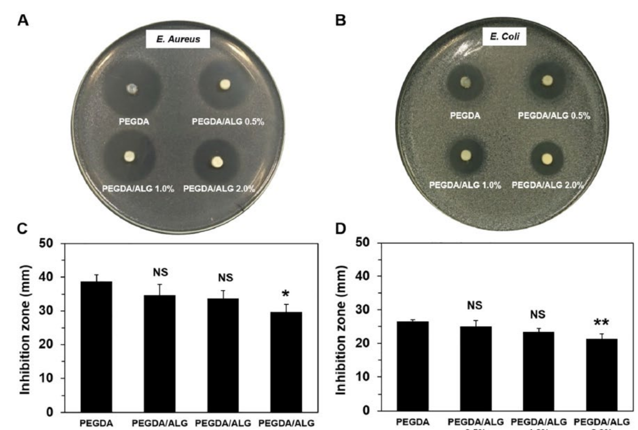
- Have done with physical, chemical, mechanical characterization, *in vitro* drug release, and antibacterial activity study
- Will add curcumin as natural anti-inflammatory
- Will conduct biocompatibility test and cytotoxicity test using mammalian cell line





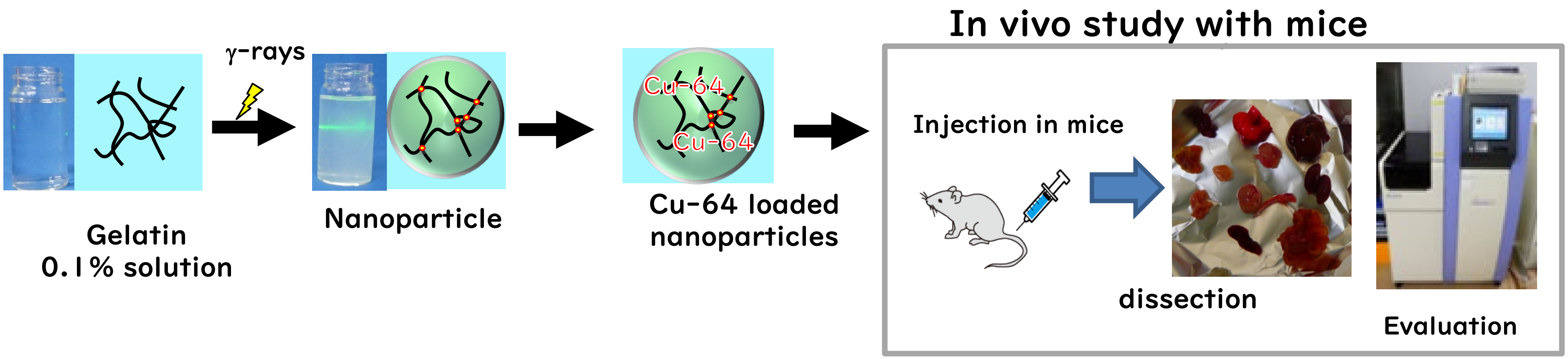


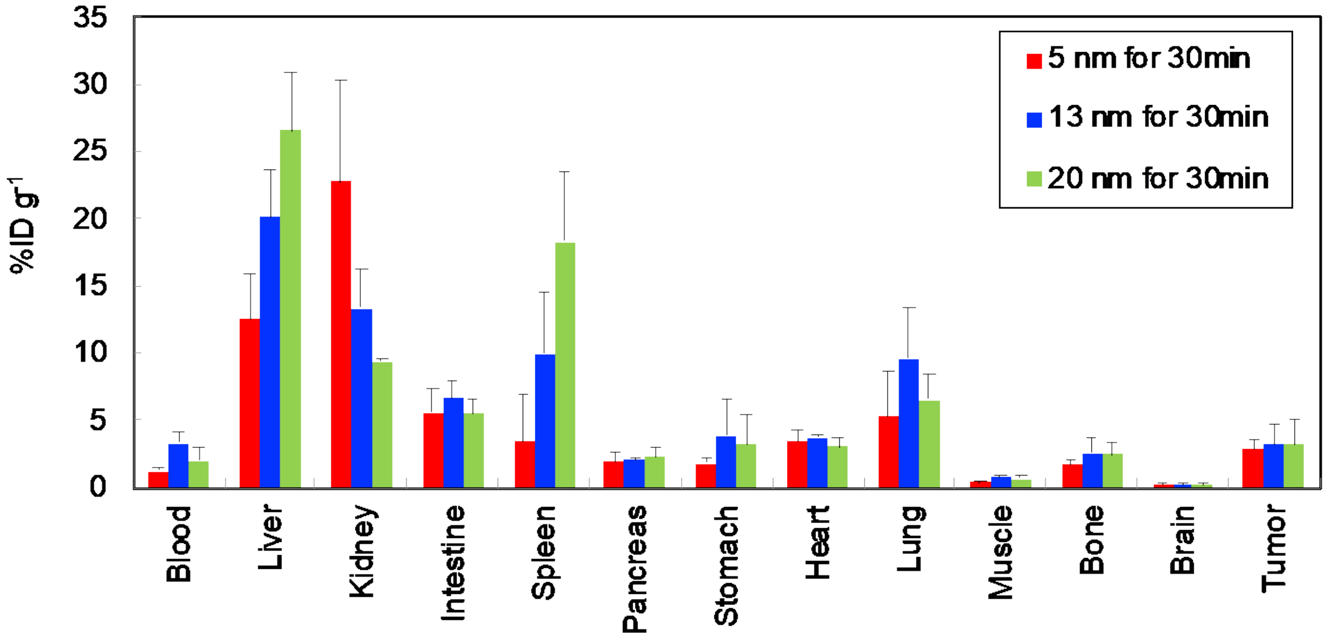




R&D Area: 2. Hydrogel for Medical Application (2024)

Group member: Mitsumasa TAGUCHI (Japan)





Cu-loaded nanoparticles were accumulated in serious pancreatic cancer.

R&D Area: 2. Hydrogels for Medical Applications (2024)

Group member: Lorna Relleve (Philippines)

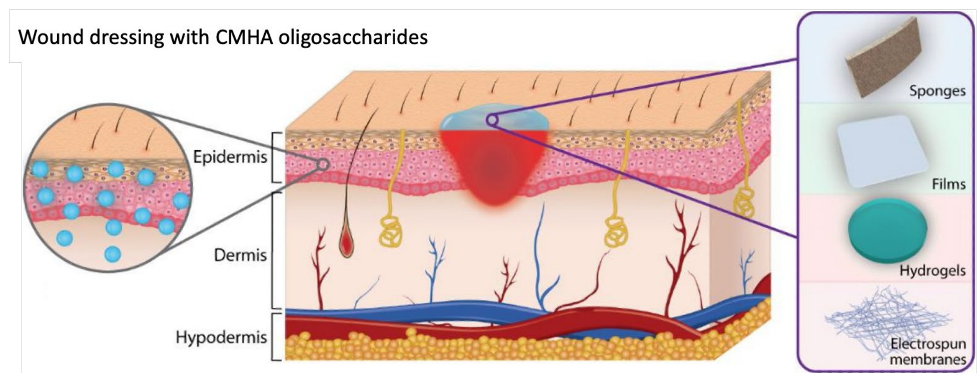
CMHA hydrogel w/ CMHA oligosaccharides

CMHA Oligosaccharides prepared by radiation degradation

→

Cytotoxicity testing
Antioxidant activities
Cell Proliferation and Migration
Wound Healing Assay
Angiogenesis Assay

↓



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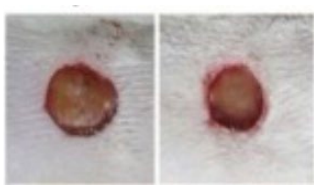


Animal Model

←

Clinical Trials

R&D area: Environmental Remediation (2024)

Group member: Nguyen Ngoc Duy (Vietnam), Hongjuan MA (China), Azat Nurkassimov (Kazakhstan), Murat Kassymzhanov (Kazakhstan)

Current status

<Improvements from 2023> (specify the name of the country if needed)

- Synthesis of Ag nano/TiO2 by electron beam irradiation for photodegradation of rhodamine B compound in water. (Vietnam)
- Treatment of cardiovascular drug salbutamol (SAL), decompose Cu-ethylenediaminetetraacetic acid (Cu-EDTA), defluorination of perfluorinated compounds, and microplastics by EB irradiation. (China)
- Enviromental remediation: Production of pipes made of cross-linked polyethylene for hot water supply. (Kazakhstan)

R&D area: Environmental Remediation (2024)

Group member: Nguyen Ngoc Duy (Vietnam), Hongjuan MA (China), Azat Nurkassimov (Kazakhstan), Murat Kassymzhanov (Kazakhstan)

<Remaining/New Challenges>

- Pollutant dioxin in the soil, pesticides and organic pollutants from waste water hospital is big challenges. (Vietnam)
- EB accelerator manufacturers are reluctant to develop off-beam devices. (China)
- High costs in the construction and operation of pipelines for hot water supply, since metal is currently used as the material for pipelines for hot water supply in most cases. (Kazakhstan)

R&D area: Environmental Remediation (2024)

Group member: Nguyen Ngoc Duy (Vietnam), Hongjuan MA (China), Azat Nurkassimov (Kazakhstan), Murat Kassymzhanov (Kazakhstan)

Gap in basic aspect

- It is difficult to recover photo catalytic materials because they are in powder form. Photo catalytic efficiency is still low when processed under sunlight. (Vietnam)
- High costs in the construction and operation of pipelines for hot water supply, since metal is currently used as the material for pipelines for hot water supply in most cases. (Kazakhstan)
- Biological toxicity of the degradation products of drugs is unclear. EB irradiation treatment of wastewater need to be combined with biological treatment. (China)

Group member: Nguyen Ngoc Duy (Vietnam), Hongjuan MA (China), Azat Nurkassimov (Kazakhstan), Murat Kassymzhanov (Kazakhstan)

Gap in application aspect

- Advanced remediation techniques, such as bioremediation, phytoremediation, or radiation, can be costly and technically complex. Many regions lack access to these technologies, limiting their ability to address contamination effectively. Vietnam has not a medium- and low-energy, high-power electron beam machine yet for research in the field of environmental treatment. (Vietnam)
- Processing capacity and speed are advantages of EB irradiation while environmental remediation policies using EB irradiation in China are controversy, details will under consideration. The treated wastewater cannot be connected to the grid with other wastewater. (China)
- Low awareness of the organization involved in the design, installation and operation of hot water pipelines about the existence of pipes made of cross-linked polyethylene. (Kazakhstan)

R&D area: Environmental Remediation (2024)

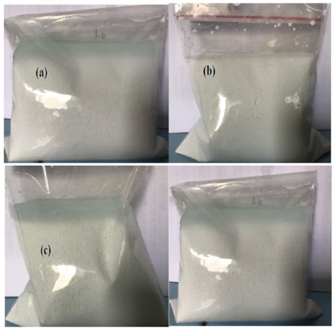
Group member: Nguyen Ngoc Duy (Vietnam), Hongjuan MA (China), Azat Nurkassimov (Kazakhstan), Murat Kassymzhanov (Kazakhstan)

Implementation plan

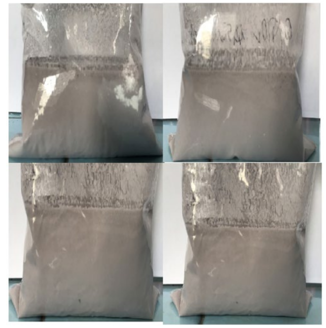
- Study on the treatment of hospital wastewater treatment using electron beam method. (Vietnam).
- Degradation behavior of new drugs, microplastics, metal complex et al. will continue to be studied. The key laboratory of the Ministry of education of comprehensive treatment of complex pollutants works well and the application of National key laboratory of nuclear industry effluent is submitted. (China)
- An application has been submitted for grant financing for the commercialization of the results of scientific and technical activities. The amount of attracted investments is about 1 million US dollars. (Kazakhstan)

R&D area: Environmental Remediation (2024)

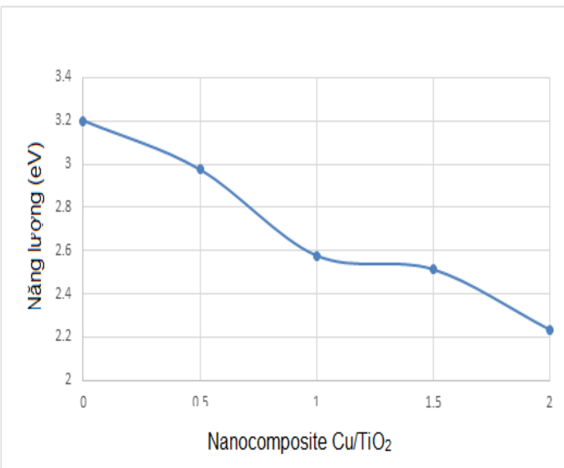
Group member: NGUYEN NGOC DUY (Vietnam),

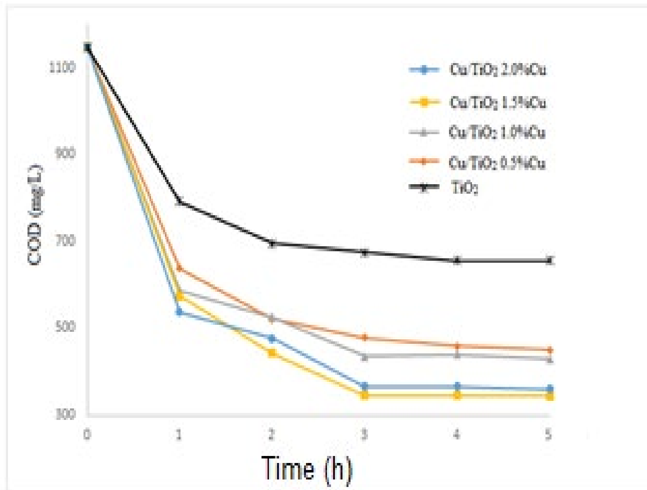


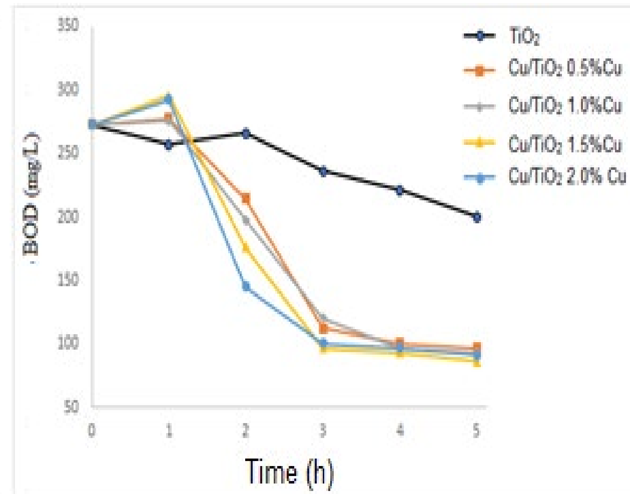
Irradiation

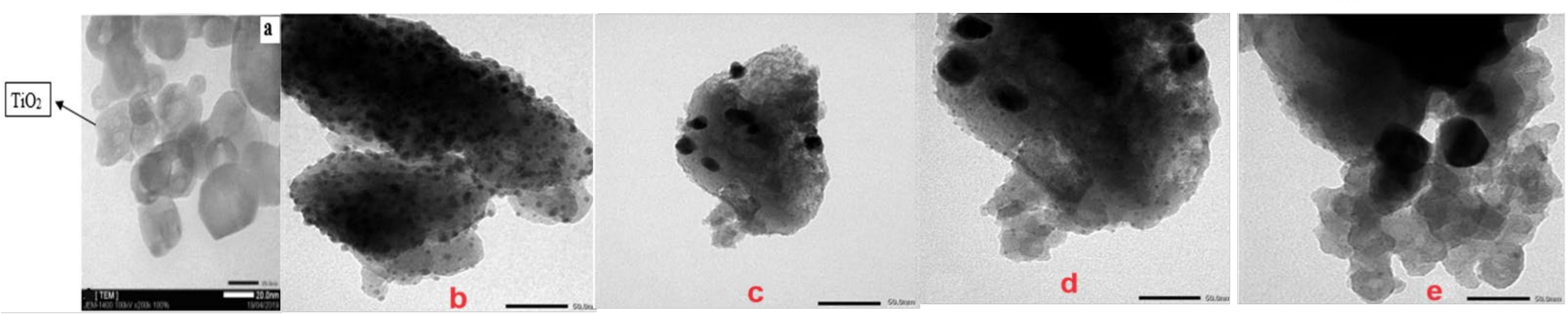


Dried





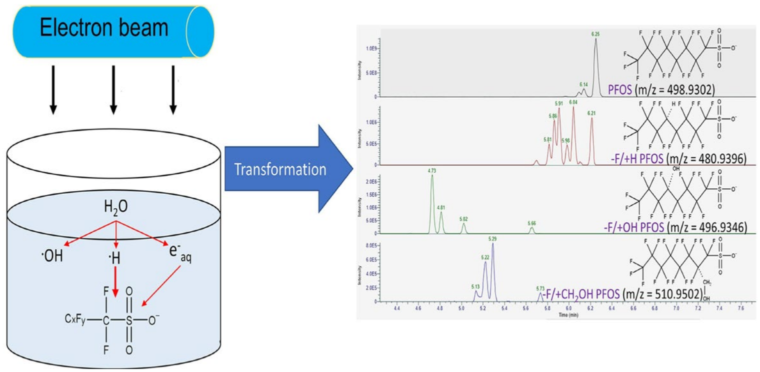


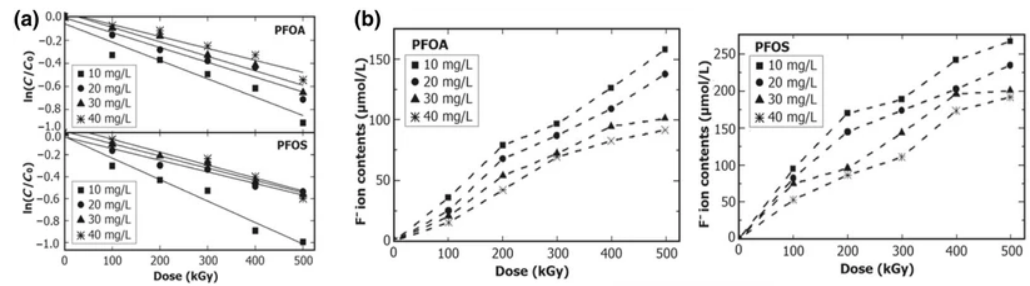


R&D area: Environmental Remediation (2024)

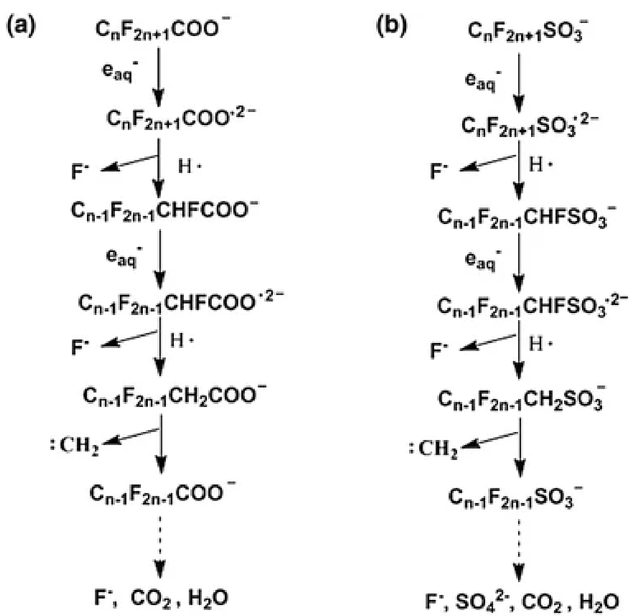
Group member: Hongjuan MA (China),

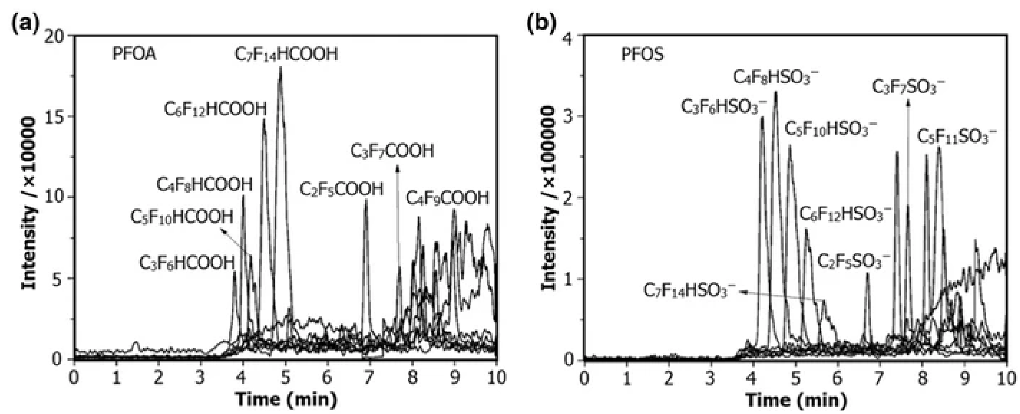
Electron beam irradiation can achieve complete degradation and effective defluorination of perfluorinated compounds





- Achieve effective removal of high concentrations of PFOS and PFOA.
- Effectively realize the defluorination of PFOA and PFOS





PFOS and PFOA are continuously attacked by e_{aq}^- and •H generated by EB, leading to defluorination of PFAs and the formation of other short-chain perfluorocarboxylic acids

R&D area: Environmental Remediation (2024)
Group member: Azat Nurkassimov (Kazakhstan),

Characteristic	Control	Sample №1	Sample №2	Sample №3
		Thermal strength		
Lengthening, %	251	170,9	234,4	202,4
Strength, MPa	22,7	25,6	25,83	26,14
		Thermal deformation		
Lengthening, %	Did not pass	110	196	336
Residual elongation, %	Did not pass	10	20	23

Table 1 – results of physical and chemical studies of cross-linked PE samples

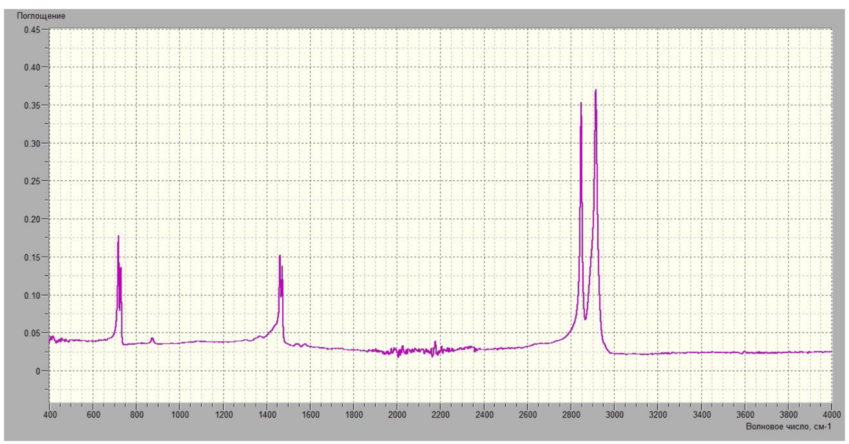


Figure 1 – The main peaks characteristic of polyethylene (samples No. 1...3)

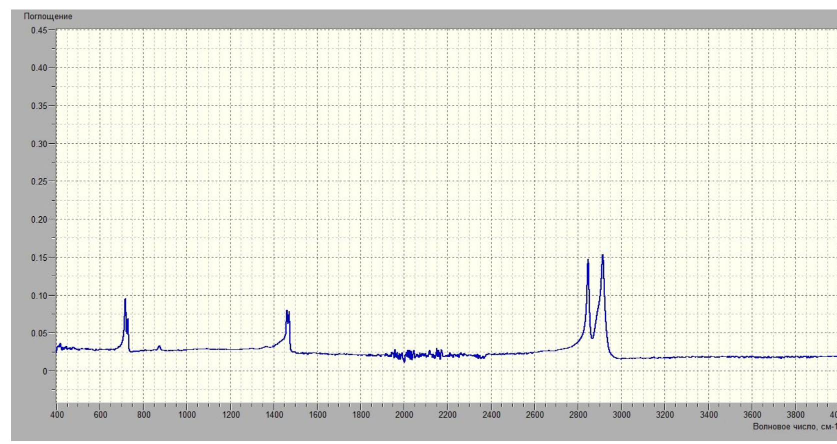


Figure 2 – Low intensity peaks (C=O connection)

R&D area: 4. Synergistic Effect among Plant Growth Promoters, Super Water
(2024) Absorbents and Biofertilizer

Group member: Prof. TRAN Minh Quynh (Vietnam)
Prof. TAWARAYA Keitaro (Japan)
Dr. PHUA CHOO Kwai Hoe (Malaysia)
Dr. Ruifu ZHANG (China)
Ms. OYUNDALAI Nyamdorj (Mongolia)

Current status

Improvements from 2023:

(Overall) In this topic all of the member country reported different biofertilizer products, plant growth promoters and super water absorbents with significant effect on plant growth, improved soil health, increased crop yield and reduction in the utilization of chemical fertilizer up to 10-20%.

(Vietnam) Though many kinds of biofertilizers have been approved to apply in whole country, but their applications still limited due to their slow impacts and high costs. The stronger supports by policy-makers are required to promote the use of these biofertilizers in agriculture production.

(Japan) *Bacillus*-based biofertilizer possesses a growth promotion effects on rice and soybean and antifungal activity on several plant fungal pathogens. Synergiistic effect of *Bassillus*-based biofertilizer and oligochitosan was observed on controlling soybean root rot disease.

(Malaysia) Six biofertilizer products undergoing commercialization. Drafting of the Malaysian Standard for Biofertilizers is under way. Effects of biofertilizers on methane (CH_4) and carbon dioxide (CO_2) emissions in rice crops has been studied. SWA and PGP showed promotion of the crops.

(China) Biofertilizer significantly increased the salt stress tolerance of rice and maize, resulting the yields increase in the saline land; SWA can promote the spore gemination, the root colonization, and the performance of Biofertilizer.

(Mongolia) The combined application of Biofertilizer, PGP and SWA supports stronger, healthier plant growth and improved crop resilience to environmental stress. This synergy offers a promising solution for sustainable agriculture, particularly in areas prone to water scarcity. The soil moisture with SWA was higher than the control and other treatments.

Remaining/New Challenges:

1. Reduction on costing of the product
2. Promotion of the products to the farmers
3. Prolonged the shelf life
4. Lack of testing data for various crops
5. Study more on synergistic effect of biofertilizer with SWA, PGP/ Caragenan
6. Budget for R&D and testing
7. Quality, safety and efficiency of the products

Gap in basic aspect:

1. The effects of bacteria and fungi are not same on different site, different soil require different microbes and BF
2. Development of New BF for stress soil condition

Gap in application aspect:

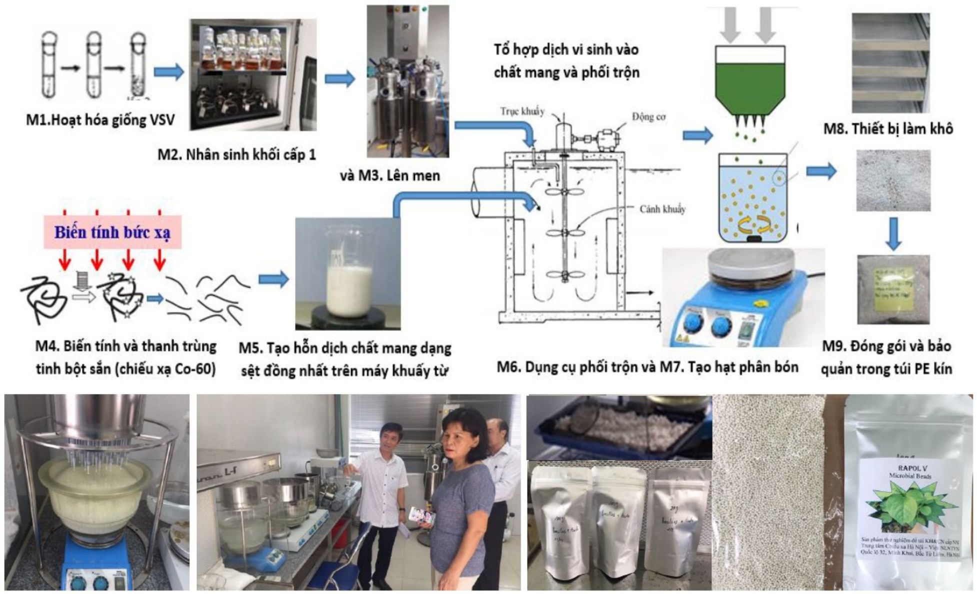
1. Lack of cooperators/farmers for field test
2. Adapt to Climate change
3. Technology transfer from lab to Industry is still challenging (Policy support)
4. Difficulties in looking for stakeholders
5. Communication to farmers (Education / public awareness)

Implementation plan

1. Improved products (SWA, PGP, Biofertilizer)
2. Metagenomic, meta-transcriptomic, and metabolomic study for efficiency and correlation study.
3. Search for the suitable carrier for different type of biofertilizer (a consortium of bacteria, fungi, *etc.*),
4. Optimization of the production on the large scale
5. Improvement of equipment/techniques for biofertilizer production.
6. Promotion and aplication of PGPB, SWA and Biofertilizer

Vietnam

Scale up for BF production at HIC



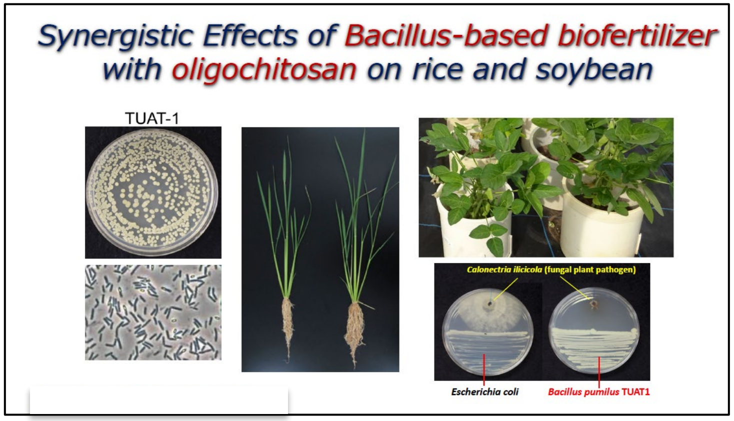
A BF (Rapol V) composed of *B. megaterium* was successful prepared with radiation modified starch as carrier

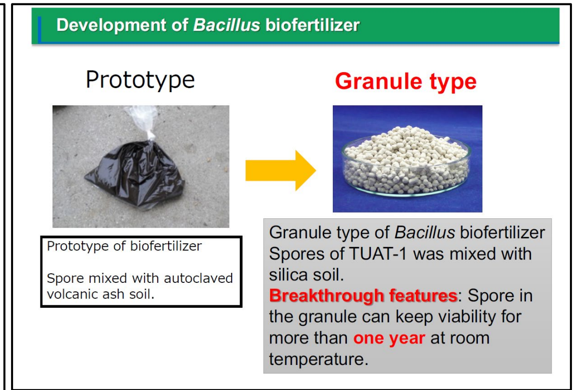
Application of Rapol-V for vegetable production

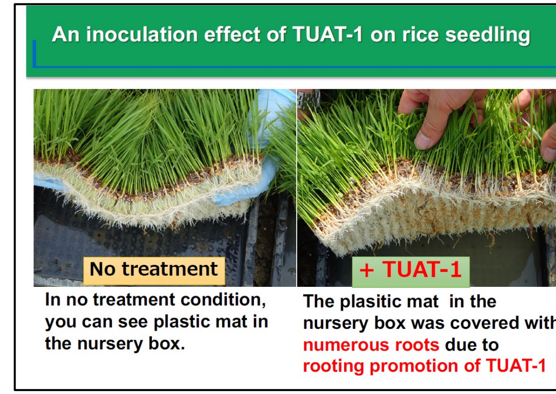
Field test: Effect of biofertilizer on growth of vegetable

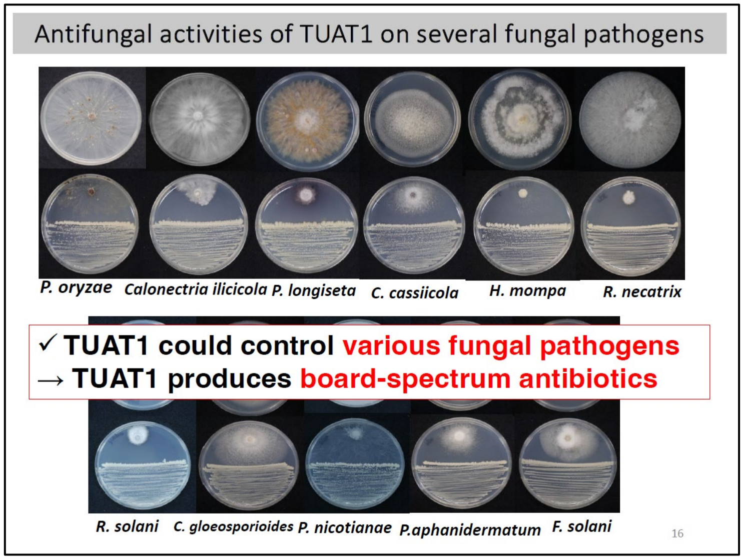
Application of Rapol-V for watermelon

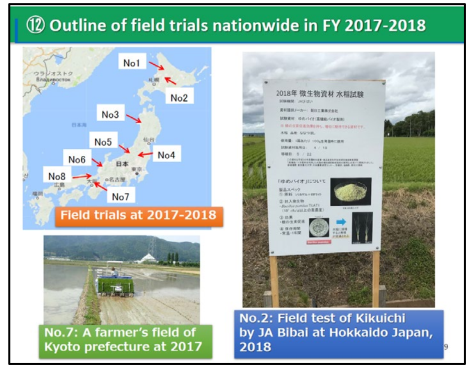
Japan

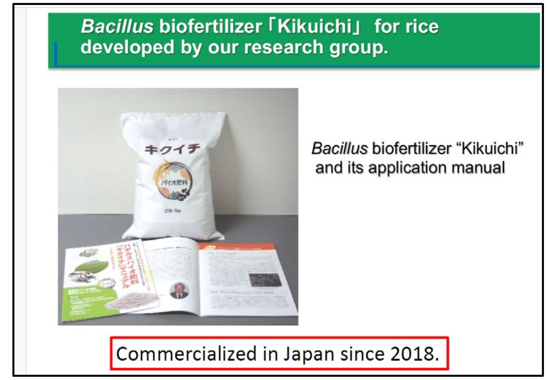

Synergistic Effects of Bacillus-based biofertilizer with oligochitosan on rice and soybean
TUAT-1
Calonectria ilicicola (fungal plant pathogen)
Escherichia coli
Bacillus pumilus TUAT1

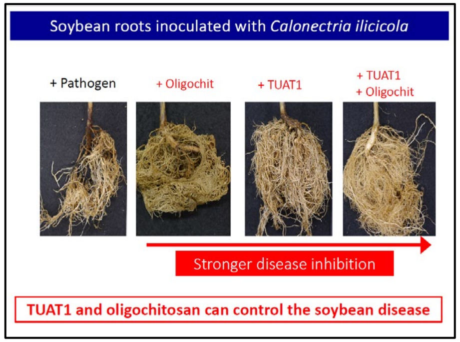

Development of Bacillus biofertilizer
Prototype
Granule type
Prototype of biofertilizer
Spore mixed with autoclaved volcanic ash soil.
Granule type of Bacillus biofertilizer
Spores of TUAT-1 was mixed with silica soil.
Breakthrough features: Spore in the granule can keep viability for more than one year at room temperature.

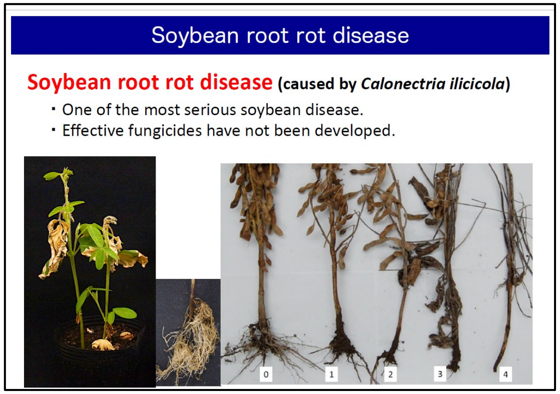

An inoculation effect of TUAT-1 on rice seedling
No treatment
+ TUAT-1
In no treatment condition, you can see plastic mat in the nursery box.
The plasitic mat in the nursery box was covered with numerous roots due to rooting promotion of TUAT-1

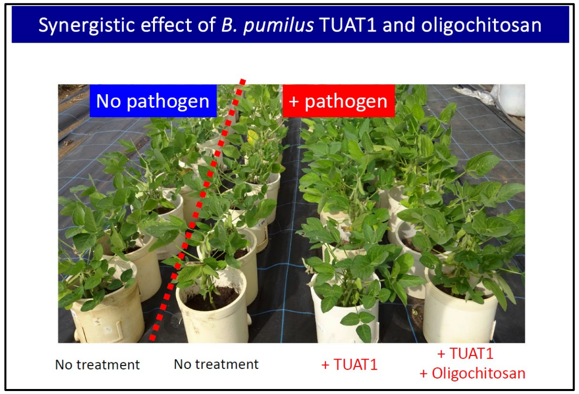

Antifungal activities of TUAT1 on several fungal pathogens
P. oryzae
Calonectria ilicicola
P. longiseta
C. cassiicola
H. mompa
R. necatrix
✓ TUAT1 could control various fungal pathogens
→ TUAT1 produces board-spectrum antibiotics
R. solani
C. gloeosporioides
P. nicotianae
P.aphanidermatum
F. solani
16


⑫ Outline of field trials nationwide in FY 2017-2018
No1
No2
No3
No4
No5
No6
No7
No8
Field trials at 2017-2018
No.7: A farmer's field of Kyoto prefecture at 2017
No.2: Field test of Kikuichi by JA Bibai at Hokkaido Japan, 2018


Bacillus biofertilizer「Kikuichi」 for rice developed by our research group.
キクイチ
Bacillus biofertilizer "Kikuichi" and its application manual
Commercialized in Japan since 2018.

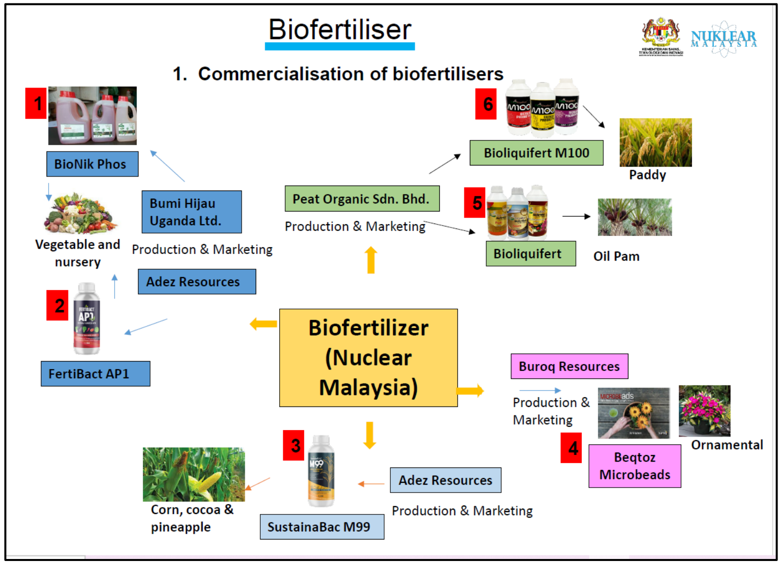

Soybean roots inoculated with Calonectria ilicicola
+ Pathogen
+ Oligochit
+ TUAT1
+ TUAT1
+ Oligochit
Stronger disease inhibition
TUAT1 and oligochitosan can control the soybean disease

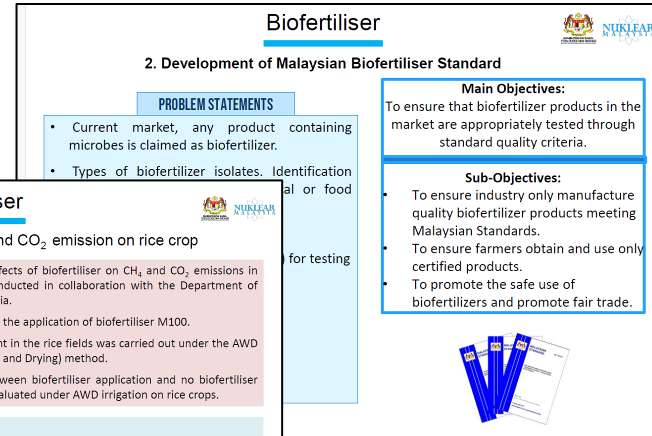

Soybean root rot disease
Soybean root rot disease (caused by Calonectria ilicicola)
・One of the most serious soybean disease.
・Effective fungicides have not been developed.
0
1
2
3
4

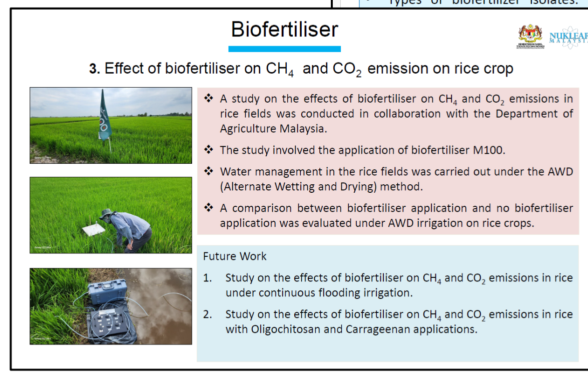

Synergistic effect of B. pumilus TUAT1 and oligochitosan
No pathogen
+ pathogen
No treatment
No treatment
+ TUAT1
+ TUAT1
+ Oligochitosan

Malaysia

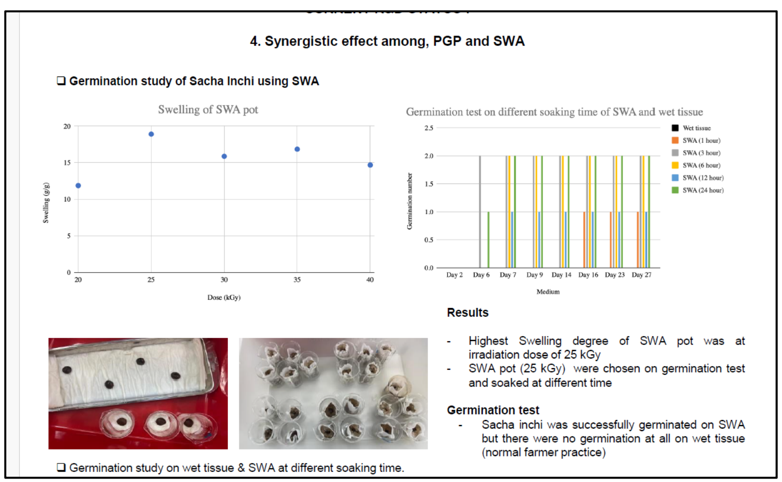
Biofertilizer

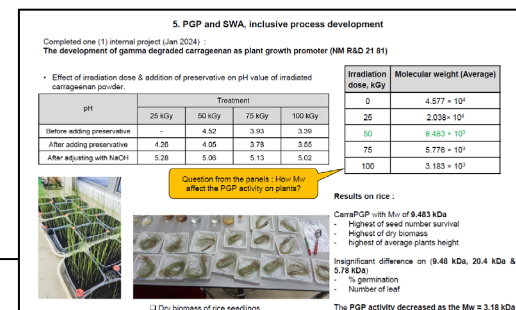


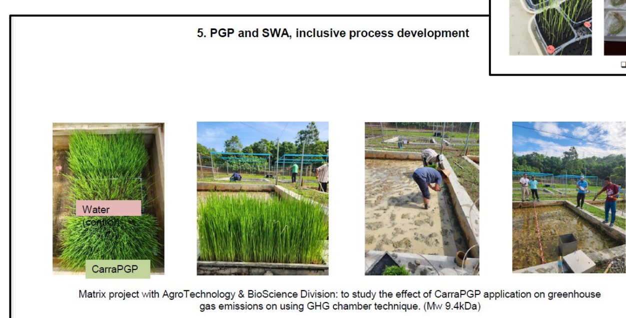




PGP & SWA



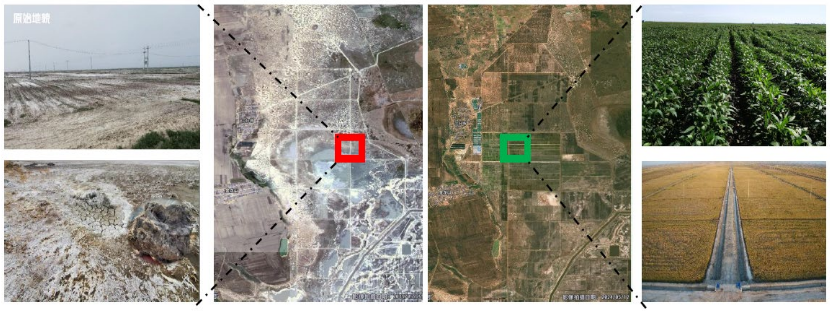




China

Trichoderma biofertilizer increased crop growth in the saline soil

Baicheng, Jilin province （123.05 N，46.04 E）



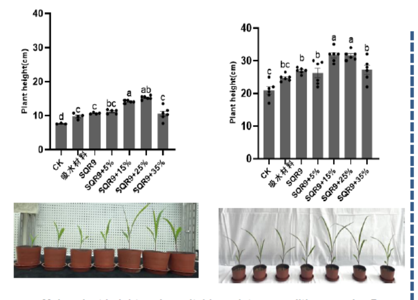
2019.5.25 2024.5.12

The mazie grow well in the saline soil with *Trichoderma* biofertilizer

（Baicheng, Jilin，2024.07.20）

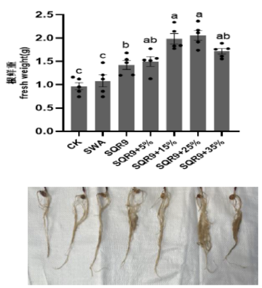
The effect of SWA on the performance of PGPR SQR9 on maize growth (in brown soil)

·Plant height



Maize plant height under suitable moisture conditions on day 7 (left) and day 14 (right)

·Fresh weight of roots

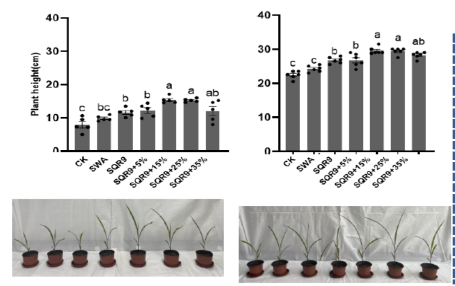


Fresh weight of maize roots on day 14 under suitable moisture conditions

- Under simulated suitable moisture conditions in the field, the addition of SWA at 15%-25% significantly increased corn plant height and root ($p < 0.05$).

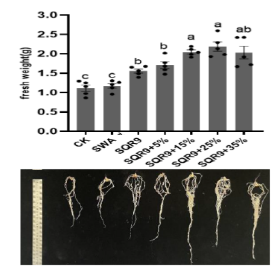
The effect of SWA on the performance of PGPR SQR9 on maize growth under simulated field drought conditions (in chernozem)

·Plant height



Maize plant height under normal moisture conditions on day 7 (left) and day 14 (right)

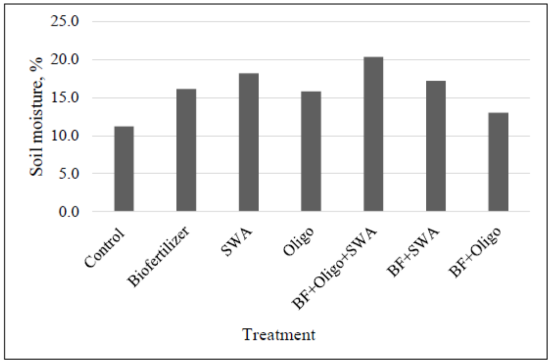
·Fresh weight of roots

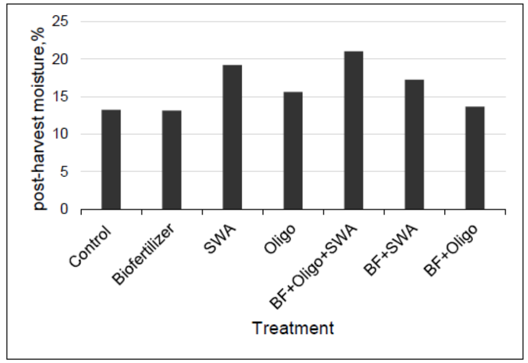


Fresh weight of maize roots on day 14 under suitable moisture conditions

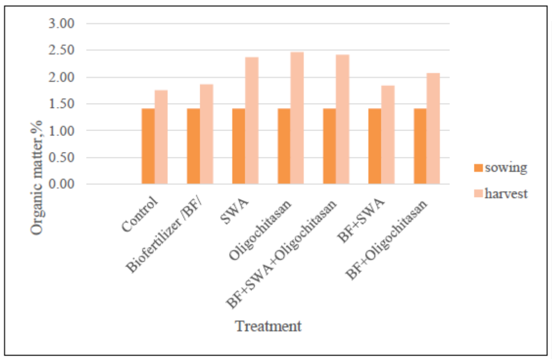
- Under field drought conditions, the addition of SWA at 15%-25% significantly enhanced the promoting effect of SQR9

Mongolia



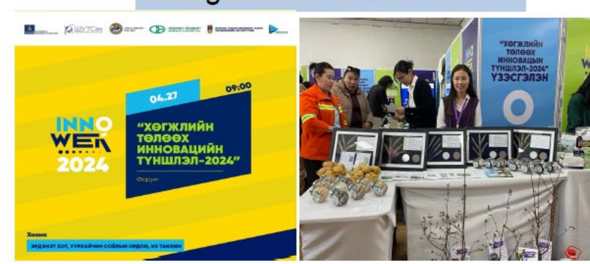


- The soil moisture was observed that single and combined treatments were better than control.
- All combination of SWA were enhanced the soil moisture with growth and after harvesting period.
- To increase soil properties
- Add the amendment or improve by biofertilizer.



MNS 7029:2023 MNS 6998:2023

Mongolian innovation week



AGROEXPO –International Agricultural Fair 2024

R&D area: **PGP SWA INCLUSIVE PRCESS DEVELOPMENT (2024)**

Group member: Dr. Kasinee Hemvichian (Thailand); Maznah Binti Mahmud (Malaysia); Mr. Nurkassimov Azat Kanatovich (Kazakhstan); Mr. Kassymzhanov Murat (Kazakhstan); Dr. Tamada Masao (Japan); Prof Tawaraya Keitaro (Japan)

Current status (MALAYSIA)

1. Gamma radiation of carrageenan affects the pH value of carrageenan solution. As the dose increased, the pH reduced (more acidic). The addition of preservative also reduces the pH of carrageenan solution. As the ion H increased, polymer tends to aggregate. The pH of CarraPGP adjusted to pH5 – 6, to avoid aggregation of active compound and highly acidic conditions in planting media can lead to nutrient deficiencies, which hinder seed germination and growth.
2. Establishing on method of application for various plants including rice.
3. Matrix project with AGROTECHNOLOGY & BIOSCIENCE Division on rice.
4. Participated in promotional road tour.

Current status (KAZAKHSTAN)

1. The resulting material capacity is ~ 300%
2. An innovative patent of the Republic of Kazakhstan has been obtained. A Patent has been obtained for a utility model "Method for synthesizing polymer hydrogel for agricultural crops". An experimental batch of absorbent has been produced. Trademark registration has been carried out.

Current status (THAILAND)

1. The new method for preparation of SWA beads (that can save a lot of time and energy) has been published in a journal and filed for patent.

<u>Remaining/New Challenges (MALAYSIA)</u>

- **Scientific Complexity**: Understanding the biochemical and physiological mechanisms of plant growth promoters requires a deep knowledge of plant biology, microbiology, and chemistry. Sometimes very difficult to explain/educate the farmers/potential clients.
- **Field Trials**: Conducting field trials to test efficacy and safety can be logistically challenging, requiring significant resources and time.
- **Stakeholder Engagement**: Engaging farmers, distributors, and other stakeholders is crucial for adoption, but it can be challenging to communicate the benefits effectively. (addition of PGP may increases the farming cost)
- **Variability in Conditions**: Plant responses to growth promoters can vary significantly due to environmental factors, soil types, and crop species, making it hard to generalize results.
- **Sustainability Concerns**: Increasingly, there are demands for environmentally sustainable practices. Balancing efficacy with eco-friendliness can be a challenge.
- **Funding and Resources**: Securing funding for research and development, especially in the early stages, can be difficult. Resource allocation must be managed effectively.
- **Intellectual Property Issues**: Protecting innovations while navigating existing patents can pose legal challenges.
- **Public Perception**: There may be skepticism or negative perceptions regarding synthetic or novel growth promoters, which can affect market acceptance.

- **<u>Remaining/New Challenges (THAILAND)</u>**

1. Not easy to initiate technology transfer (from TINT to private companies)

promoters function at the molecular and physiological levels. More research is needed to clarify these mechanisms.

•**Efficacy Across Varieties**: Many studies focus on specific plant varieties, leaving gaps in understanding how growth promoters perform across a wider range of species and cultivars.

•**Environmental Interactions**: The effects of different environmental conditions (soil type, climate, etc.) on the efficacy of plant growth promoters are not always well understood, leading to variability in results.

•**Formulation Optimization**: The formulation of plant growth promoters (e.g., concentration, delivery method) may not be fully optimized for maximum efficacy and ease of use in agricultural practices.

•**Consumer Acceptance**: There is a gap in understanding consumer perceptions and acceptance of plant growth promoters, especially those derived from synthetic sources.

•**Integration with Existing Practices**: Research is needed on how to best integrate new growth promoters into existing agricultural practices and systems.

•**Economic Viability**: Evaluating the cost-effectiveness and economic impact of using plant growth promoters in different agricultural contexts is often underexplored.

•**Data Sharing and Collaboration**: There is often insufficient collaboration and data sharing among researchers, which can slow the pace of innovation and understanding in this field.

Gap in basic aspect (KAZAKHSTAN)

1. The lack of a domestic raw material base necessary for the production of SWA.

Gap in basic aspect (THAILAND)

1. New experiments to be done to study the effects of SWA on plants and soil (water potential of plants for example)

Gap in application aspect

•**Field Application Techniques/ Timing & Dosage**: There may be limited knowledge on the best application methods (seeds soaking, foliar seed soaking/ frequency of application), leading to suboptimal results. The optimal timing and dosage for applying growth promoters are often not well established, which can impact their effectiveness and crop response..

•**Compatibility with Other Inputs**: There is often insufficient data on how plant growth promoters interact with other agricultural inputs (fertilizers, pesticides), which is crucial for integrated pest and nutrient management.

•**Monitoring and Evaluation**: Effective monitoring systems to assess the impact of growth promoters in real-time during the growing season are often lacking, making it hard to measure efficacy accurately.

•**User Education and Training**: Farmers may not be adequately educated on how to use new growth promoters effectively, leading to misuse or underutilization of the product.

•**Economic Assessment**: There is often a gap in evaluating the economic viability of using growth promoters, including cost-benefit analyses specific to local agricultural contexts.

•**Local Adaptation**: Many growth promoters are developed without considering local agricultural practices and conditions, resulting in limited applicability in diverse regions. The addition of extra input (PGP) leads to increase of farming cost.

•**Feedback Mechanisms**: Lack of mechanisms for feedback from end-users (farmers, agronomists) can hinder the iterative improvement of growth promoter products.

Gap in application aspect (KAZAKHSTAN)

1. The lack of government support measures for the introduction of water-saving technologies. High cost for the end user.

Gap in application aspect (THAILAND)

1. Extra cost of applying SWA should be less than value addition caused by higher productivity of plants

Implementation plan (MALAYSIA)

1. Research Initiative & field trials: Conduct comparative study (with and without PGP) & large scale trial to gather real-world data on the efficacy of CarraPGP.
2. Data collection & Guideline Development: Establish clear guidelines for optimal timing and dosage based on growth stage and environmental conditions.
3. Run Pilot Projects: Develop pilot projects that test lab-scale formulations in larger field settings to evaluate scalability.
4. Compatibility Studies: Conduct research to assess interactions between growth promoters and common agricultural inputs.
5. Feedback Mechanisms: Establish regular feedback channels for farmers to report outcomes and experiences.
6. Educational Materials: Create easy-to-understand guides, videos, and digital resources for farmers.
7. Cost-Benefit Analyses: Conduct comprehensive economic studies to evaluate the financial impact of using growth promoters. (counter the cost issue with the yield)
8. Local Adaptation : Engage local farmers in the research process to understand their specific needs and conditions. Conduct trials in diverse locations to adapt growth promoters to different climates and soils.
9. Stakeholder Engagement: Collaborate with universities, agricultural extension services, NGOs, and local farming communities throughout the implementation process to ensure broad support and effective dissemination of findings.
10. Implement Feedback Mechanisms

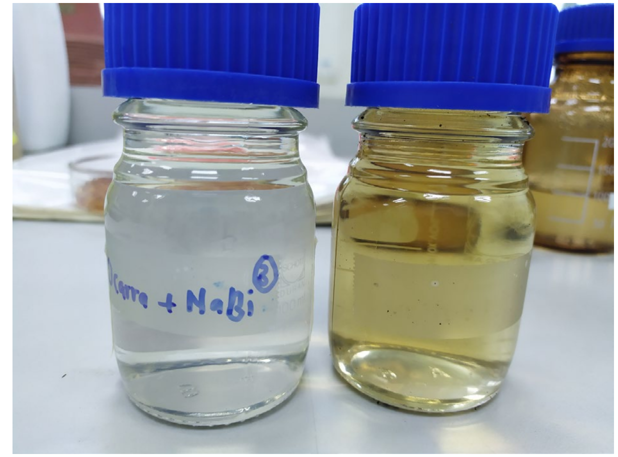
- User Surveys: Develop a system for collecting user feedback to identify areas for improvement.
- Advisory Groups: Establish groups of users and experts to provide ongoing input on CarraPGP's performance and application.

Implementation plan (KAZAKHSTAN)

1. Expanding the customer base through vegetable growers, greenhouses, nurseries and retail sales of indoor plants, gardening and horticulture.

Implementation plan (THAILAND)

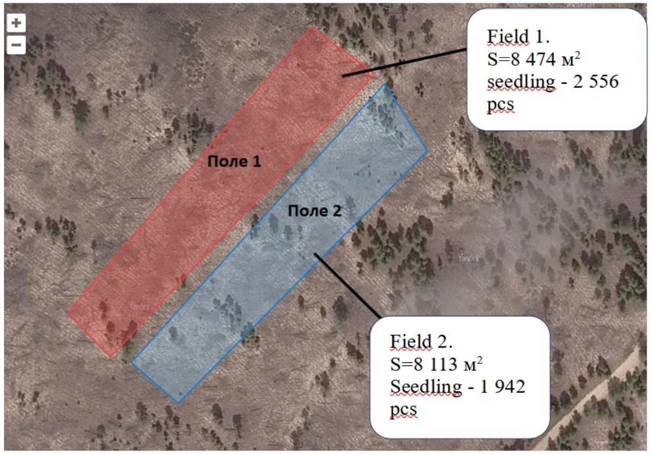
1. Initiate a study to analyze the effects of SWA on plants and soil



CarraPGP (< 10 kDa, > 4kDa) preserved with EDTA for preservation. The irradiation dose and preservative influence the pH and the performance of PGP. The pH adjustment is important for product stability and performance.


Application at 80 ppm CarraPGP twice a week increases yield of mustard and kale.

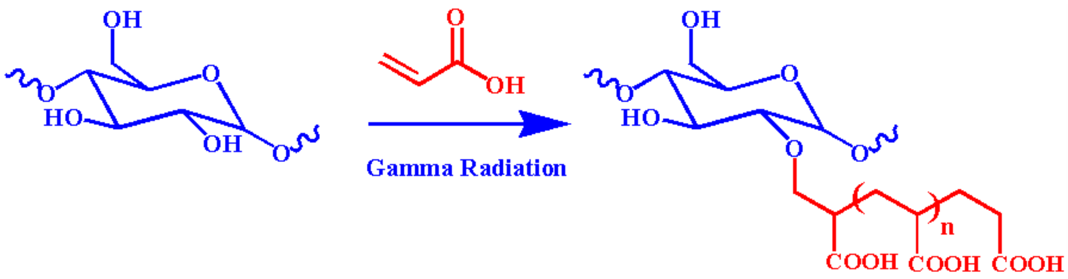
Group member: Azat Nurkassimov (Kazakhstan), Murat Kassymzhanov (Kazakhstan)

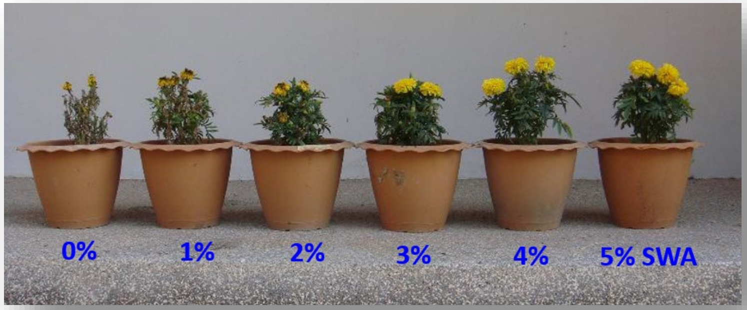


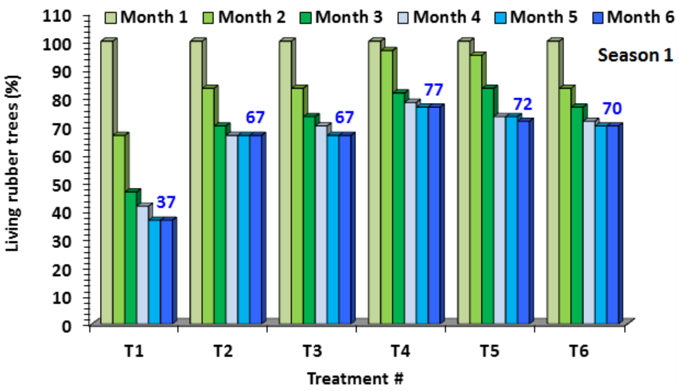
			
2022	**26%** ↑	**38%** ↑	
2023	**24%** ↑	**32%** ↑	**18%** ↑
2024	**28%** ↑	**45%** ↑	**21%** ↑

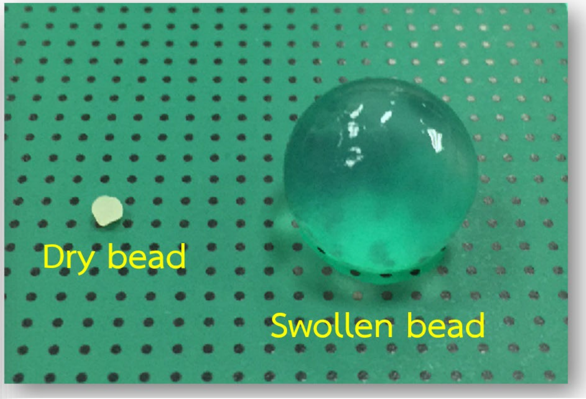
R&D area: SWA

Group member: Kasinee Hemvichian (Thailand),



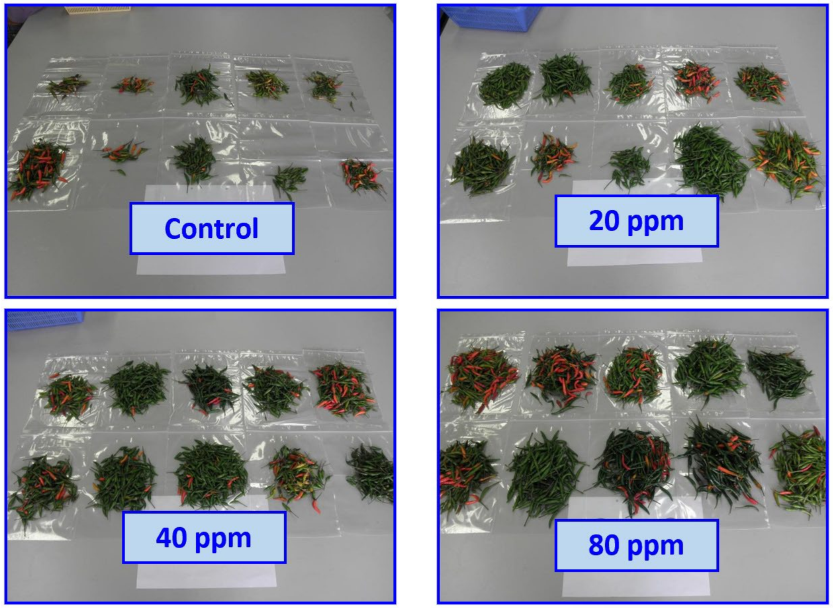


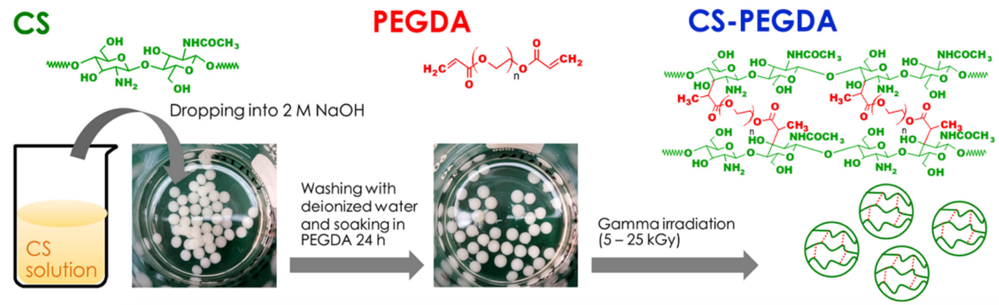


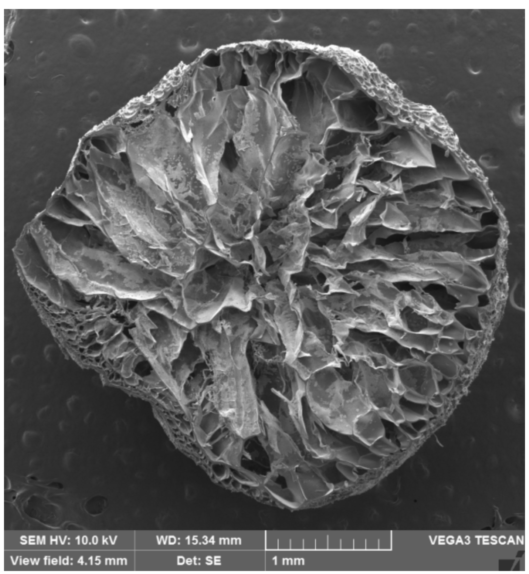


R&D area: PGP

Group member: Kasinee Hemvichian (Thailand)







R&D area:
Group F: Mutation Breeding of Microbe Using Radiation (2023)

Group member: Prof. TRAN Minh Quynh (Vietnam)
Dr. Ruifu ZHANG (China)
Dr. PHUA CHOO Kwai Hoe (Malaysia)
Ms. HING Jan Nie (Malaysia)

<u>Current status</u>

(Malaysia) Mutagenesis involving Gram-negative and Gram-positive bacteria has been completed, while mutagenesis projects for phosphate solubilising microbes (M100) and silicate-solubilizing bacteria (SSB) are in progress.

(China) Identification of *Trichoderma guizhouenase* NJAU4742 secreted cedrene to promote root development, solid fermentation production of *Trichoderma guizhouenase* NJAU4742 conidia as biofertilizer, field application of *Trichoderma guizhouenase* NJAU4742-based biofertilizer in several crops.

(Vietnam) *Trichoderma koningopsis* VTCC 31325 with antagonist ability against phytopathogens were gamma irradiated to screen the potential mutants for control the rice blast and rice sheath blight diseases replacing for chemical pesticides.

Remaining/New Challenges

Irradiation doses, number of screening generation, stability of the mutant strains, methods of mutagenesis.

Gaps in basic aspect

Identified the changes of the responsible genes due to mutagenesis

Screening strategy (Fast, effective, cost saving)

Gaps in application aspect

Cost for mutagenesis

Stabilities of the irradiated microbes

Public acceptance and awareness

Implementation plan

Financial supports

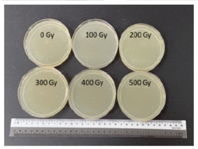
Develop standard protocol for radiation mutagenesis

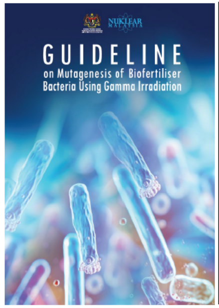
Cooperation of irradiation facilities

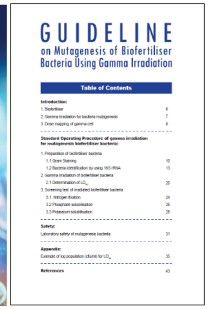
Field trial of the potential mutants

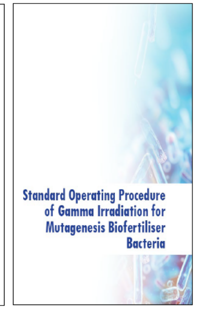
Malaysia

1. Mutagenesis of Gram-negative and Gram-positive bacteria.









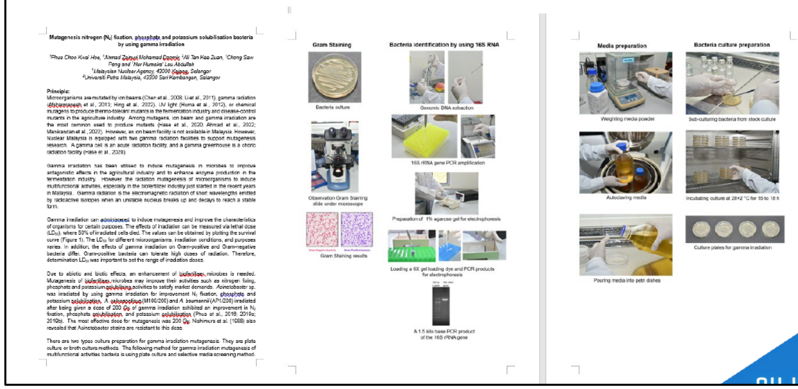
Achievements (2024):

- Publish E-book "Guideline on Mutagenesis of Biofertilizer Bacteria using gamma Irradiation."

2. Development of Mutagenesis Guideline (FNCA).

Plan (2025 -2027):

- Development of mutagenesis guideline (FNCA)



3. Mutagenesis of phosphate solubilising microbe (M100).

Achievements (2024):

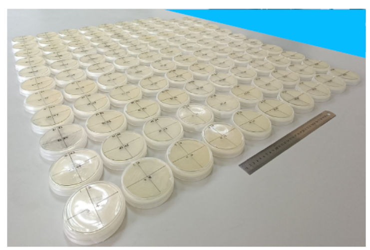
- A total of 932 colonies from *Acinetobacter calcoaceticus* (M100) were irradiated using gamma irradiation at the Malaysian Nuclear Agency.
- 8.9% (83 colonies) showed enhanced phosphate activities during the phosphate bioassay screening using PDYA plates.
- Further screening through molecular methods will be conducted to identify potential mutants of phosphate solubilising microbes.

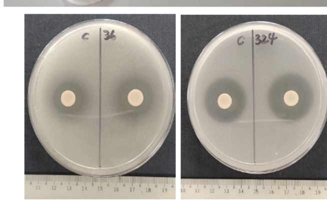
Plan (2025):

- Development of allele-specific primers for detection of mutation in phosphate solubilising bacteria.

Way Forward (2026-2030):

- Development of high commercial value biofertiliser mutants using various ionising radiation methods.





4. Mutagenesis of silicate solubilising bacteria (SSB).

Achievements (2024):

- Sixteen beneficial bacterial strains were previously isolated from various crops. Three strains showed positive results for silicate solubilising ability. Two are identified as *Enterobacter* spp. and one is *Bacillus* sp.

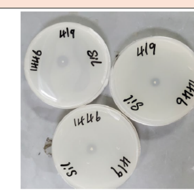
Plan (2025):

- To evaluate the effect of silicate solubilising bacteria (SSB) on rice growth and yield under glasshouse conditions (UPM)
- Mutagenesis of SSB by using gamma irradiation (Malaysian Nuclear Agency)

Way Forward (2026-2030):

- Obtain potential gamma irradiated SSB as biofertilizer.

UNICC		Soil Microbiology Lab			
Accession No.	Species	Accession No.	Specie	Accession No.	Specie
UPMC 1405	Bacillus tequilensis	UPMC 382	Bacillus spp.	UPMC 382	Bacillus sp.
UPMC 1406	Bacillus aryabhattai	UPMC 383	Bacillus spp.	UPMC 383	Bacillus sp.
UPMC 87	Bacillus sphaericus	UPMC 385	Bacillus spp.	UPMC 385	Bacillus sp.
UPMC 1109	Bacillus subtilis	UPMC 1340	Enterobacter spp.	UPMC 386	Bacillus sp.
UPMC 1110	Lysinibacillus xylanilyticus	UPMC 1341	Enterobacter spp.		
UPMC 1111	Alcaligenes faecalis	UPMC 1342	Enterobacter spp.		

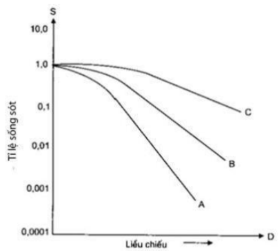


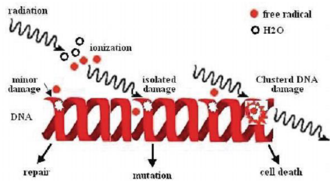
Qualitative positive indication for silicate solubilising ability by the formation of a halo, clear zone around the colony on insoluble silicate media

Vietnam

II. Radiation induced mutation of *Trichoderma* advantages and disadvantages

Gamma irradiation at sublethal dose produced high frequency of mutants



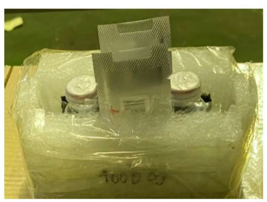


Trichoderma has been widely used as antagonistic fungal agents due to their strong aggressiveness against plant pathogenic fungi. In our previous study, *T. koningiopsis* and *T. reesei* were irradiated to screen high cellulase producing strains for rice straw decomposition. This *T. koningiopsis* also irradiated to screen high antagonistic ability mutants to control plant diseases

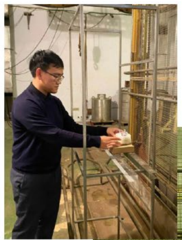
Radiation mutation of *Trichoderma* for antagonist formulations to control fungal diseases in rice

Objectives: Prepare and screen the potential mutant strains with high fungal antagonist (*Pyricularia oryzae* and *Rhizoctonia solani*) from gamma irradiated *Trichoderma* to incorporated to the products for controlling the rice blast and rice sheath diseases.

Gamma irradiation treatment



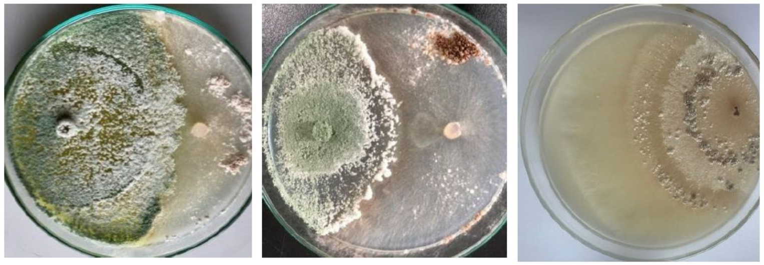
Each sample consisted of 10 ml spore culture (10^8 – 10^9 CFU/mL)



Dosimeters (Gafchromic for the doses below 1 kGy, and B3 Dose Stix for the doses within 1-5 kGy) have been attached in the samples to determine absorbed dose

The samples were fixed in irradiation chamber and irradiated at the same dose rate with various time intervals

Growth of pathogen in the medium with and without *T. koningiopsis* as potential antagonist fungi



a b c

Dual culture test (a) *R. solani* and VTCC(a) I-1, (b) *R. solani* and *T. koningiopsis* VTCC 31435, and (c) single *R. solani* only.

China

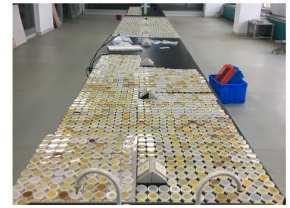
Irradiation mutation of *Trichoderma guizhouenase* NJAU4742 for improved biofertilizer

To get enhanced 4742 strains for different characters: Stress tolerance and antagonism, breeding of this strain with X-ray radiation was carried out.

Biological X-ray irradiator, RS 2000 Pro, RADSOURCE USA

- ✓ Irradiation dose: 84Gy, 84Gy and 82Gy for three times, and the total was 250Gy;
- ✓ After irradiation, the spores of *Trichoderma guizhouenase* NJAU4742 was coated on different screening media;

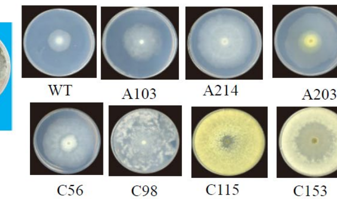
About 3500 different mutants were isolated and screened.

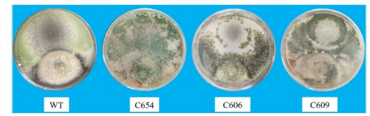


Salt tolerance mutants screening (1 M Nacl)

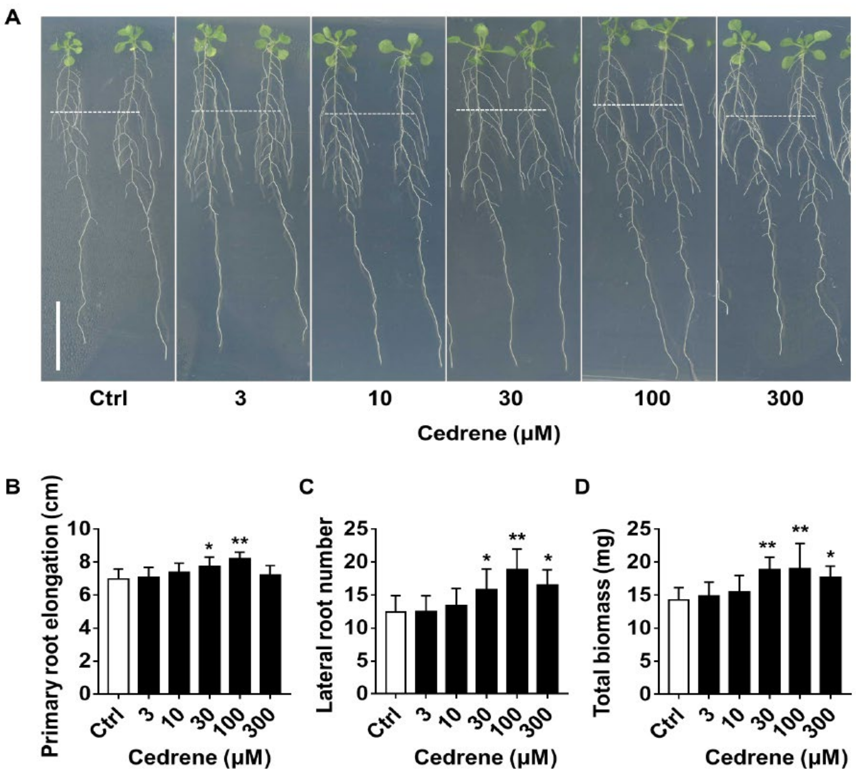
After irradiation, the salt tolerance of different mutants were significant improved, especially for the mutants of M4 and M5

Acid resistant mutants screening (pH 2.5)





Screening for improved mutants to against different fungal pathogens



Large scale production

R&D area: 7. Sterilization and Sanitation using Radiation (2024)

Group members: Farah Fadzehah (Malaysia), Nyamdorj Oyundalai (Mongolia), Charito Aranilla (Philippines), Lorna Relleve (Philippines)

Current status

<Improvements from 2023>

Malaysia

The sanitization and sterilization for gloves and also fruits (to be exported) commercially in the gamma facilities.

Mongolia

Locally grown potatoes were irradiated by low-energy x-rays with various low doses. Single side irradiation was carried out and dose uniformity within potatoes has not been considered this study.

Philippines

On-going research on the comparison of gamma and e-beam irradiation on polymer-based medical devices due to increasing shift in e-beam sterilization. We study different medical device models to determine the suitability of ionizing radiation as sterilization modality.

R&D area: 7. Sterilization and Sanitation using Radiation (2024)

Group members: Farah Fadzehah (Malaysia), Charito Aranilla (Philippines), Lorna Relleve (Philippines), Nyamdorj Oyundalai (Mongolia)

Current status
<Remaining/New Challenges>
Gap in basic aspect

Malaysia
Have not yet established studies on the comparison sterilization and sanitization using the gamma, eb and xray

Mongolia
The are no irradiation center or infrastructure in Mongolia.

Philippines
To study more medical devices to create a database that ca be used as reference for clients that will use e-beam for sterilization.
To initiate studies on sterilization using X-ray.

R&D area: 7. Sterilization and Sanitation using Radiation (2024)

Group members: Farah Fadzehah (Malaysia), Charito Aranilla (Philippines), Lorna Relleve (Philippines), Nyamdorj Oyundalai (Mongolia)

Current status

<Remaining/New Challenges>

Gap in application aspect

Malaysia

No extensive studies on the xray due to limited facilities of xray irradiation.

Mongolia

Public acceptance is critical to introduce ionization irradiation-based applications to farmers.

Philippines

Limitation in e-beam irradiation facilities. Unavailability of X-ray irradiation facility to start studies.

R&D area: 7. Sterilization and Sanitation using Radiation (2024)

Group members: Farah Fadzehah (Malaysia), Charito Aranilla (Philippines), Lorna Relleve (Philippines), Nyamdorj Oyundalai (Mongolia)

Current status

<Remaining/New Challenges>

Implementation plan

Malaysia

Planning a comparison studies between 3 facilities and compare the results on the bioburden

Mongolia

a. Post-harvest treatment of basic vegetables with irradiation to reduce losses during preservation.
b. Meat treatment to improve hygiene and sanitation.
c. Promote and educate farmers and small businesses, provide nuclear technological information to the public as a safe.

Philippines

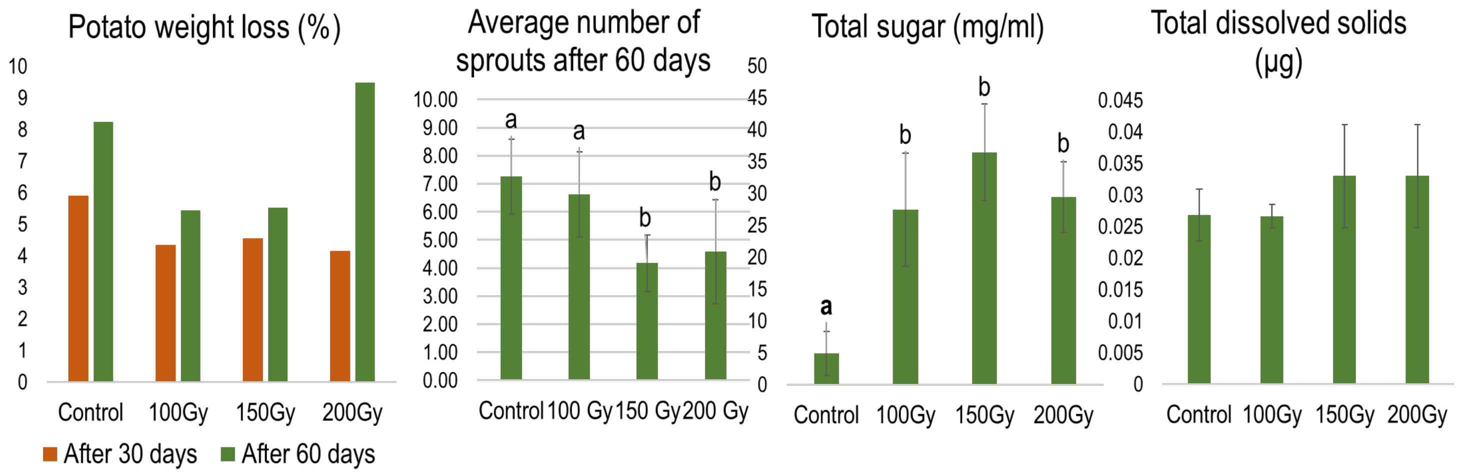
Collaborate with medical device manufacturers to promote radiation sterilization.
Collaborate with FNCA members with x-ray irradiation facilities.

R&D area:7. Sterilization and Sanitization using Radiation (2024)

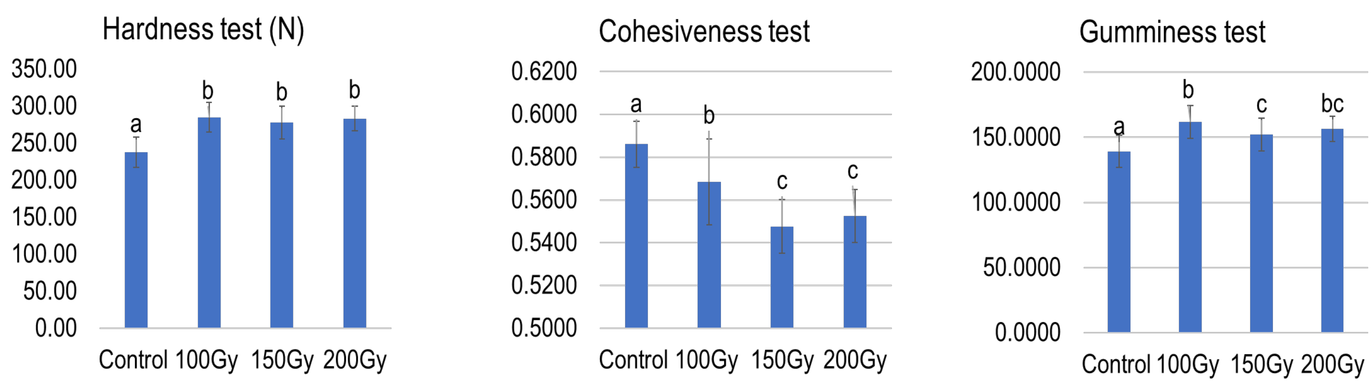
Group member: Malaysia

R&D area:7. Sterilization and Sanitization using Radiation (2024)

Group member: Mongolia



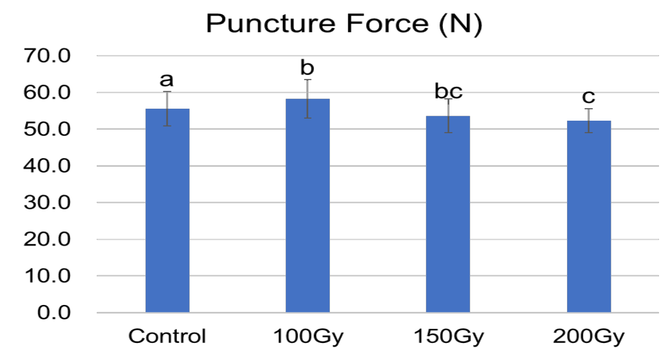
Potato weight loss, average number of sprouts, and biochemical results were compared between groups.

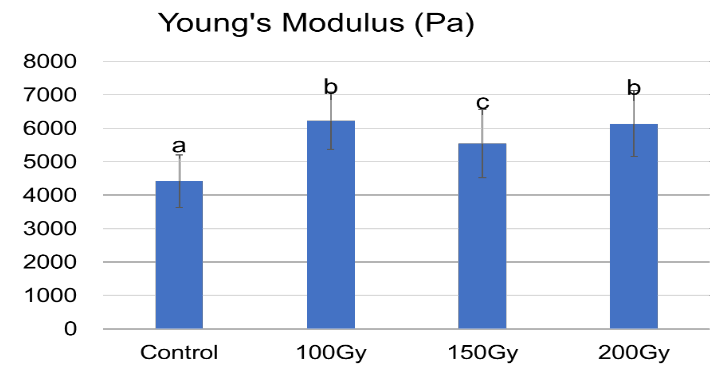


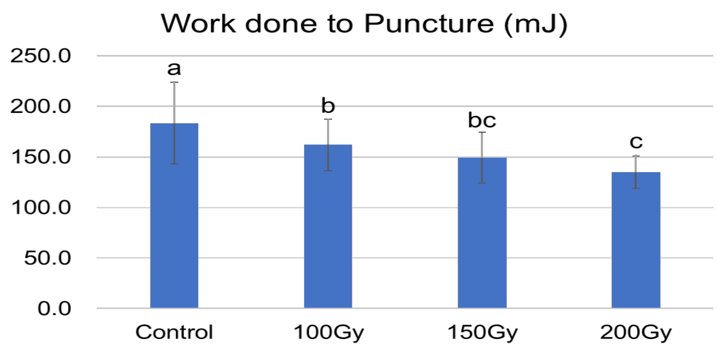
Texture Profile Analysis was performed compressing the samples twice by 25% at a speed of 0.25 mm/s with a 30 mm diameter flat disc and results were expressed as Hardness test, Cohesiveness, and Gumminess test.

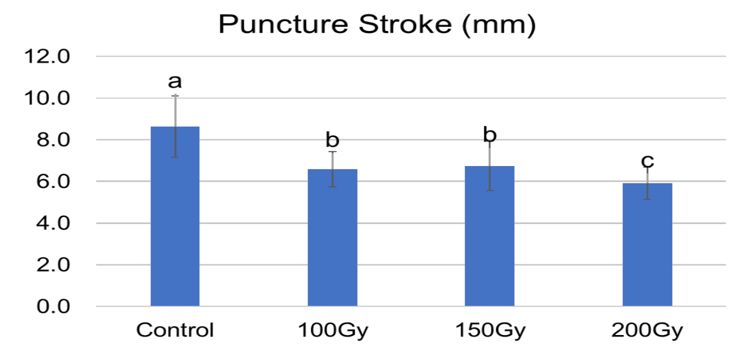
R&D area:7. Sterilization and Sanitization using Radiation (2024)

Group member: Mongolia









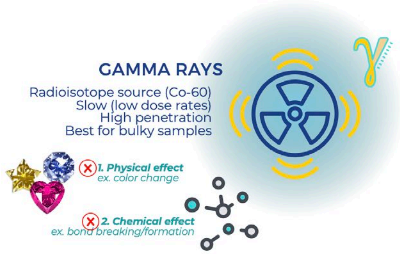
A puncture test was performed using a cylindrical probe with a diameter of 5 mm at a speed of 0.25 mm/s on Shimadzu texture analyzer EZ-SX and results were expressed as Puncture test, Young's Modulus, Work done and Puncture Stroke.

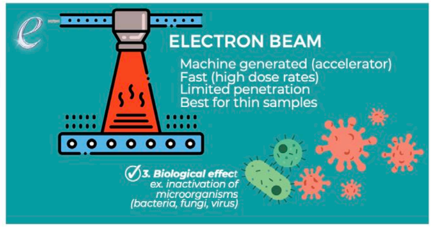
Previous studies have suggested that lower doses of irradiation can actually make potatoes more susceptible to rot, even during high-temperature storage.

To test this theory, we incubated both irradiated and non-irradiated potatoes at room temperature (RT) and 22°C, respectively. We observed significant differences between the two groups, including measurable physical-mechanical and biochemical changes. Based on our results, it can be inferred that before storing potatoes at room temperature, 150Gy X-ray irradiation is the most suitable for *cv. gala* variety.

R&D area: 7. Sterilization and Sanitation using Radiation (2024)

Charito Aranilla (Philippines)



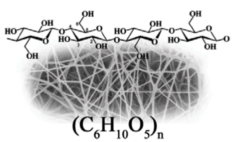


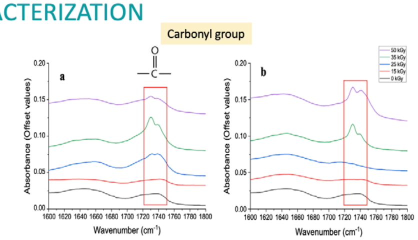
1. PHYSICO-CHEMICAL CHARACTERIZATION

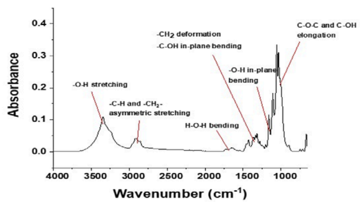
2. FUNCTIONAL CHARACTERIZATION

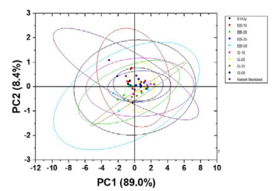
3. ESTABLISHMENT OF STERILIZATION DOSE

PHYSICO-CHEMICAL CHARACTERIZATION

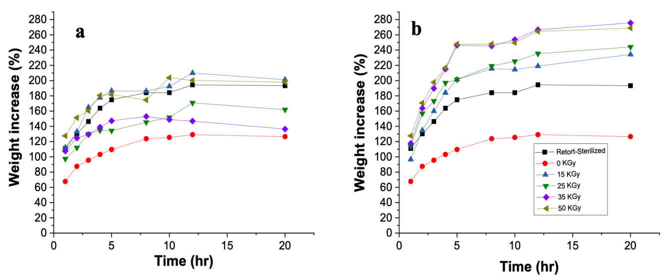






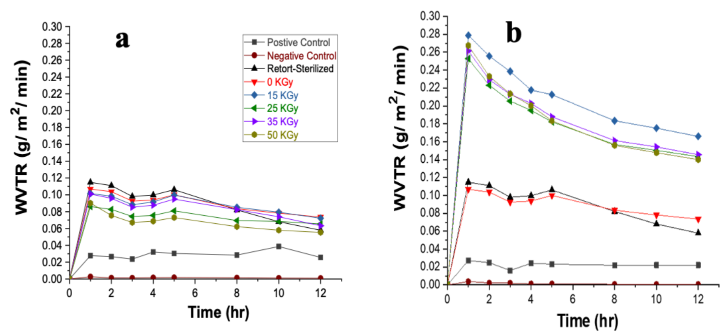


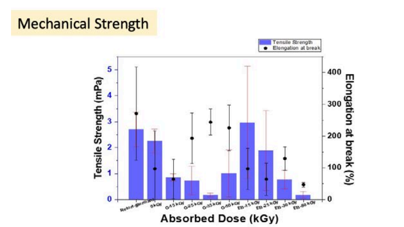
2. FUNCTIONAL CHARACTERIZATION

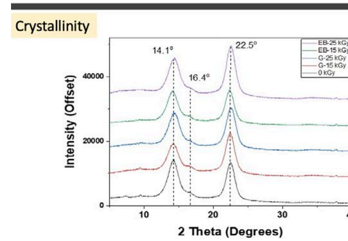


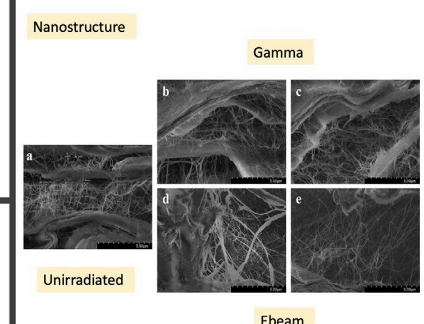
The percentage weight increases of BC-M samples irradiated at different doses of gamma ray (a) and electron beam (b)

Water Vapor Transmission Rate









Establishment of Radiation Sterilization Dose (ISO 11137-2)

Bioburden Analysis

Sample [SIP=1]	Batch 1		Batch 2		Batch 3	
	APC	YMC	APC	YMC	APC	YMC
1	0	0	0	0	0	0
2	0	0	0	0	1	0
3	0	0	2	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	1	0
6	0	0	0	0	1	0
7	2	0	0	0	0	0
8	0	0	1	0	0	0
9	0	0	0	0	0	0
10	0	0	1	0	0	0
Ave. Bioburden	0.2	0.0	0.4	0.0	0.3	0.0
Batch Ave. Bioburden	0.2		0.4		0.3	
Overall Ave. Bioburden	0.3 CFU/g					

From Table 10 Values of **VDmax15** for levels of average bioburden </= 1.5, the verification dose is 1.3 kGy.

Ten samples were irradiated at 1.3 kGy via gamma and EB and tested each for sterility.

Sterility Test

Gamma Irradiation (1.3 kGy)		E-beam Irradiation (1.3 kGy)	
SIP (1)	Sterility	SIP (1)	Sterility
1	negative	1	negative
2	negative	2	negative
3	negative	3	negative
4	negative	4	negative
5	negative	5	positive
6	negative	6	negative
7	negative	7	negative
8	negative	8	negative
9	negative	9	negative
10	negative	10	negative

The verification dose was accepted and 15 kGy was substantiated since there was no more than 1 positive test of sterility.

Sterilization Dose: 15 kGy

R&D area: (2024)

Group H: Recycle Plastic
(Dr. Honjuan MA, Dr. Farah Nurlidar, Prof. Nguyen Ngoy Duy, Mr. Wada Tomoaki, Dr. Taguchi Mitsumasa, Ms. Bin Jeremiah Barba))

<u>Current status</u>

<Improvement from 2023>

Vietnam

- Study on the preparation PVDF-G-AAc waste membrane by irradiation method and the antibacterial activity of PVDF-G-AAc /nano metal membranes.
- Recycling plastic waste from lobster net cages by irradiation.

China

- Radiation degradation of rubber tires has been commercialized on a small scale.
- Recycled plastic membrane is modified into metal ion adsorbents.

Indonesia

- Development of a compatibilizer from irradiated recycler polyethylene (rPE) for WPC production has passed TRL 3, has already reached TRL 4 and now, is doing on TRL 5 (Indonesia)

The Philippines

- Trial runs with industry extruder, showed improvement in compressive strength

R&D area: (2024)

Group H: Recycle Plastic
(Dr. Honjuan MA, Dr. Farah Nurlidar, Prof. Nguyen Ngoy Duy, Mr. Wada Tomoaki, Dr. Taguchi Mitsumasa, Ms. Bin Jeremiah Barba)

<Remaining/New Challenges>

Vietnam:

- waste classification at the source, especially for plastic waste, remains a significant issue. The lack of effective waste sorting at households, businesses, and public places leads to mixed waste collection, complicating recycling efforts and increasing the burden on landfills and waste treatment facilities. This is particularly problematic for plastic waste, which constitutes a large portion of Vietnam's solid waste and often ends up polluting rivers, coasts, and the marine environment.

China:

- Automatic control devices need to be matched, especially the abnormal shape of plastic bottles

Indonesia

- Indonesia has no medium or low energy EB facilities to irradiate the rPE
- Need more study to decrease the irradiation dose less than 200 kGy

The Philippines

- Distribution of irradiated samples within the extruded material
- Transport of irradiated pellets / time effect

R&D area: (2024)

Group H: Recycle Plastic
(Dr. Honjuan MA, Dr. Farah Nurlidar, Prof. Nguyen Ngoy Duy, Mr. Wada Tomoaki, Dr. Taguchi Mitsumasa, Ms. Bin Jeremiah Barba)

Gap in basic aspect

Vietnam:

- Vietnam's plastic waste collection system is largely informal and fragmented,relying on individual waste pickers and small-scale operators.
- There is no standardized, efficient system for collecting and processing plastic waste, which limits the reach and effectiveness of recycling efforts.
- The infrastructure for basic recycling processes, such as collection centers, sorting facilities, and recycling plants, is lacking or underfunded.
- This infrastructure gap limits the volume of plastic waste that can be processed and reduces the effectiveness of recycling efforts.

China:

- The adsorbed dose needs to be evenly distributed
- **Indonesia**
  More experiments need to be conducted to meet technically and economically feasibility to reduce the cost of production

The Philippines

- Mechanism of improvement - more characterization and trials needed

R&D area: (2024)

Group H: Recycle Plastic
(Dr. Honjuan MA, Dr. Farah Nurlidar, Prof. Nguyen Ngoy Duy, Mr. Wada Tomoaki, Dr. Taguchi Mitsumasa, Ms. Bin Jeremiah Barba)

Gap in application aspect

Vietnam:

- Due to limited sorting and processing technologies, recycled plastic in Vietnam often has inconsistent quality, making it challenging for manufacturers to reuse it in high-quality products.
- Vietnam faces challenges in accessing advanced recycling technologies that could make the process more efficient and less labor-intensive.
- The high cost of equipment and technology often makes recycling economically unviable for smaller operators.

China:

- Recycled plastic in China is already commercialized, EB and gamma irradiation only shows very low percentage. There is not much advantage in cost.

Indonesia:

- The availability of irradiation source that can be easily used by the company

The Philippines

- Variability in raw material (coming from post-consumer waste)
- Life cycle analysis, recyclability and economic feasibility

R&D area: (2024)

Group H: Recycle Plastic
(Dr. Honjuan MA, Dr. Farah Nurlidar, Prof. Nguyen Ngoy Duy, Mr. Wada Tomoaki, Dr. Taguchi Mitsumasa, Ms. Bin Jeremiah Barba)

Implementation plan

Vietnam

- Study on the increase of mechanical properties of plastic waste (mesh waste) using irradiation for recycle purposes at pilot scale.

China

- Enhance market share of radiation degradation of rubber tires, EB degradation of microplastics will be combined with microbiological treatments.

Indonesia

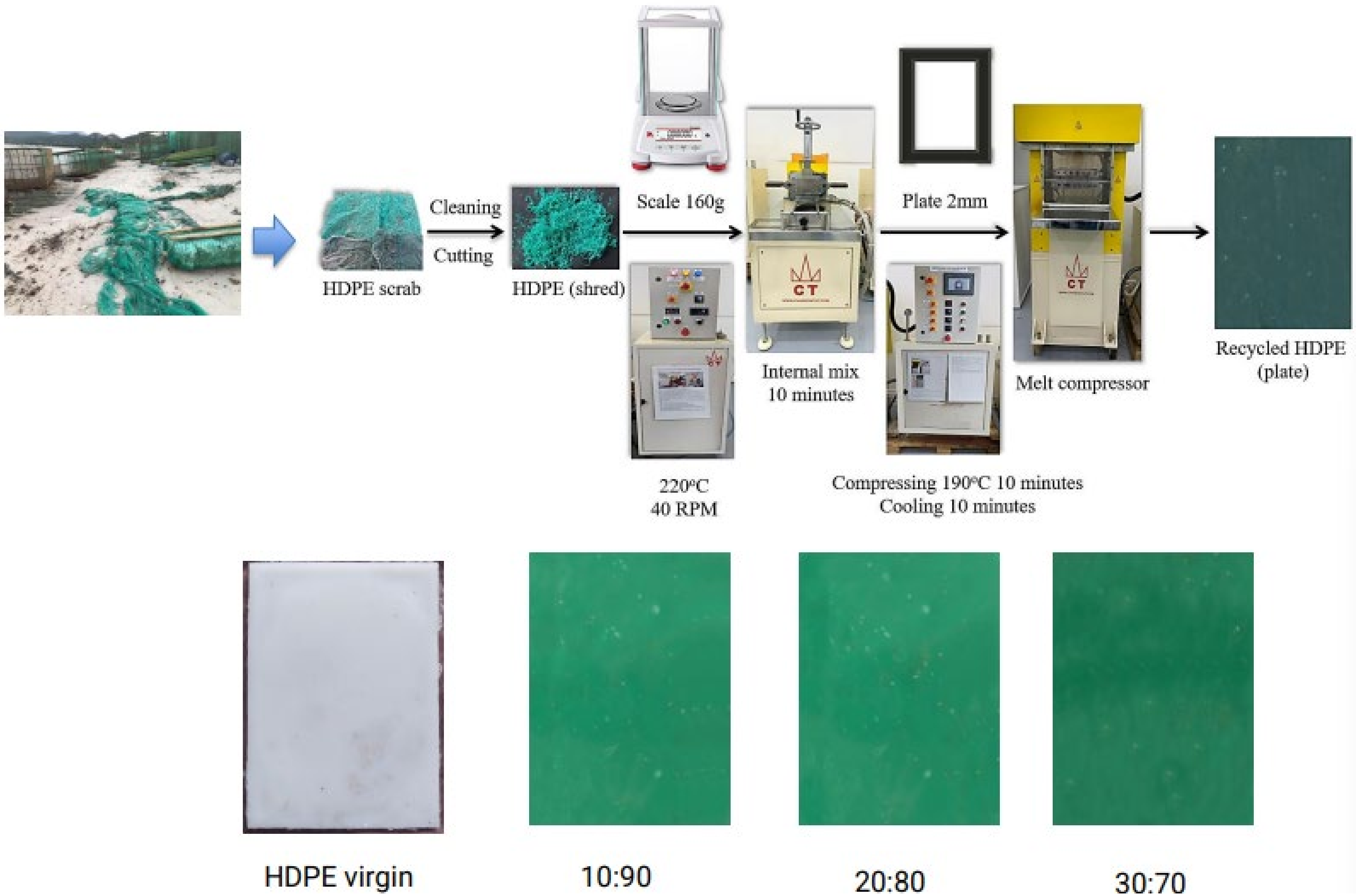
- Working on TRL 5

The Philippines

- Continuing TRL 4 studies closely with private recycling company
- Characterization for understanding mechanism

R&D area: (2024)

Vietnam

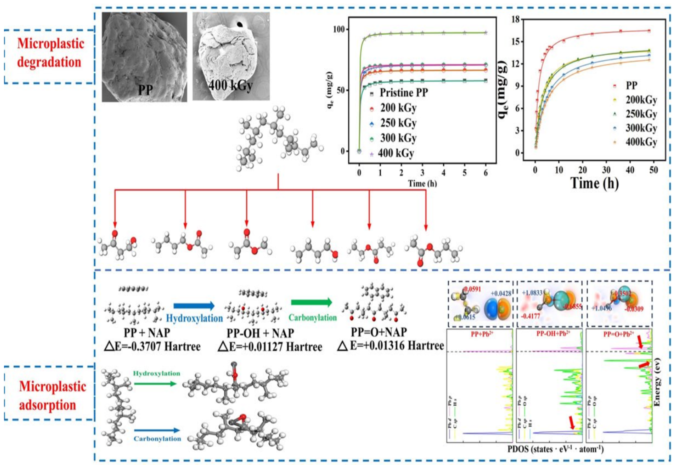


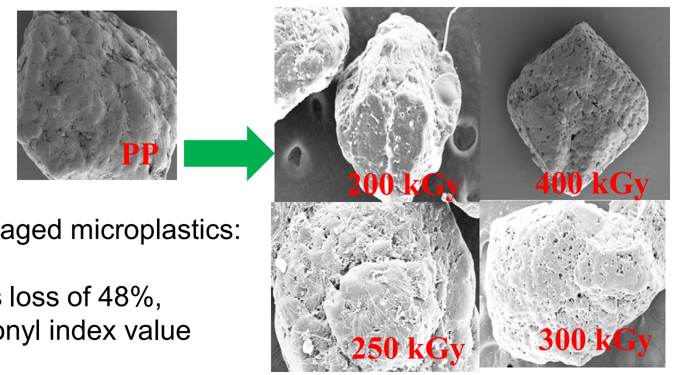
R&D area: (2024)

China

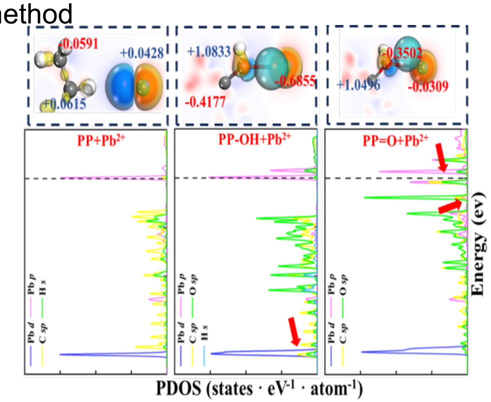
Achievements: Electron beam irradiation for efficient treatment of microplastics

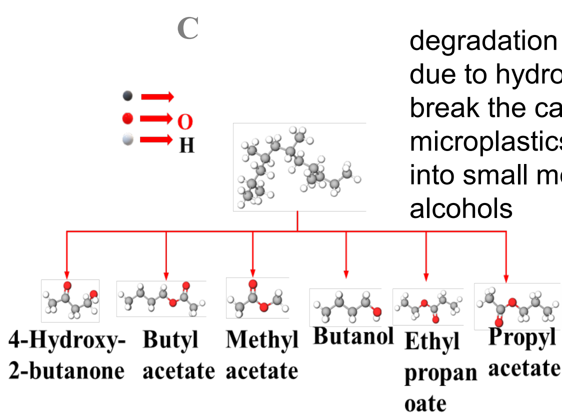
EB irradiation technology can effectively promote the aging and degradation of microplastics





- O/C of aged microplastics: 0.071,
- a mass loss of 48%,
- a carbonyl index value 0.69,
- the most effective method for short-term aging treatment





degradation of microplastics is mainly due to hydroxyl radicals, which can break the carbon chain of microplastics and gradually degrade into small molecular esters and alcohols

an increase in oxygen-containing functional groups on the surface leads to a gradual decrease in hydrophobic pollutant adsorption capacity while increasing hydrophilic pollutant adsorption capacity for aged microplastics

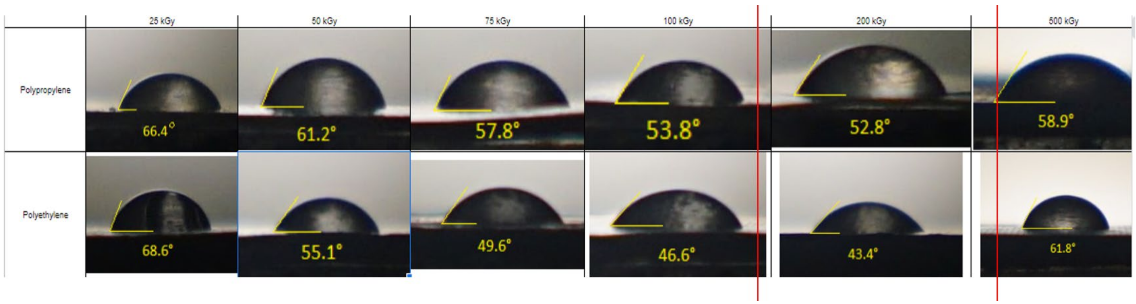
R&D area: (2024)

Indonesia

Passed TRL 4

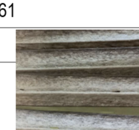
Artificial Thatch

Agreement cooperation with PT VIRO



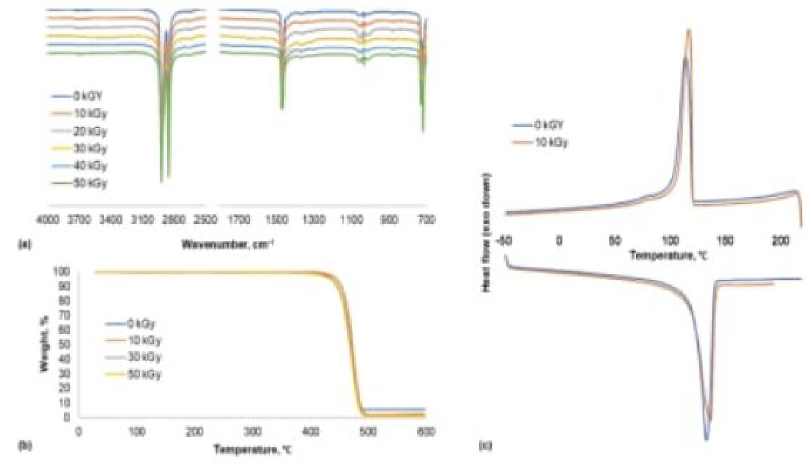
200 kGy is chosen for effective irradiation dose for a compatibilizer

The artificial thatch made by irradiation rPE has better mechanical properties compare to that made by commercial compatibilizer

Formulation	F3 (HDPE)	F4 (HDPE)	F5 (HDPE)
Recycle Material HDPE	90.2 %	92.7%	90.2 %
ADD - MBPE Rice Husk (Existing)			5.0%
ADD - MBPE Rice Husk RC (BRIN)	5.0 %	2.5%	
IHMB UV	4.8 %	4.8%	4.8 %
ADD Foaming			
Mechanical Properties			
Max Force (Mpa)	18.12	22.34	15.98
Fracture Force (Mpa)	17.61	19.56	15.42
Product			

R&D area: (2024)

The Philippines



Non-irradiated

Irradiated