

Ionizing Radiation as a New Technique for Treating Sewage Wastewater and Sludge in Arid Regions

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Introduction

- Among all wastes, sewage water and sludge are the most hazard waste as it contain several contaminants which adversely affect the environment and human health
- However, if they properly treated they can be the most beneficial waste for reuse in agriculture land
- Agriculture soil has always been the disposal site for sewage water and sludge (biosolid) in many countries in the world. This is the best recycling option
- Sewage wastewater had been used in irrigation without treatment in a large number of countries. This practice is not accepted from environmental and health point of view
- Crops irrigated with sewage water or fertilized with sludge and consumed uncooked induce health hazard because of the accumulation of heavy metals, toxic organic pollutants and nitrate

Harmful Effect of Using Sewage Water and Sludge without proper treatment

- Harmful pathogens cause several human diseases (Cholera, Fever, Diarrhoea, Ascariasis, Respiratory illness)
- Heavy metals cause human diseases (Cd impair kidney function and cause bone diseases, Pb cause brain damage, Nickel cause cancer, allergy and respiratory disorder, Arsenic is associated with skin, bladder, liver and colon cancer)
- Toxic organic compounds cause cancer to human
- High BOD and COD are indication of water pollution

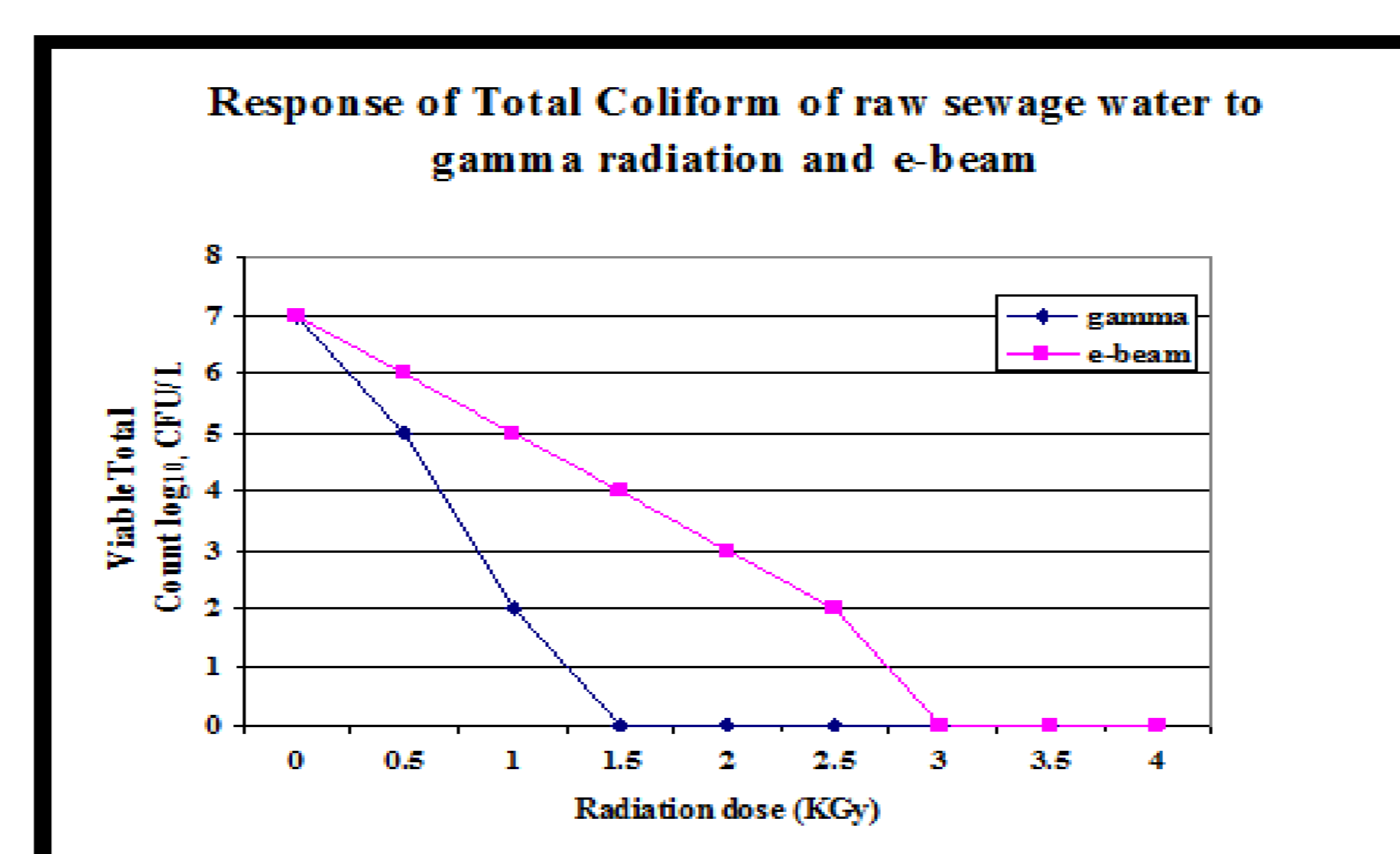
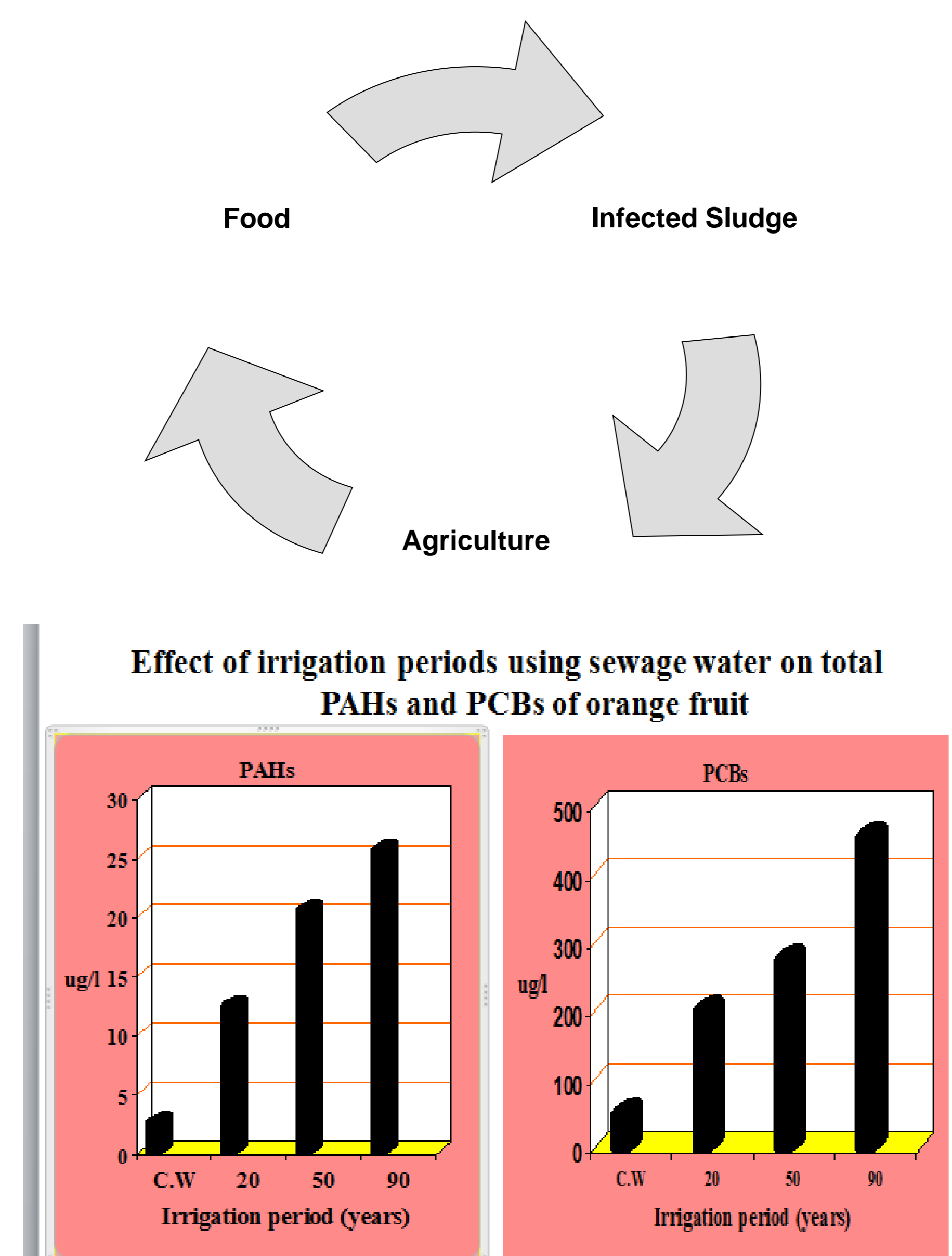
Justification for Reuse of Sewage Water and Sludge in Arid Region

- Shortage in conventional water resource
- Particularly, in arid and semi-arid regions of the world, the reuse of treated sewage water in irrigation can partially help solving the problem of water scarcity and sewage water disposal
- Reclamation of the desert soil require water, nutrients and organic matter , sewage water and sludge can provide such constituents
- Low concentration of heavy metals due to low heavy industrial activities in our region
- The soils in arid and semi-arid region are high in CaCO₃ and pH is above 7 which render low heavy metals mobility and availability to crops
- Sludge is a soil conditioner which improve soil fertility and soil physical and chemical characteristics and yield.

Utilization of Radiation Technology in Sewage Water and Sludge Treatment

- Utilization of radiation technology in controlling environmental pollution has become a new area since the last four decades
- Gamma radiation and electron beam has been recently introduced for sewage water and sludge treatment
- Radiation method is gaining world wide recognition as a means of improving sewage water and sludge quality by pathogens disinfection, organic pollutants degradation, reduction in BOD, COD and TSS, reduction in soluble heavy metals, reduction in NO₃ and reduction in odor
- Radiation prevent the problem of pathogens regrowth
- Radiation treatment has proved to be more effective than the conventional method

Contaminants Transfer from wastewater and sludge into the food Chain



Growing Ornamental Plants Using Irradiated Sewage Sludge



Reduction of soluble heavy metals of raw sewage water as a result of radiation treatment

Gamma radiation					Electron beam				
Treatments (KGy)	Cd	Pb	Co	Ni	Treatments (KGy)	Cd	Pb	Co	Ni
(ppb)									
control	0.02	0.50	3.30	19.5	control	0.02	0.50	3.30	19.5
0.5	0.00	0.00	3.28	18.4	0.5	0.00	0.08	3.20	18.0
1.0	0.00	0.00	3.24	17.5	1.0	0.00	0.00	3.17	17.5
1.5	0.00	0.00	3.24	16.2	1.5	0.00	0.00	3.10	17.0
2.0	0.00	0.00	3.02	13.7	2.0	0.00	0.00	3.05	16.0
2.5	0.00	0.00	2.80	13.2	2.5	0.00	0.00	2.97	15.4

Reduction of BOD and COD in raw sewage water as a result of radiation treatment

Gamma radiation					Electron beam				
Treatment (Kgy)	BOD (mg/L)	% red.	COD (mg/L)	% red.	Treatment (Kgy)	BOD (mg/L)	% red.	COD (mg/L)	% red.
Control	190		370		Control	190		370	
0.5	85	55	220	41	0.5	106	44	250	32
1.0	71	63	175	53	1.0	91	52	245	34
1.5	69	64	170	54	1.5	90	53	235	36
2.0	64	66	170	54	2.0	85	55	230	38
2.5	64	66	155	58	2.5	83	56	210	43

Effect of gamma radiation on PAH in sewage sludge

Dose (KGy)	PAH (mg/kg)	% Reduction
0	29.0	
2	13.7	53
4	10.1	65
6	7.2	75
8	6.8	77
10	6.1	79

Advantage of electron beam

- High capacity per unit time
- The Energy can be switched off
- It needs no radioactive materials
- Low energy consumption
- Easy operation and low cost
- Fast and safe

Advantage of gamma radiation

- Excellent penetration power
- Environmentally clean
- Uniform Dosage in the Materials
- Complete Disinfection
- Small Energy Consumption
- Neither toxic chemicals nor residual radioactivity are produced in the material
- Radiation can replace chloronation

Summary of Main Results

- Irradiated sewage sludge is a good source of organic matter and plant nutrients for sandy and calcareous soils, major soils in Egypt
- Irradiated sewage sludge resemble a slow release fertilizer capable for sustaining crop production without harming the environment
- Trees grown under untreated sewage water irrigation system resulted in accumulation of heavy metals (Cd, Pb, Ni, Co) and toxic organic pollutants (PAHs and PCBs) in fruits
- The transfer of such pollutants into the food chain represent hazard to human health
- Ionizing radiation resulted in pathogen elimination (bacteria, parasites, virus), organic pollutant degradation, reduction in sewage water BOD and COD and reduction in soluble heavy metals
- The best radiation dose for pathogens disinfection is 1 KGy and 6 KGy for sewage water and sludge, respectively
- Composted irradiated sewage sludge is an excellent media for growing ornamental plants and fruit trees

Recommendation

- A policy including banding the utilization of raw sewage water in irrigation of edible crops should be implemented in order to avoid the adverse effect on the environment, fruit quality and human health
- The reuse of treated sewage water and sludge is a must in arid and semi-arid region to insure water and food security
- Establish standards, regulations and strategy for sewage wastewater and sludge reuse
- Irradiated Egyptian domestic sludge is a potential fertilizer for sandy and calcareous soils without a need for mineral fertilizer. It is a source of organic matter and nutrients in addition it contain minimum amount of heavy metals
- Radiation is a good tool for sewage water and sludge treatment.

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