Check R&D subject(s) that apply.

☐1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☒3. Medical and Biological Application

Name: **Dr. Md Kamruzzaman Pramanik** (Country) **BANGLADESH**

Affiliation: Chief Scientific Officer and Head
Microbiology and Industrial irradiation Division
Institute of Food and radaiton Biology
Atomic Enrgy Research Establishment
Bangladesh Atomic Enery Commission

Presented by : Tabassum Mumtaz, PhD, Chief Scientific Officer, MIID, IFRB

Subject: Hydrogel for medical application

Short summary

In an attempt to increase anti-microbial activity of the radiation-induced PVA/DMA hydrogel; at first chitosan and then Chitosan-Ag Nanocomposite have been developed. The effect of gamma radiation at different doses (0, 5, and 10 kGy) on the antimicrobial activity of this nanocomposite before incorporating into the gel matrix was re-examined. Hydrogel casting was improved by fabricating a gel-caster to cater multiple gel casting with varied thickness (1mm, 2mm, 3mm) in one slot. Some preliminary set up has been made regarding animal trial experiment with developed hydrogel.

Results

Antimicrobial activity of Chitosan-Ag Nanocomposite was assessed in both nutrient agar and Muller Hinton agar plates by disc diffusion method. Similar results were obtained in both media and the diameter of clear zone increased when it is irradiated with relatively low dose of γ-irradiation viz. 5 kGy. The gel thickness was reduced into 1-2mm using the fabricated casting apparatus. Moreover the apparatus can be portable to radiation facility. A 10 sq feet lab space has been allocated for animal trial experiment set up. Procurement of some basic requirements like air-conditioner, dehumidifier, cages, multi-layered steel rack etc. are awaiting financial approval. Formation of Ethical Committee intern under BAEC is underway.

Future plan

i. Improvement of multiple gel casting apparatus and new device development to measure Gel elasticity, elongation at break of produced composite hydrogel.
ii. Comparative study of market/ commercially available wound dressing material with hydrogel.

Subject: Sterilization and sanitization using radiation

Short summary

The importance of sterilization and sanitization has been well understood during Covid-19 outbreak and since then, in the post-Covid era, radiation processing seems more relevant and have been applied in medical and biological fields. Consequently, there is an increasing demand from various medical and pharmaceutical companies for commercial services on sterilization and sanitization by ionizing radiation in Bangladesh. Microbiology Division is involved in providing data on microbiological analysis as well as sterility dose optimization of several medical, pharmaceutical, food and feed products using Co-60 irradiator at GSD, IFRB.

Results

The total viable count, total coliform, total Salmonella and total Staphylococcal count have been assessed in certain samples after irradiated at different doses of gamma radiation (0-25kGy). In this reporting period, samples analyzed includes Beef Pizzles, Drinking water, Pharmaceutical Raw Water, Spray Dried Beet Root Powder,Leaf plate, Poly Bag, Maize Starch, Fruit Drink, Dry Fish Product, Biscuits, Tomato Ketchup, Tomato Sauce, Powder Spice, Anhydrous Lactose, Purified Water, Concentrated Bicarbonate Haemodialysis Solution, Wastewater, Sludge etc. Moreover, upon request, the minimum dose for sterility of some products have been assessed. Among medical products, minimum radiation dose was optimized for urine container, surgical thread and tooth guard. 10kGy was found to be optimum for urine container and 20kGy for surgical thread. Pharmaceutical products included rubber stopper, plastic container, maize starch, nasal spray etc. Both rubber stopper and plastic container was sterile at 10kGy whereas 15kgy was used for maize starch and for nasal spray low dose such as 1 kGy was found sufficient. Food/feed products viz. Cumin powder and chilli powder were found to be sterile at 10kGy. The database of the above services has been digitalized with the help of Ministry of Science and Technology, GoB for better access and transparency.

Future plan

i. Scaling up Gamma radiation facility
ii. Expansion of services to wider variety of products and meeting up demands by stakeholders.

Check R&D subject(s) that apply.

☒1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☐3. Medical and Biological Application

Name: Ruifu Zhang (Country) China
Affiliation: College of Resources and Environmental Science, Nanjing Agricultural University

Short summary (~5 lines)

Obtained an excellent strain *Sinomonas gamaensis* NEAU-HV1 to promote pant growth and root development; Strain *Sinomonas gamaensis* NEAU-HV1 promoted root development through remodeling of IAA14-ARF7/19 interaction; Strain NEAU-HV1 was used to produce the bacterial inoculant and biofertilizer through large-scale fermentation. SWA was made from cassava via gamma irradiation at 5 kGy, with the SWA has 305g water/g; SWA significantly increased the efficiency of strain HV1-based biofertilizer under soil drought.

Results (15~20 lines)

Obtained an excellent strain *Sinomonas gamaensis* NEAU-HV1 to promote pant growth and root development; Strain *Sinomonas gamaensis* NEAU-HV1 significantly promoted the growth and yield of several crops of lettuce, rice, maize and peanut. Compared with the widely used biofertilizer strain of FZB42 and CC-A174, HV1 showed the superiority for promoting crop growth. Strain *Sinomonas gamaensis* NEAU-HV1 promoted root development through remodeling of IAA14-ARF7/19 interaction.

Strain NEAU-HV1 has been developed as the bacterial inoculant through large-scale liquid fermentation, and the bio-organic fertilizer through mixing of the fermentation broth with the organic fertilizer. These biofertilizer products have excellent performance in field application.

SWA was made from cassava via gamma irradiation at 5 kGy, with the SWA has 305g water/g; SWA significantly increased the efficiency of strain HV1-based biofertilizer under soil drought. In the dry season of this year, synergistically application of biofertilizer with 15% of SWA significantly increased the growth of maize in two different location.

Future plan (<10 lines)

Commercial application of SWA with Biofertilizer in field

Check R&D subject(s) that apply.

☒1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☐3. Medical and Biological Application

Name : Rumella Simarmata (Indonesia)
Affiliation : Research Center for Applied Microbiology, Research Organization for Life Sciences and Environment, National Research and Innovation Agency.

Short summary (~5 lines)

Research on Plant Growth-Promoting Microorganisms (PGPM) using CMC composites is being conducted at BRIN. Collaborations with Gadjah Mada University and local partners focus on biofertilizers under salinity stress. Another project develops LCO-SWA-based biofertilizers with IPB and PT Pupuk Kaltim, now at TRL 5. Studies show LCO addition enhances plant productivity and strengthens the symbiotic interactions between microbes and their host plants under saline conditions. Overall, these findings highlight promising steps toward sustainable biofertilizer strategies for soil restoration and stress mitigation.

Results (15~20 lines)

1. We developed the biofertilizer formulation using Carboxyl Methyl Cellulose (CMC) as SWA, and the result showed that the bacterial population in CMC formulation is more stable and higher than in liquid media. The use of CMC as a super water absorbent (SWA) composite in biofertilizers increased microbial viability and enhanced plant productivity compared to the control under salinity stress. When CMC is added at 4%, plant height, stem diameter, and number of leaves increase significantly compared to the control without the addition of SWA. We are applying the CMC-based biofertilizer to *Paraserianthes falcataria* seedlings and Shallot plants to evaluate its effectiveness.
2. Another research is the development of LCO-based biofertilizer involves the extraction of LCO from rhizobia, the application of LCO-based biofertilizer in greenhouses, and the identification of the LCO molecule structure, in collaboration with IPB and PT. Pupuk Kaltim. The research showed that the addition of LCO to biofertilizers improved plant productivity and enhanced symbiotic interactions between microbes and host plants under saline stress. Root colonization and symbiotic structures were more abundant in treated plants compared to controls. Consistent trends across experiments suggest that LCO contributes to better plant resilience under salinity. Overall, these results highlight the potential of LCO-based biofertilizers in sustainable soil restoration strategies.
3. LCOs from Bradyrhizobium B64 exhibit broad-spectrum activity and establish symbiotic interactions with a wide range of host plants.

Future plan (<10 lines)

- Support local governments in conducting research collaborations on the application of LCO-SWA-based biofertilizer products in village areas.
- Continue development toward TRL 5 of a compatibilizer generated from irradiated carrier media of LCO-based biofertilizer for use in SWA composites.
- Develop a new formulation of LCO–SWA-based biofertilizer and evaluate its application across different crop commodities under varied stress environments.
- Complete a comprehensive data sheet on the effects of irradiation on the sterilization of LCO-based biofertilizer within SWA composites.

- Advance toward the commercial application of SWA combined with LCO-based biofertilizer in the field.

Check R&D subject(s) that apply.

☒1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☐3. Medical and Biological Application

Name: OKAZAKI, Shin (Country) JAPAN
Affiliation: Tokyo University of Agriculture and Technology, Graduate School of Agriculture

Short summary (~5 lines)

We conducted the mutation breeding of plant-growth-promoting microbes (rhizobia) via carbon-ion beam and gamma-ray irradiation to improve their ability to enhance sustainable soybean and rice cultivation. We addressed the adverse effects of climate change such as high temperature and greenhouse gas emission together with agricultural productivity, and proposes innovative microbial solutions aimed at improving plant growth while concurrently mitigating nitrous oxide (N_2O) emissions.

Results (15~20 lines)

We develoved high-temperature-tolerant mutants (M10 and M14) from a soybean symbiotic microbe *Bradyrhiozbium diazoefficiens* USDA110 through carbon-ion beam irradiation. Both mutants maintained symbiotic functions with soybean plants. Although M14 strain exhibited a slower growth rate at 32°C compared to the wild type, it retained significant nitrogen-fixing capabilities and nodule formation. Whole-genome sequencing revealed a 1.27-Mb inversion in M14, alongside 7 unique point mutations. In contrast, M10 showed no structural alterations but had 8 unique point mutations. The mutation frequencies were established at 0.8–0.9 x 10^{-6}/bp, with base substitutions comprising 86% of total point mutations.

The mutants M5, M7, and M22 derived from *B. ottawaense* SG09 exhibited superior symbiotic performance compared with its wild-type. These mutants induced more nodules on soybean roots and increased plant weights than wild-type strain. In addition, the M5 mutant strain was shown to effectively promote rice growth and significantly reduce N_2O emissions in the rhizosphere, a critical factor given the environmental impact of nitrous oxide as a potent greenhouse gas. Experimental measurements indicated that M5 could reduce N_2O concentrations in the root zone by a substantial margin, demonstrating its potential as a biological agent for mitigating greenhouse gas emissions in agricultural settings. Moreover, the colonization efficiency of the M5 strain was evaluated across various crop species, including wheat, barley, sorghum, and rice. The findings illustrated that M5 not only enhanced plant growth but also exhibited a strong capacity for N_2O reduction, establishing it as a promising candidate for sustainable agriculture.

Future plan (<10 lines)

We plan to integrate experimental evolution techniques with gamma irradiation to enhance mutation breeding, aiming to generate a diverse pool of mutant strains with beneficial traits. Systematic screenings will identify strains with improved symbiotic efficiency and resilience to abiotic stresses.
Field trials will assess the performance of selected mutants in agricultural settings, focusing on plant growth, yield, and N_2O reduction.

A comprehensive sustainability assessment will evaluate the environmental impact of the mutant strains, including greenhouse gas reductions and soil health improvements. We expect to explore the international collaboration for continuously developing resilient microbial strains to address the challenges of climate change while enhancing agricultural productivity.

Check R&D subject(s) that apply.

☐1. Agricultural Bio-stimulant

☒2. Environmental Remediation

☐3. Medical and Biological Application

Name: Sadykov Adlet (Country) Republic of Kazakhstan
Affiliation: Head of the Production and Technology Department JSC "Park of Nuclear Technology" Kurchatov city. Kazakhstan

Short summary (~5 lines)

The special polymer, developed on the basis of an SWA, is designed to improve the effectiveness of firefighting. It is intended for use in extinguishing Class A fires and for providing fire and thermal protection for personnel, surfaces, and materials .Upon contact with water or liquid, it swells and binds an amount of water 200–400 times its own weight; that is, 1 gram of the substance can turn 200–400 ml of water into gel. It has

Results (15~20 lines)

During the testing of the fire-extinguishing agent, it was found that the agent demonstrates a sufficiently strong cooling effect and does not evaporate compared to water. It was recommended and proposed to conduct tests using aviation for extinguishing large-scale fires and forest fires.The fire-extinguishing substance is highly effective in combating fires due to its dual action, which is associated with the material's increased adhesion (cooling effect and cutting off oxygen access to the burning surface).

Due to its increased adhesion compared to water and foam, it is used for extinguishing buildings and structures, forest fires, and creating firebreaks, which is effective in combating rapidly spreading and large-scale fires.

Aerial firefighting – does not disperse in the wind and does not evaporate upon release, and does not require critical altitude reduction to reach the target.

Future plan (<10 lines)

1.Conducting tests using aviation (need helicopter)
2.Continue field tests on SWA application
3.Work on the modification of SWA for the use of SWA in cold weather.

Check R&D subject(s) that apply.
☒1. Agricultural Bio-stimulant
☐2. Environmental Remediation
☐3. Medical and Biological Application

Name: Name: Dr. Phua Choo Kwai Hoe (Malaysia)
Affiliation: Senior Research Officer, Malaysian Nuclear Agency.

Short summary (~5 lines)

Six biofertiliser products undergoing commercialisation. Drafting of the Malaysian Standard for Biofertilisers is under way. Mutagenesis projects for phosphate solubilising microbes (M100) and silicate-solubilizing bacteria (SSB) are in progress. A guideline for mutagenesis (FNCA) is drafted, and the development of a gamma-sterilised carrier biofertiliser is also ongoing. A new proposal was initiated on the valorisation of gamma-irradiated rice residues for high-performance *Trichoderma* biocontrol formulations.

Results (15~20 lines)
In 2025, the commercialisation of six biofertiliser products, viz. Bioliquifert, FertiBact AP1, BioNiKPhos, SustainaBac M99, Bioliquifert M100, and Beqtoz Microbe Beads—is ongoing.

As part of a quality control plan for biofertiliser products, cooperation with the Department of Agriculture Malaysia and the Department of Standards Malaysia will lead to the drafting of a Malaysian Standard for Biofertilisers. The proposal for developing the Malaysian Standard for Biofertiliser received approval from the Department of Standards Malaysia.

Work on the FNCA Mutagenesis Guideline advanced substantially, with the final draft currently in progress. This guideline includes other mutagenesis methods and fungi from member countries (Japan, Vietnam, and Malaysia).

A total of 931 colonies from *Acinetobacter calcoaceticus* (M100) were irradiated using gamma irradiation and screened for phosphate solubilization activity. Among the hypermorphic mutant strains, three potential mutated strains (C371, D20 & D100) were selected based on a significant phosphate solubilization index (SI).

Mutagenesis of silicate-solubilising bacteria resulted in three potential SSB strains (UPMC1341, UPMC1446 and UPMC383) that were evaluated in a greenhouse trial on rice. The best-performing treatment was a combination of UPMC1446 and UPMC1341 with kaolinite. Yield increased substantially, reaching an extrapolated 8.9 t/ha, nearly double Malaysia's national average.

A new irradiated carrier-based biofertiliser formulation was explored, including a shelf-life study of isolate B1 on Nanobooster and commercial zeolite. Spray and direct mix methods were used in this study. Overall, spray method show stability of the isolate B1.

A new proposal was initiated on the valorisation of gamma-irradiated rice residues for high-performance *Trichoderma* biocontrol formulations.

Future (<10 lines)

In 2026, commercialisation efforts will continue with the introduction of six biofertiliser products to new industry sectors. The first draft of the Malaysian Standard for Biofertiliser is targeted for development during the year. The FNCA Mutagenesis Guideline is planned for finalisation and publication in 2026. Work on the M100 phosphate-solubilising microbe will include developing allele-specific primers for mutation detection. Research on silicate-solubilising bacteria will focus on dose mapping and screening new mutated SSB strains. Formulation studies for irradiated carrier-based biofertilisers will expand using gamma-irradiated Nanobooster and commercial zeolite at 10 kGy. Shelf-life evaluation will continue to support product optimisation. The valorisation project on gamma-irradiated rice residues will advance with the isolation of *Trichoderma* strains. Overall, the 2026 plan aims to strengthen innovation, standard development, and product readiness through irradiation, mutagenesis, and strategic collaboration.

Check R&D subject(s) that apply.

☒1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☐3. Medical and Biological Application

Name: Sunjidmaa Otgonbayar Mongolia

Affiliation: Head of Soil microbiology laboratory, Institute of Plant and Agricultural Sciences

Short summary (~5 lines)

The combined use of biofertilizers, PGP, and SWA supports stronger, healthier plant growth and improved crop resilience to environmental stresses. 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 during the growing season and post-harvest period.

Results (15~20 lines) rove water retention and distribution in the soil, which helps with t

In cucumbers, the application of bacterial fertilizer, growth promoter and SWA resulted in soil moisture levels that were 0.85–4.3% higher than the control at a depth of 0–10 cm, and 0.3–4.2% higher at a depth of 10–20 cm. The combined use of fertilizer, oligo, and SWA demonstrated a clear advantage over the other treatment options.

The yield increased by 522–3110 g compared to the unfertilized control, with the BF+SWA+Oligo treatment demonstrating a statistically significant advantage and emerging as the most effective option.

Future plan (<10 lines)

1. Study of synergistic effect of BF+SWA on another green house plant yields, quality and soil agrophysical and agrochemical properties /pepper/
2. Determination /Bacillus sp – 4 strain/ and identification the N fixation and IAA producing activity.
3. Determination of the effect of Bacillus sp bacterial fertilizer on the main crops of Mongolia

Check R&D subject(s) that apply.
☒1. Agricultural Bio-stimulant
☐2. Environmental Remediation
☐3. Medical and Biological Application

Name: **Jean Louise C. Damo** (Country) **Philippines**
Affiliation: National Institute of Molecular Biology and Biotechnology (BIOTECH), University of the Philippines Los Baños (UPLB)

Short summary (~5 lines)
BIOTECH-UPLB's biofertilizer technologies promote sustainable and cost-effective crop production in the Philippines. This research program showcases BioN™, NitroPlus™, and AMF-based products, including their performance in field trials. Recent innovations include alternative carriers, integration with other bio-stimulants, and development of sustainable production protocol for biofertilizer technology. Current efforts emphasize farmer adoption, waste valorization, and environmental benefits. In the long run, the program aims to strengthen biofertilizer deployment in the Philippines.

Results (15~20 lines)
BIOTECH-UPLB has developed more than 50 technologies and products in its 46-year history, including effective microbial fertilizers for agriculture and forestry. One of the technologies is Bio N™, which converts atmospheric nitrogen into plant-available forms for rice, corn, and vegetables. Studies show that Bio N™ performs particularly well when used with AMF inoculants like VAMRI and MYKOVAM. Moreover, it was demonstrated that integrating nitrogen-fixing bacteria with mycorrhiza enhances bio-organic fertilizers. Subsequent trials further revealed that the synergistic use of BIOTECH biofertilizers improved both yield and nutrient content in crops such as corn and sorghum. Lastly, alternative carriers like bentonite and liquid formulations performed comparably to the original soil–charcoal mix under field conditions. Likewise, NitroPlus™ which is a rhizobia inoculant showed comparable effectiveness of chemical nitrogen fertilizers in pole sitao and delivering yield increases of up to 15% in field trial. Strong synergy observed when combining microbial inoculants with proper nutrient management. Field demonstration conducted with farmers in Laguna validated the practicality, acceptance, and impact of biofertilizers. Furthermore, research on AMF cultivation also explored the use of local agri-industrial waste materials in Mindanao region as promising substrates. This reduces dependence on synthetic media, although optimization efforts are still ongoing. For capacity building component, training-workshops were conducted to increase awareness of stakeholders of the benefits and proper usage of biofertilizers. Multi-site farmer field demonstration trials were also conducted in Laguna and Quezon. Adoption of these technologies will be further supported by continuous promotion and technical assistance. These results collectively highlight the economic and ecological benefits of microbial fertilizers; demonstrating that BIOTECH's innovations are effective, scalable, and well-aligned with sustainable agriculture goals.

Future plan (<10 lines)
Future efforts will focus on expanding research into the synergistic interaction of Carrageenan PGP with nutrient-mobilizing biofertilizers, particularly for high-value crops. Parallel to this, the continued prospecting and evaluation of agri-industrial wastes as low-cost raw materials

will support more sustainable and economical biofertilizer production. Optimized AMF substrate formulations will be scaled up for commercial application, ensuring consistent supply, and improved product quality. Also, field trials of the sustainably produced AMF inoculant will be undertaken. Biofertilizer efficiency will also be validated across a broader range of agro-ecological zones in the Philippines to ensure robustness and adaptability. In addition, efforts will be directed toward developing improved formulations that enhance shelf life, ease of use, and field performance. To strengthen technology adoption, farmer training and capacity-building programs will be further enhanced. Wider distribution and technology deployment will be promoted through stronger public-private partnerships. This will be complemented with continuous technical support for local government units, agricultural extension workers, and students. Eventually, these initiatives will support the widespread adoption and long-term sustainability of biofertilizers in the Philippines.

Check R&D subject(s) that apply.

☒1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☐3. Medical and Biological Application

Name: LE XUAN VINH (Country) Vietnam
Affiliation: Hanoi Irradiation Center (HIC) – Vietnam Atomic Energy Institute (VINATOM)

Short summary (~5 lines)
In 2025, we successfully conducted irradiation mutagenesis and selected three superior mutant strains of Trichoderma: AM2 (derived from TVN-A0), HM2 (derived from TVN-H0), and KM2 (derived from VTCC 31435). These mutants exhibited outstanding performance, genetic stability over at least five generations, and were confirmed as elite mutants with high potential for development into biological control agents against rice diseases. We also developed a fast-dissolving tablet formulation, Radichoderma-FD, containing radiation-induced mutant Trichoderma strains with a spore density of 10^9 CFU/g. Field trials under net-house conditions demonstrated that Radichoderma-FD significantly suppressed rice blast (38,78–53,76%) and sheath blight (63,62–65,2%), thereby confirming the promising application potential of this biocontrol product for disease prevention in rice.

Results (15~20 lines)

1. Spore suspensions of the three *Trichoderma* strains (VTCC 31435, TVN-H0, and TVN-A0) were irradiated using a Co-60 gamma source with doses ranging from 100-1500 Gy at the Hanoi Irradiation Center. Survival rate decreased with increasing dose; VTCC 31435 exhibited the highest radiation tolerance, followed by TVN-H0, while TVN-A0 was more radiosensitive and nearly inactivated at 1500 Gy.
2. Among all mutants obtained from the three original strains, AM2 (derived from TVN-A0), HM2 (derived from TVN-H0), and KM2 (derived from VTCC 31435) exhibited superior performance. All three mutants maintained these traits stably over at least five generations and were identified as elite mutants with high potential for development into biocontrol products for rice disease management.
3. The study optimized solid-state fermentation (SSF) protocols for the three mutant Trichoderma strains AM2, KM2, and HM2, achieving an average spore density of $\geq 10^{11}$ CFU/g.
4. A fast-dissolving tablet formulation, RADICHODERMA-FD, containing mutant *Trichoderma* spores ($\geq 10^9$ CFU/g), was successfully developed. The product demonstrated advantages in stability, ease of application, room-temperature shelf life ≥ 6 months, safety according to OECD 420 guidelines, and cost-effective production.
5. The RADICHODERMA-FD tablets formulation exhibited significant efficacy in reducing rice blast (38,78–53,76%) and sheath blight (63,62–65,2%) under greenhouse conditions, particularly when applied as a root drench both before and after pathogen inoculation. The performance was comparable to or better than commercial products, whereas application only after inoculation showed limited effect. these results underscore the strong potential of the formulation for preventive disease management.

Future plan (<10 lines)

- Advance toward commercialization of the RADICHODERMA-FD product.
- Continue R&D on additional agricultural formulations incorporating gamma-radiation-induced *Trichoderma* mutants.

- o 1.Agricultural Bio-stimulant
- X 2. Environmental Remediation
- o 3. Medical and Biological Application

2. Environmental Remediation: Dye and metal adsorption by Co-60 gamma irradiated hydrogels

Name: Salma Sultana (Country) Bangladesh
Affiliation: Nuclear and Radiation Chemistry Division (NRCD), Institute of Nuclear Science and Technology (INST), Bangladesh Atomic Energy Commission(BAEC)

Short Summary
In response to the harmful impacts of heavy metals and cationic dyes of modern civilization, a series of superabsorbent hydrogels were prepared via γ-ray induced crosslinking such as Polyethylene Oxide (PEO), Starch, 4-styrene sulfonic acid sodium salt (SSA)blend hydrogel and Carboxy-methyl Chitosan (CMCh), Acryl Amide (AAm), Diallyl Dimethyl Ammonium Chloride (DADMAC),N,N'Methylene-bis Acrylamide(MBA) blend hydrogel.

Resultas

In the Case of PEO/PSSA/Starch blend hydrogel, the irradiation dose and the composition of starch and SSA were optimized in terms of gel fraction, degree of swelling, porosity, and crosslink density. The pH dependent, thermodynamically spontaneous and feasible adsorptions of the cationic dyes: Basic Fuchsine (BF), Methylene Blue (MB), and Crystal Violet (CV) were governed by film diffusion at maximum adsorption capacities of 625, 569, and 498 mg/g, with the isotherms being best characterized by Modified Langmuir, Redlich-Peterson, and Aranovich Donohue models, respectively. After four adsorption/desorption cycles the hydrogel could still remove 77- 82% of the dyes from aqueous solutions. Adsorption kinetics followed pseudo 1st order for MB (98% removal) and CV (91% removal) but pseudo 2nd order for BF (92% removal). The pH dependent slower adsorption of the metal ion Cr^{3+} (61% removal) was best described by Freundlich isotherm, intra particle

diffusion, and pseudo 2nd order kinetic models with three adsorption sites per adsorbate.

In the Case of CMCh/AAm/DADMAC/MBA hydrogels, the irradiation dose and the composition of CMCh, AAm, DADMAC and MBA were also optimized in terms of gel fraction, degree of swelling, porosity, and crosslink density. CMCh/AAm/DADMAC/MBA hydrogels, adsorption behavior followed pseudo second order kinetic model with maximum removal efficiency ~ 87% for MB whereas they followed pseudo 2nd order kinetic model with maximum removal efficiency 91 % for CR. The maximum monolayer adsorption capacities of CMCh/AAm/DADMAC/MBA blend hydrogel for MB(cationic) and CR(anionic)were found to be 58mg/g & 147 mg/g respectively. The hydrogel was employed to adsorb five different industrial dyes. Among these dyes, the hydrogel could also remove 7.27-87.93% of industrial dyes from respective 100 ppm (aq) solution where Ocean HSRN dye exhibited a removal effectiveness of 87.93% over 48h. In the case of industrial effluent (species-1), Na-Alg/PVP/DMA and CMCh/AAm/DADMAC/MBA blend hydrogels, removal efficiency after three (3) days are ~ 41 and ~21% and after ten (10) days are 57 and 23% respectively. In the case of industrial effluent (species-2), Na-Alg/PVP/DMA and CMCh/AAm/DADMAC/MBA blend hydrogels, removal efficiency after three (3) days are ~ 41 and ~22% and after ten (10) days are 43 and 8 % respectively.

Future Plan

i. Industrial effluents collected from various dye industries in the country will be used to measure the dye adsorption and dye removal capacity of the prepared hydrogel.

ii. And also plan to measure heavy metal adsorption and removal efficiency from industrial effluents using the prepared hydrogel.

- o 1.Agricultural Bio-stimulant
- X 2. Environmental Remediation
- o 3. Medical and Biological Application

2. Environmental Remediation: Concrete block preparation by irradiated and non-irradiated plastic waste

Name: Salma Sultana (Country) Bangladesh
Affiliation: Nuclear and Radiation Chemistry Division (NRCD), Institute of Nuclear Science and Technology (INST), Bangladesh Atomic Energy Commission(BAEC)

Short Summary

Bangladesh produces around 1700 tons of plastic waste every day across the country. In just single-use plastic bottles78.6% end, the country discards about 3.15-3.84 billion bottles annually. Only about 21.4% of single-use plastic bottles are recycled; 78.6% end up polluting rivers, landfills, and other environment. Our target is to reduce plastic waste. Again, conventional brick making in Bangladesh is a highly polluting, energy intensive and producing a large scale of CO_2. The government of Bangladesh is encouraging people to use concrete blocks instead of clay bricks. We have started research on use of waste PET as filler material in concrete technology through radiation technique.

Results

At the lab scale, we prepared concrete blocks (5cm × 5cm × 5cm) by mixing non-irradiated and irradiated waste PET flakes with cement, sand and gravel. We optimized gravel and PET mesh size less than 0.25 mm. We optimized the ratio of cement: sand: gravel as 2.2:3:5. For irradiated PET, 50kGy has been optimized. In some of the experiments, a portion of the sand was replaced with PET, and in others, a portion of the cement was replaced with PET. In both cases, it was observed that the compressive strength did not decrease significant. We observed that sample with irradiated PET showed slightly higher compressive strength than with non-irradiated PET. We have increased the amount of PET up to 5 %. The compressive strength of prepared concrete blocks (20% cement replaced by PET flakes) was found to be 17.0 MPa. We compared the compressive strengths of concrete blocks prepared using

PET/LDPE/PP. Concrete block prepared with PET showed higher compressive strength compared to LDPE/PP.
We have already contacted a few concrete block manufacturing industries in our country to prepare large size blocks for practical applications, and Hatim Global Concrete Industry has agreed to work with us jointly. In this context, we have carried out a trial. We observed that the compressive strength of prepared concrete blocks (dimension 22.2cm × 11.0 cm × 6.0cm) containing irradiated PET flakes (16.7% cement was replaced by PET flakes) was higher (32.32 MPa) than that of regular concrete blocks (30.30MPa).

Future Plan

- We will pay effort to increase the amount of PET in the blocks more than 5%
- We will attempt to investigate other properties of the concrete blocks, including workability, air content, tensile strength, and water absorption.
- In future experiments further studies will be conducted on an industrial scale under different conditions to increase the use of waste plastics in blocks while maintaining the compressive strength of the product. The conservation of mechanical stability of the blocks for long period of time will be compared with regular blocks (without plastics) of Hatim Global Concrete Industries Ltd.
- We will continue to work jointly with Concrete Block Manufacturing Companies such as Hatim Global Concrete Industries Ltd., Dhaka, Bangladesh and there are plans to sign MoU with them.

Check R&D subject(s) that apply.

☐1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☐3. Medical and Biological Application

Polymer modification and application in Environmental Remediation and Medical

Name: Hongjuan Ma (Country) China
Affiliation: Shanghai University

Short summary (~5 lines)
Greenly dyeing cotton fabric with reactive dyes via EB irradiation was investigated and dyeing 1 kg of cotton fabric can save at least 120 L of water; Rigid skeleton PEI fabric was synthesized with EB irradiation induced crosslinking and used in the $^{99}Mo/^{99m}Tc$ generator, impressive Mo adsorption capacity of 2077 mg/g; Hydrogel-encapsulated-ion sieves-based photothermal fabric was synthesized with EB irradiation induced crosslinking, adsorption amount of the adsorbent can reach 15.71 mg g^{-1}, 25.9% increasement compared with non-photothermal ones.

Results (15~20 lines)

1. Three vinyl containing reactive dyes were designed and synthesized and were covalently bonded to cotton fabric individually or in combination via graft copolymerization under EB irradiation. The synthesized dyes have high polymerization activity and irradiation stability, and the utilization rate of the dyes is nearly 100%. The grafted cotton fabric had the advantages of uniform and diverse colors and a high color fastness; even after 20 cycles of accelerated laundering the color remained unchanged. Dyeing 1 kg of cotton fabric can save at least 120 L of water.
2. PEI functionalized novel polymeric adsorbent Fabric@CNPIgPEI was fabricated by EB irradiation induced crosslinking between PEI, rigid polymer skeleton of CNPI and PE fabric. Irradiation induced crosslinking covalently integrates both components with the PE fabric matrix, resulting in a mechanically robust, easily processable, and outstanding adsorption performance. The material demonstrated an impressive adsorption capacity of 2077 mg/g. The elution yield of ^{99m}Tc reached 90 %, indicating efficient generator operation.
3. EB irradiation was employed to utilize the hydrophilic property of polyvinyl alcohol for crosslinking, thereby loading graphite powder and ion sieve onto cotton fabric to prepare a lithium adsorbent. Under 1 sun of illumination, the removal ratio of lithium ions by CF-G3-H4 increases from 30.0% (in the dark condition) to 55.0% within 30 min in natural seawater. The offshore seawater results indicate that the adsorption amount of the CF-G3-H4 adsorbent can reach 15.71 mg g^{-1}, which is a 25.9% increase compared to the adsorbent without the addition of GP.

Future plan (<10 lines)

Carry out the scale-up verification of EB irradiation for dyeing, and conduct research on dyeing of other types of fabrics, such as nylon and other materials.
Prepare resin materials with appropriate particle sizes for the separation of medical isotopes.
Large-scale production of photothermal conversion materials and their application in seawater desalination and the comprehensive utilization of marine resources.

Check R&D subject(s) that apply.
☐1. Agricultural Bio-stimulant
☒2. Environmental Remediation
☒3. Medical and Biological Application

Name: **Farah Nurlidar** (Country) **Indonesia**
Affiliation: Research Center for Radiation Technology, National Research and Innovation Agency of Indonesia (BRIN)

Short summary (~5 lines)
The first project is developing tissue engineering scaffolds for wound dressing and drug delivery applications using polysaccharides as a main polymer. We successfully fabricated a wound dressing from dextran and alginate. Physicochemical and mechanical characterizations on these have been performed and showed a potential application.
The second project is utilizing irradiated recycled-HDPE as a compatibilizer for artificial thatch production. The project is now under TRL 5 and in collaboration with a private company and Indonesia university. In this year, we are conducting the aging experiment on the artificial thatch in real and accelerated conditions.

Results (15~20 lines)
In the first project, we developed two hydrogels. The first hydrogel is synthesized from dextran and PEGDA, and the second hydrogel was fabricated from alginate and PEGDA.
Hydrogel from dextran and PEGDA incorporated ciprofloxacin was successfully fabricated simultaneously using gamma rays. The drug release study showed that the 15 kGy hydrogel can release the ciprofloxacin up to 84 % after 24 hours of immersion in phosphate-buffered saline solution. Antibacterial test showed that both hydrogels exhibited pronounced antibacterial properties toward *E. coli* and *S. aureus*, implying that the ciprofloxacin incorporated into the network remained pharmacologically active following crosslinking by gamma radiation. Overall, the study revealed that dextran–PEGDA hydrogels exhibit satisfactory mechanical stability and enable a controlled release pattern, suggesting their suitability for future development of drug delivery systems.
Another hydrogel-encapsulated nanosilver has been successfully fabricated simultaneously using gamma rays. The reduction of silver ions (Ag^{+}) into Ag nanoparticles (Ag^{0}) and the encapsulation of the nanoparticles into the hydrogel occurred simultaneously with hydrogel formation. This simultaneous method is eco-friendly because it avoids the use of additional harsh chemicals. The reduction of silver ions (Ag^{+}) to Ag^{0} (silver nanoparticles) was observed visually by the change of colour of the solution (colorless) before radiation into brown hydrogel after the radiation, indicating surface plasmon resonance (SPR) phenomena induced by the silver nanoparticles. Interestingly, the hydrogel can inhibit the growth of *S. aureus*. After 24 hours of incubation, no bacterial growth was observed on the medium containing the nano silver hydrogel. Cytotoxicity evaluation using fibroblasts showed that the hydrogel is not toxic.

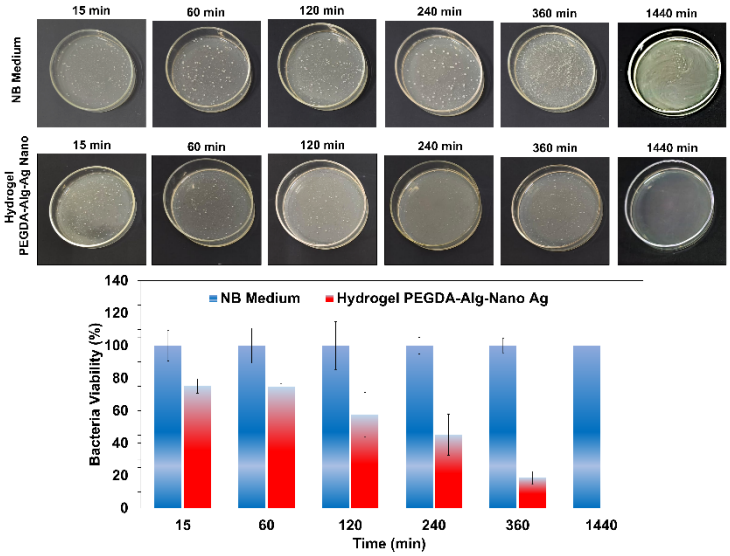

Figure 1. Antibacterial activity of nano silver hydrogel

For the second project, we are still waiting for the aging experiment results. In addition, we are trying to develop other products using our irradiated recycled-HDPE as a compatilizer.

Future plan (<10 lines)

1. Conduct cytotoxicity and fibroblast proliferation test on dextran hydrogel containing ciprofloxacin.
2. Conduct in vivo analysis using mice for nano silver hydrogel to evaluate its ability as an active wound dressing for burn wounds.
3. Develop other products using our irradiated recycled-HDPE as a compatilizer.

Check R&D subject(s) that apply.
☐1. Agricultural Bio-stimulant
☐2. Environmental Remediation
☐3. Medical and Biological Application

Name: Zhanat Baigazinov (Country) Republic of Kazakhstan
Affiliation: Cheirman of the Board JSC "Park of Nuclear Technology" Kurchatov. Kazakhstan

Short summary (~5 lines)
In 2024, the research results on radiation crosslinking of PE-100 polyethylene, obtained at the ELV-4 electron accelerator, were presented at the FNCA Workshop on Radiation Processing and Polymer Modification (Tokyo, 2024). After validation of the research results we apploted the progect for Kazakh government and win the grant for Development of Production of Radiation-Modified Polymer Pipes for Hot Water Supply for 2025-2027 in amount of 650 thousand US dollars.

Results (15~20 lines)
The study confirmed the industrial applicability of radiation-modified polyethylene, demonstrating improved physical, thermal, and mechanical properties. Stable radiation crosslinking regimes (75–150 kGy) increased the degree of crosslinking from ~70% to ~80%, enhanced property stability, reduced internal stresses, and ensured an extended service life of polyethylene pipes at operating temperatures up to 95° C, supported by laboratory and full-scale testing.
In 2025, the project moved to the implementation and commercialization stage according to the approved technological and economic plans. The main work focused on scaling the radiation crosslinking technology from pilot to industrial level. This included optimization of irradiation parameters at the ELV-4 electron accelerator, adjustment of processing conditions for industrial pipe sizes, and preparation of technological guidelines for radiation modification of polyethylene pipes.
At the same time, economic and marketing activities were carried out. The target market was analyzed, and construction, heating, and water supply companies were identified as the main customers. A comparison with existing metal and polymer pipes showed clear advantages of radiation-modified pipes in service life, operating temperature, corrosion resistance, and overall cost. A basic business model and sales strategy were prepared to support the launch of industrial production and market entry.

Future plan (<10 lines)
In 2026, the project will focus on commissioning industrial equipment, launching pilot and serial production of radiation-modified polymer pipes for hot water supply, and completing certification and regulatory approval procedures. In 2027, planned activities include expansion of production capacity, market scaling within Kazakhstan, entry into regional markets, and further improvement

of product characteristics based on operational feedback, ensuring sustainable commercialization and long-term industrial implementation of the technology.

Check R&D subject(s) that apply.
☐1. Agricultural Bio-stimulant
☑2. Environmental Remediation
☑3. Medical and Biological Application

Name: Maznah Mahmud; Sarada Idris (Malaysia)
Affiliation: Radiation Processing Technology Division, Malaysian Nuclear Agency

Short summary (~5 lines)

Two new research projects are planned for 2026. The first aims to address a critical environmental challenge i.e the heavy-metal contamination in agricultural and industrial wastewater, by developing a cost-effective and biodegradable absorbent derived from degraded chitosan. The second project will focus on engineering biosynthetic scaffolds for three-dimensional tissue culture which will offer a compatible micro-environment and structural support to facilitate the formation of intact and viable spheroids.

Results (15~20 lines)

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Future plan (<10 lines)

An appropriate methodology of synthesis and physicochemical characterization of gamma-degraded chitosan in various forms, including beads, using techniques such as FTIR and FESEM. Key objectives include detailed studies to evaluate adsorption performance for metals such as lead and cadmium across a range of conditions, such as pH and contact time. Ultimately, the research aims to provide practical recommendations for process improvement, offering sustainable pathways to control pollution and converting waste into high-value products.

The scaffold will be fabricated through the copolymerization of natural and synthetic polymers induced by gamma irradiation. Carrageenan, PVA, and PDMS will serve as the primary components in the formulation. The aim of this project is to develop a robust 3D tissue-culture template capable of withstanding prolonged exposure to growth media while supporting the formation and maintenance of intact, viable spheroids

Check R&D subject(s) that apply.
☑1. Agricultural Bio-stimulant
☐2. Environmental Remediation
☐3. Medical and Biological Application

Name: Maznah Mahmud, Sarada Idris, Norhashidah Talip (Malaysia)
Affiliation: Radiation Processing Technology Division, Malaysian Nuclear Agency, Bangi, 43000 Kajang, Selangor.

Short summary (~5 lines)

Nuclear Malaysia has conducted a study on the effects of fertilizers and plant growth promoter (CarraPGP) on greenhouse gas (GHG) emissions in the NMR152 rice-field ecosystem. The findings demonstrated that the application of PGPs reduced GHG emissions compared to the use of chemical fertilizers alone, without compromising crop productivity. The combined application of PGPs and chemical fertilizers improved nutrient absorption efficiency and enhanced the decomposition of organic matter.

Results (15~20 lines)

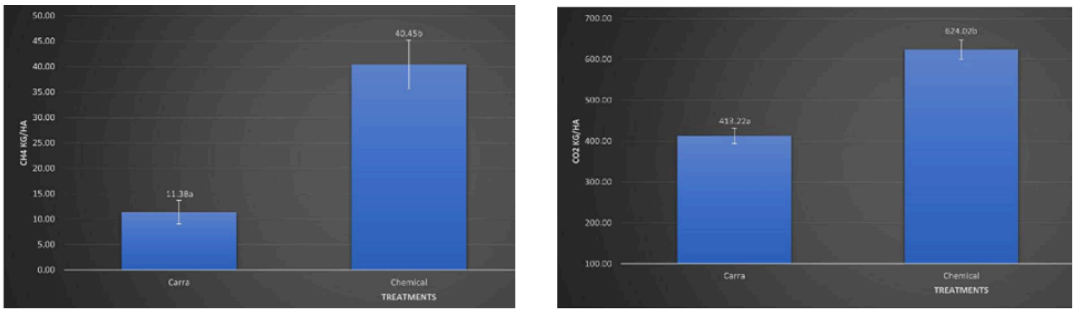

Figure 1. The cumulative emission of CH4 gas (left) and CO2 gas (right) from the rice ecosystem after treated with chemical fertilizer and CarraPGP

Figures 1 presents the cumulative CH_4 and CO_2 emissions, respectively from the rice-plot ecosystem over the period from planting to harvesting. The CarraPGP treatment did not receive any chemical fertilizer, the plants relied solely on the nutrients and minerals already present in the soil. In contrast, the Chemical treatment received only chemical fertilizer and was not supplemented with any growth promoter.

Chemical fertilizer can increase methane emissions by stimulating the growth of methanogenic microbes in anaerobic soil, which accelerates the decomposition of organic matter and thereby boosts methane production. Chemical fertilizer generates CO_2 emissions during its production because fossil fuels are burned in the manufacturing process. Once applied to soil, the fertilizer stimulates microbes and plant roots to break down soil organic matter more quickly. Thus, this accelerates decomposition and respiration releases additional CO_2 from the soil into the air

The CarraPGP treatment resulted in lower CH_4 and CO_2 emissions compared with the Chemical. Although low-molecular-weight carrageenan (LMC) is known mainly as a plant growth stimulant, elicitor and soil stabilizer, no published study currently demonstrates that LMC directly reduces methane emissions. As a soil stabilizer, however, LMC could improve soil aeration, shift microbial communities and thus potentially enhance methane-oxidizing microbial activity. Regarding CO_2 emissions, LMC may improve nutrient uptake, stress

tolerance and crop yield and reduce reliance on chemical fertilizers, the factors that might lower overall GHG emissions. Nevertheless, there is no definitive evidence that LMC alone reduces CO_2 emissions in agricultural systems. Based on our results, applying CarraPGP may support climate-smart farming and carbon-mitigation goals by lowering GHG emissions without noticeably sacrificing productivity. Refer to Figure 2 and Table 1.

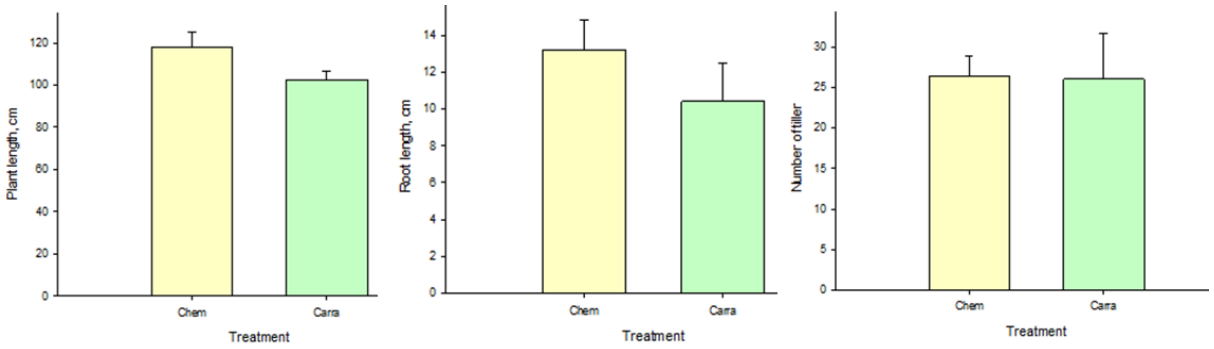

Figure 2. The effect of Chemical fertilizer vs CarraPGP on plant length (left); root length (middle) and number of tiller (right) on rice (NMR 152)

Average 1000 grains, g	
Chem	**Carra**
28.956	28.997

Future plan (<10 lines)

1. Conduct effect of combination treatment chemical fertilizer, CarraPGP, NM Oligochitosan and liquid organic fertilizer particularly reagarding GHG emission.
2. It is now ready for scale-up production. Since scaling up may require some time, its application should also be explored across other crops.
3. Participating in exhibitions will provide a platform to showcase the technology and products, while the community outreach program organized by the ministry offers an alternative way to introduce the technology to the public

Check R&D subject(s) that apply.
☐1. Agricultural Bio-stimulant
☐2. Environmental Remediation
☒3. Medical and Biological Application

Name: Chinzorig Radnaabazar (Country) Mongolia
Affiliation: Associate professor at National University of Mongolia

Short summary (~5 lines)

This study analyzed aflatoxin M1 (AFM1) in Mongolian dried curd and milk and tested X-ray irradiation for toxin reduction. Homemade dried curd showed significantly higher AFM1 levels, with 80% exceeding safety limits. X-ray treatment reduced AFM1 by up to 21% in dried curd and 23% in milk. However, high radiation doses caused nutrient loss. A 3 kGy dose was identified as the optimal method for improving food safety while preserving quality.

Results (15~20 lines)
Homemade dried curd contained significantly higher AFM1 levels (67.65 ± 28.13 ng/kg) compared to commercial samples (37.58 ± 17.07 ng/kg), and 80% of homemade products exceeded the regulatory limit of 50 ng/kg. Industrial and household milk showed low contamination (3.4 ± 2.8 and 5.7 ± 0.9 ng/L, respectively).

X-ray irradiation reduced AFM1 in dried curd by 3.8% (1 kGy), 14.4% (3 kGy), and 21% (5 kGy), and in milk by 7%, 11%, and 23%, respectively. Microbial load also decreased sharply with irradiation, particularly at 3–5 kGy. Sugar and protein content declined with increasing dose, indicating nutritional loss at 5 kGy, while antioxidant activity remained unchanged.

Overall, 3 kGy was identified as the most suitable dose, effectively reducing AFM1 and microbes while better preserving nutrients.

Future plan (<10 lines)

Further work will include collecting more dried curd samples from local markets to confirm the current findings. Irradiation doses between 1–5 kGy will be slightly adjusted to better determine the optimal treatment point. Simple microbial tests and short-term storage observations will be added to evaluate stability after irradiation. These steps will help improve the practical application of X-ray treatment for safer dried curd.

Check R&D subject(s) that apply.
☐1. Agricultural Bio-stimulant
☐2. Environmental Remediation
☒3. Medical and Biological Application

Name: Charito T. Aranilla

Affiliation: Philippine Nuclear Research Institute, Department of Science and Technology (Public Organization)

Short summary (~5 lines)
Investigational CMC granules and gauze hemostat devices for clinical trial use were successfully produced at a local GMP-certified toll manufacturer for medical devices. Crosslinking was achieved via gamma irradiation at 40 kGy. The resulting crosslinked CMC hydrogels exhibited a 40.0% gel fraction and a swelling capacity of 340 g water per gram of dry material. Sterilization was performed using electron beam irradiation at a dose of 25 kGy. The hemostats were characterized for gel fraction, swelling capacity, blood clotting index, and cytotoxicity. For pilot-scale production activities, collaboration with a private E-beam company has been initiated.

Results (15~20 lines)
The production of CMC granules and gauze investigational devices at Lynx-Nia Medica, Inc. was successfully completed. A total of 200 units each of the CMC granule and gauze hemostats were produced from 50 kg of CMC paste, which was crosslinked by gamma irradiation at a dose of 40 kGy. The resulting crosslinked CMC hydrogel was characterized in terms of gel fraction and swelling capacity, yielding values of 40.0% and 340 g water/g dry gel, respectively. These results demonstrate that the gel properties are comparable to those obtained at the laboratory scale (39.6%, 249 g water/ g dry gel). The crosslinked CMC gel was cut, dried, ground, and sieved to obtain particles with sizes between 0.6 and 1.0 mm. The granules were packed at 15 grams per pouch. The gauze hemostat was prepared by embedding 8 grams of granules into an 8″ × 8″ pre-cut gauze, which was then individually packed in foil pouches. The average bioburden or microbial load was determined using ten (10) representative samples per device type. The mean bioburden per sample was 19.7 CFU for granules and 87.3 CFU for gauze. Since both values were below the 1000 CFU/sample threshold, sterilization was performed at a dose of 25 kGy following ISO 11137-2 guidelines. All samples were sterilized using the 2-MeV electron beam facility of PNRI. After sterilization, sterility tests were conducted on ten (10) samples of each device type. Each sample was immersed in Tryptic Soy Broth (TSB) and incubated for 14 days at 35 °C. For the gauze samples, no turbidity was observed throughout the incubation period, indicating sterility. For the granules, slight turbidity appeared in Sample 1 (Day 12**)** and Sample 7 (Day 11)**.** This was suspected to be caused by hydrogel components diffusing out of the tea bag rather than microbial contamination. To verify this, Samples 1 and 7 were subjected to the Spread Plate Technique**,** and no colony-forming units (CFUs) were observed after 48 hours of incubation. The hemostat devices demonstrated good biocompatibility and efficacy. The cytotoxicity potential of the hemostatic devices was evaluated using the MTT assay**,** conducted through an outsourced testing laboratory. Results showed that cells incubated with extracts from both the granule and gauze-type hemostats exhibited high viability. The cell viability of the granule hemostat was 96%**,** while that of the gauze hemostat was 85%. According to ISO 10993-5: Biological Evaluation of Medical Devices – Tests for In Vitro Cytotoxicity, a cell viability greater than 70% indicates that the

material is non-cytotoxic. These results therefore confirm that both hemostat prototypes possess no cytotoxic potential and are biocompatible under the test conditions. The blood clotting index (BCI) of the granules was below 10% indicating high clotting ability. These values were comparable to the laboratory data obtained in the R&D phase.

A collaboration with Irradiation Services Inc., the first private E-beam company in the Philippines, was initiated for the pilot-scale crosslinking of the hemostats. Dose-mapping experiments were conducted to establish the appropriate radiation processing parameters and product configuration.

Future plan (<10 lines)

Conduct 15-kg and 30-kg scale productions, with three batches per production scale. Establish the radiation sterilization dose of the devices. Determine the shelf life of the hemostat devices through real-time and accelerated aging studies. All aged samples will be evaluated for sterility, blood clotting activity, gel fraction, and swelling capacity.

Check R&D subject(s) that apply.

☒1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☐3. Medical and Biological Application

Name: Thitirat Rattanawongwiboon, Theeranan Tangthong, Sakchai Laksee, Pattra Lertsarawut and Kasinee Hemvichian (Thailand)

Affiliation: Thailand Institute of Nuclear Technology (Public Organization)

Short summary (~5 lines)
Thailand utilizes various forms of radiation-modified chitosan in agriculture and fisheries. In agriculture, irradiated chitosan serves as a plant growth promoter with antifungal activity, while radiation-assisted chitosan beads extend the shelf life of fruits and vegetables, and an intelligent chitosan-based film helps preserve freshness and indicate ripeness. All products have been successfully developed as laboratory-scale prototypes. In fisheries, high-molecular-weight chitosan is degraded using gamma irradiation and hydrogen peroxide to produce low-molecular-weight chitosan for aquafeeds. Feeding trials in Nile Tilapia demonstrated enhanced immunity, improved antioxidative status, higher survival rates, and reduced health-maintenance costs, supporting long-term sustainability.

Results (15~20 lines)
In agriculture, several forms of radiation-modified chitosan were successfully developed and applied. First, irradiated chitosan used as a plant growth promoter demonstrated significant enhancement in the growth of horticultural crops such as Saneh Jaan and Thai chili plants, along with strong antifungal activity. Second, chitosan beads produced through radiation-assisted encapsulation effectively extended the shelf life of fruits and vegetables. Antimicrobial tests showed that active compounds encapsulated within the beads inhibited *E. coli* for up to 12 hours. Shelf-life studies in Brussels sprouts further confirmed that the beads retained the active compounds efficiently, resulting in significantly lower weight loss compared with the control. Third, a radiation-modified intelligent chitosan coating film was developed, which prolonged the freshness of tomatoes and lychees while providing a visual indication of ripeness.

In aquafeeds, a different form of radiation-modified chitosan was prepared by degrading high-molecular-weight chitosan using gamma irradiation combined with hydrogen peroxide (H_2O_2). This process efficiently produced low molecular weight chitosan, which exhibited strong immunonutritional effects in Nile tilapia (*Oreochromis niloticus*), including enhanced immunity, improved antioxidative status, and increased disease resistance. These results highlight the versatility of radiation technology in tailoring chitosan structures for diverse applications and support the use of low molecular weight chitosan as a cost-effective alternative for sustainable aquaculture.

Future plan (<10 lines)

1. The chitosan-based plant growth promoter, chitosan beads, and chitosan coating film for prolonging the freshness of fruits and vegetables will progress toward further validation and performance assessment in relevant agricultural systems.

2. The chitosan-based aquafeed will be evaluated through field trials in Nile tilapia and subsequently expanded for application in white shrimp culture.

Check R&D subject(s) that apply.

☒1. Agricultural Bio-stimulant

☐2. Environmental Remediation

☐3. Medical and Biological Application

Name: Dang Van Phu, (Vietnam)

Affiliation: Research and Development Center for Radiation Technology, VINATOM.

Short summary

Vietnam has been researching the radiation-based polymer modification to create advanced materials. Notably, in agriculture, bioactive substances from natural polysaccharides and hydrogel materials from biodegradable polymers have been manufactured and applied in practice. Furthermore, the technology has also been exploited to fabricate cell culture scaffolds and recycle plastic waste, thereby demonstrating its diverse and versatile potential.

Results

Up to now, Vietnam has achieved significant results in the research and application of radiation technology in agriculture and related fields:

Plant growth stimulants and bio-fertilizers have been successfully manufactured using radiation technology for modifying biopolymers into biologically active compounds, specifically plant growth promoters (PGPs) and plant defense promoters (PDPs), for agricultural use. A notable achievement is the commercial production and distribution (10 - 20 m^3/year) of oligochitosan-based preparations for disease resistance (RIZASA), oligoalginate-based growth stimulants (T&D), and oligoxanthane-based foliar fertilizers and slow-release formulations (Rapol V, Rocket 123). Superabsorbent hydrogels based on the modified starch using irradiation techniques were successfully fabricated under the trade name Gam-sorb S. The product has a high water-holding capacity, enabling it to regulate soil moisture levels, minimize nutrient loss, thereby enhancing fertilizer use efficiency and increasing crop yield (with current production and distribution estimated at ~1 ton/year).

Additionally, the radiation processing and polymer modification have been applied to crosslink natural polymers (CM-chitosan, CM-chitin, gelatin), fabricating biocompatible scaffolds suitable for tissue engineering. Concurrently, the approach has also been feasible in modifying or degrading synthetic polymer waste, thereby supporting recycling and environmental sustainability efforts. These results confirm the effectiveness of radiation processing in creating high-value materials for agriculture, the environment, and biomedicine.

Future plan

In the future, focus on perfecting the industrial processes of manufacturing radiation-modified polymer materials and licensing the products. Elevate technology and product transfer to mass production in agriculture. At the same time, continue research to optimize scaffold materials, develop solutions for recycling plastic waste on an industrial scale, and expand radiation applications in other potential fields. Collaboration under the FNCA framework will be strengthened for joint studies and pilot-scale demonstrations.