POLYCARBONATE CHROMATOGRAPHY COLUMN TO BE USED IN A $^{99}MO/^{99M}TC$ GENERATOR IRRADIATED IN SALINE SOLUTION WITH ELECTRON BEAM AND GAMMA RAYS

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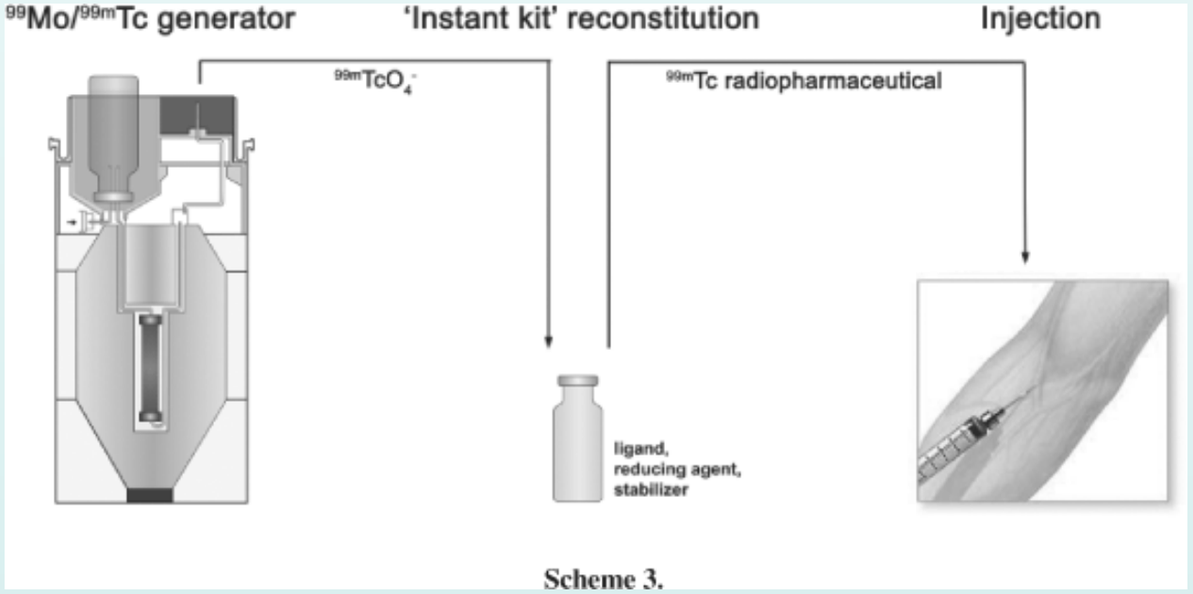
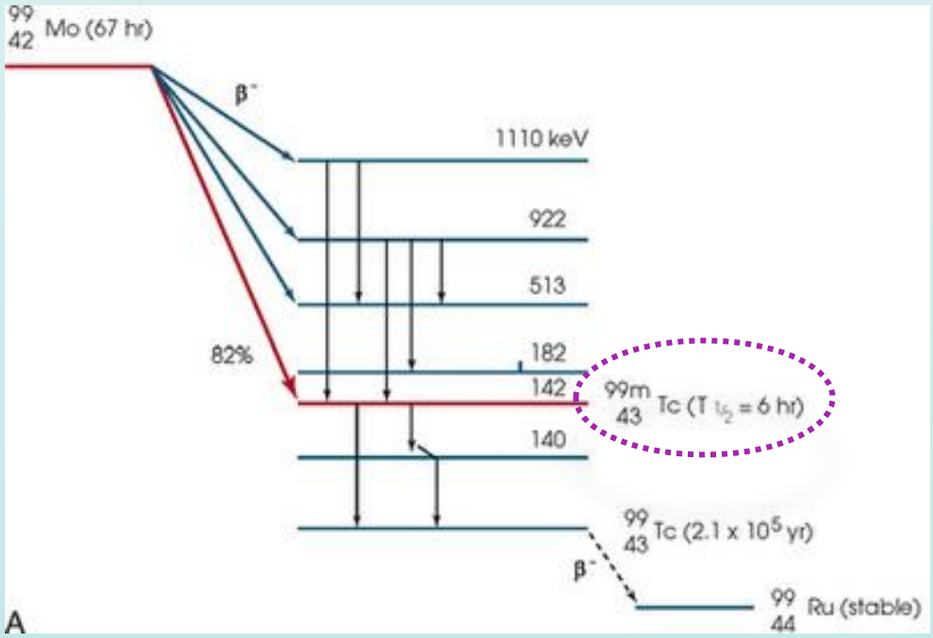
[2]Universidade Presbiteriana Mackenzie

^{99}MO/^{99M}TC GENERATOR (TECHNETIUM COW OR MOLLY COW)



Scheme 3.

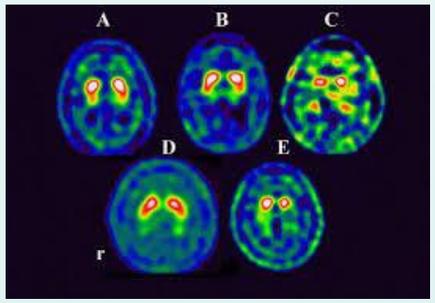
http://www.scielo.br/img/revistas/jbchs/v17n8/03s3.gif



http://radiologykey.com/wp-content/uploads/2016/03/B9780323073233500205_f34-05-9780323073233.jpg

http://www.nuclearonline.org/images/DOTgraphic.jpg

^{99}MO/^{99M}TC GENERATOR (TECHNETIUM COW OR MOLLY COW)



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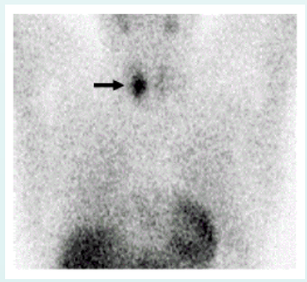

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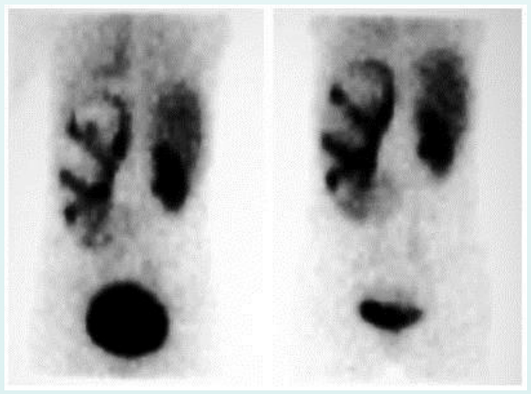

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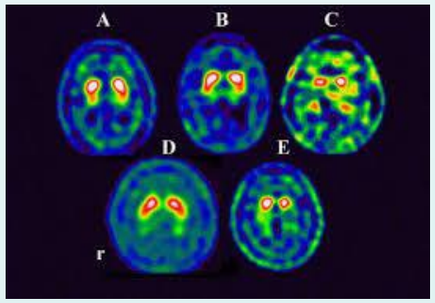
IN ADULTS

- ✓ brain imaging including cerebral radionuclide angiography;
- ✓ thyroid imaging;
- ✓ salivary gland imaging;
- ✓ placenta localization;
- ✓ blood pool imaging including radionuclide angiography;
- ✓ urinary bladder imaging (direct isotopic cystography) for detection of vesico-ureteral reflux; and
- ✓ nasolacrimal draining system imaging (dacryoscintigraphy)

^{99}MO/^{99M}TC GENERATOR (TECHNETIUM COW OR MOLLY COW)



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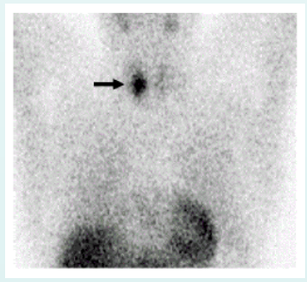

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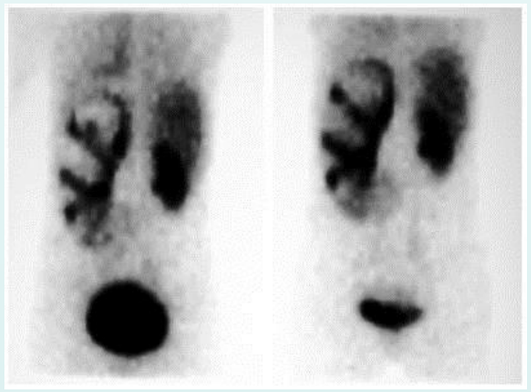

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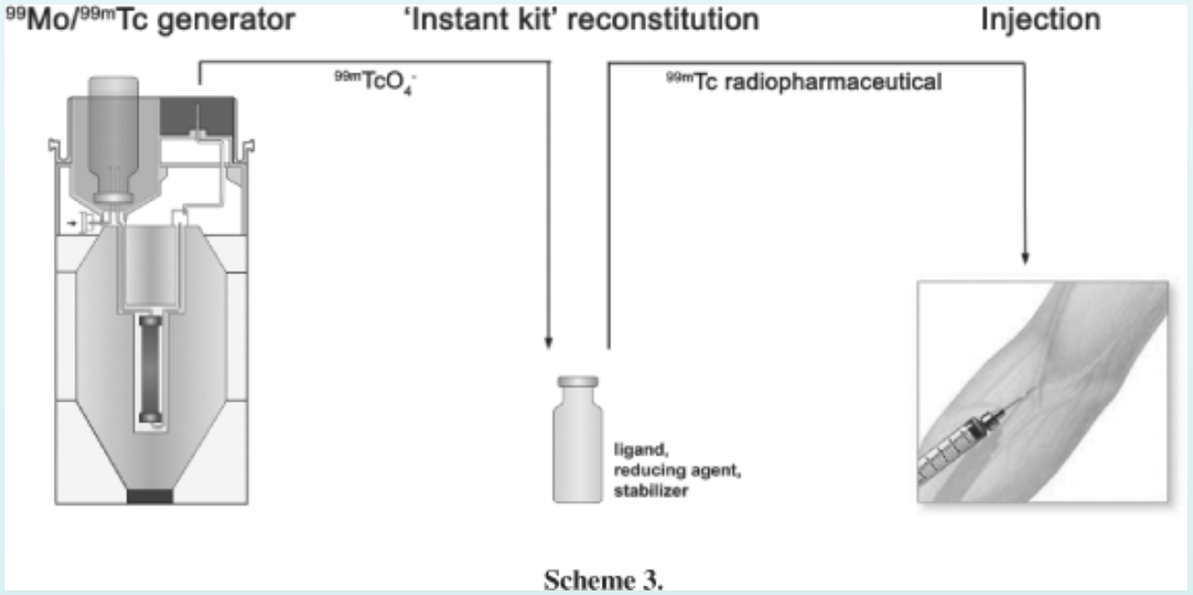
IN CHILDREN

- ✓ brain imaging including cerebral radionuclide angiography;
- ✓ thyroid imaging;
- ✓ blood pool imaging including radionuclide angiography; and
- ✓ urinary bladder imaging (direct isotopic cystography) for the detection of vesico-ureteral reflux.

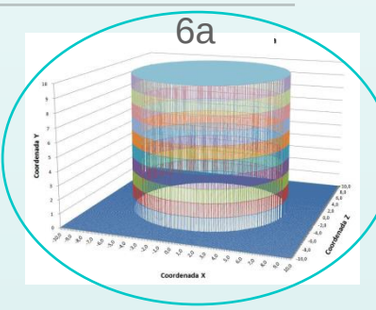
^{99}MO/^{99M}TC GENERATOR (TECHNETIUM COW OR MOLLY COW)

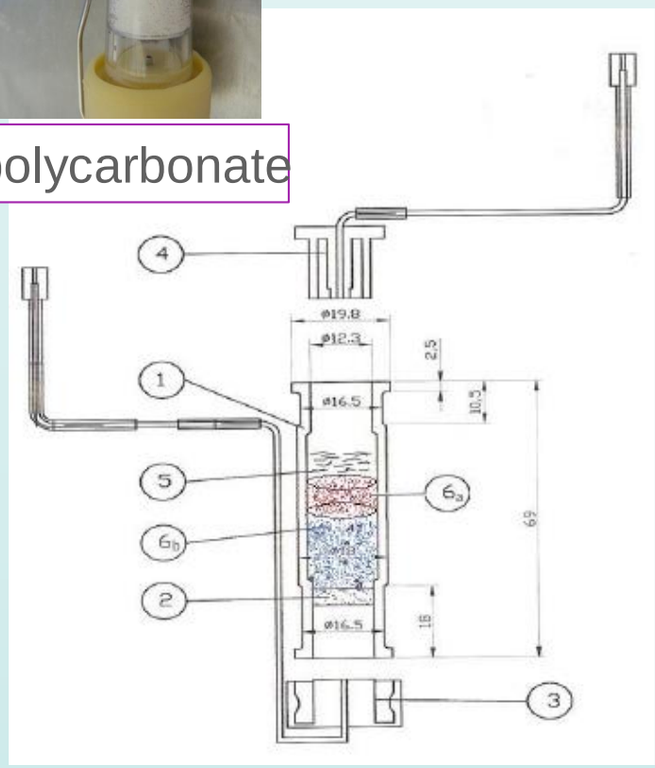


http://www.scielo.br/img/revistas/jbchs/v17n8/03s3.gif

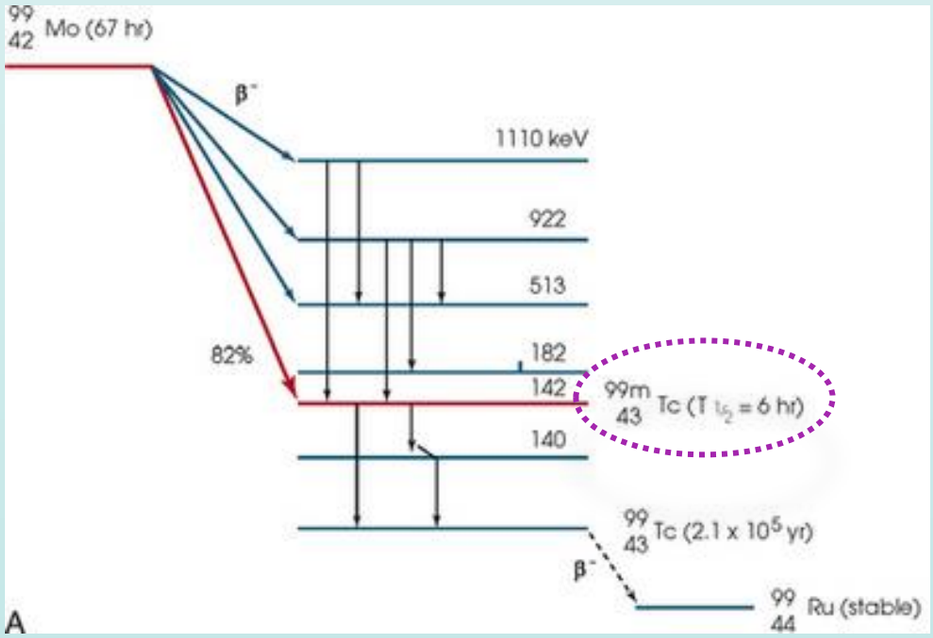
borosilicate type 1 glass

polycarbonate





Credit:Peterson Lima Squair

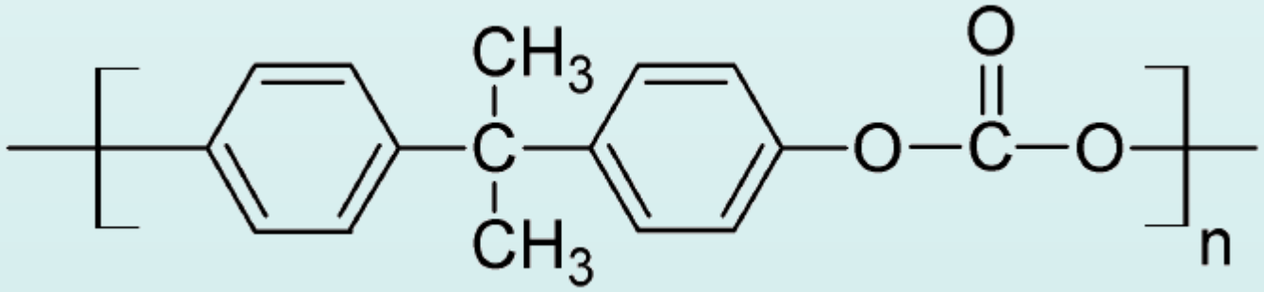


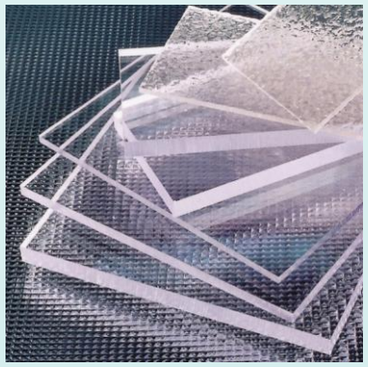
http://radiologykey.com/wp-content/uploads/2016/03/B9780323073233500205_f34-05-9780323073233.jpg

A_i=4263.1 mCi (3d 2000mCi)
Alumina – Al_2O_3 (stationary phase)
(r=7,0 mm e h=10 mm).
D= 631.1 kGy (β and γ)
^{99}Mo and ^{99m}Tc (equilibrium)

POLYCARBONATE (PC)

Polycarbonates (PCs) made from Bisphenol A, 4,4’-(1-methylhexylidene) bisphenol (BPA)





http://www.kiowa.co.uk/SupplyImages/WF00008/G_MPCS_hr.jpg

http://polycarbonate.kasuleimports.com.au/wp-content/uploads/2015/02/polycarbonate-roofing-panel-uv-protection-3682-5909017.jpg

http://www.medicaldesignbriefs.com/images/stories/mdb/2013/FEATURES/45609-161_fig1.JPG

https://oscarliang.com/ctt/uploads/2015/02/polycarbonate-application-items-product.jpg

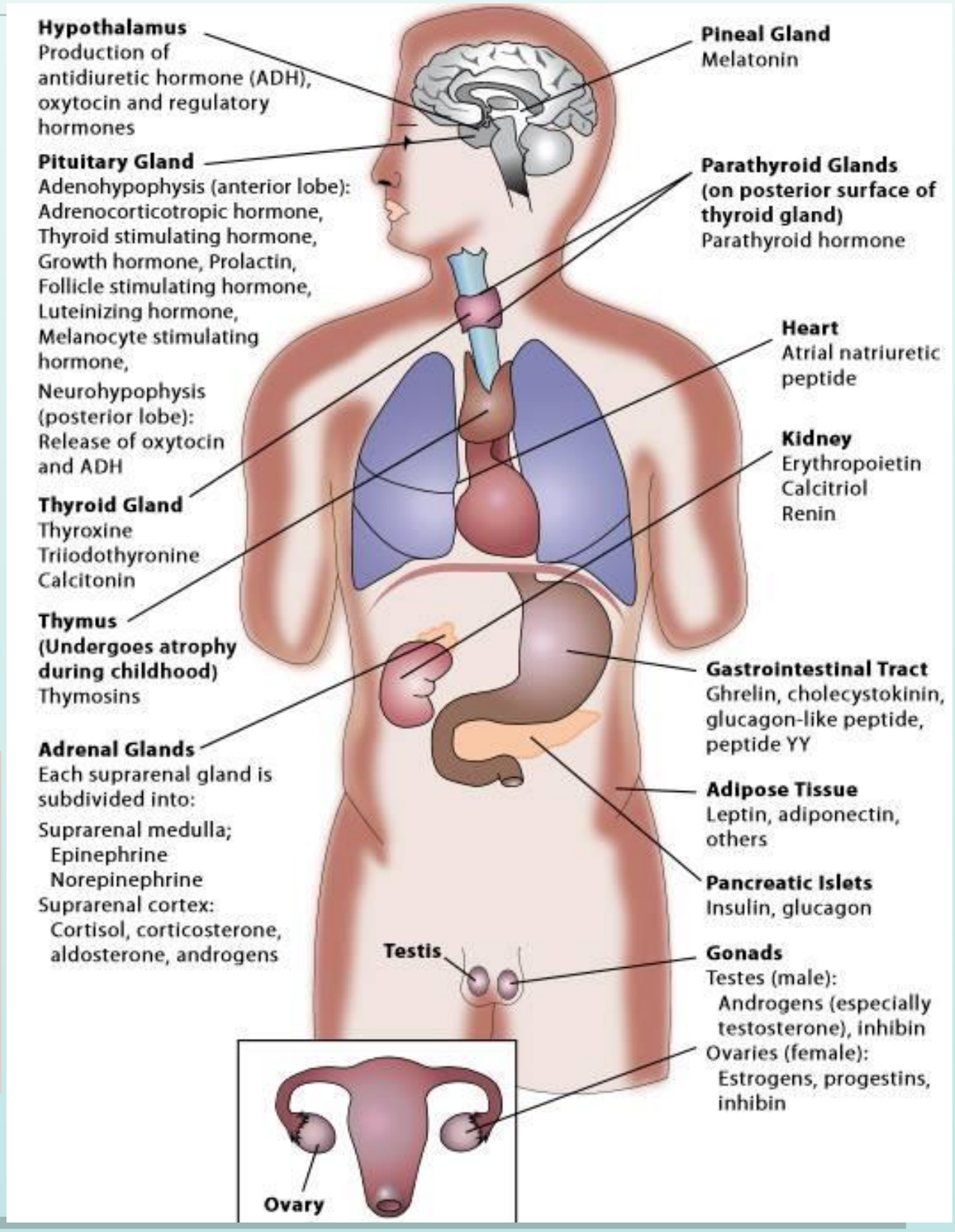
http://www.plasticseurope.org/documents/document/20130315162121-pc_bottles.jpg

http://www.dmcmedical.net/wp-content/uploads/polycarbonate-syringes.jpg

ENDOCRINE DISRUPTOR

"Natural or synthetic substances capable of disturbing endocrine functions through mimicking or blocking endogenous hormones are called endocrine disrupting chemicals or xenoestrogens".

Results of epidemiological surveys have showed toxic, endocrine, mutagenic and oncogenic action of BPA



http://sustainablenutritionlifestyle.com/wp-content/uploads/2014/01/The-endocrine-system-disruptors.jpg

Bisphenol A, BPA

NTP
National Toxicology Program
U.S. Department of Health and Human Services

Safe reference dose (RfD) of BPA for humans at 50 $\mu g kg^{-1} day^{-1}$

Usman & Ahmad (2016) reported an extensive review on toxicological profile of BPA the RfD reduced to 2 $\mu g kg^{-1} day^{-1}$

http://www.stecindia.co.in/img/Kitchenware/Gastronorm/Polycarbonate%20Pans%20and%20Covers.gif

Pedersen et al (2015) cited that levels of residual BPA in PC samples (food contact materials, plastics industry intended for food contact, medical applications or toys) were 5-80 µg/g.

For toys for children under 3 years and for toys intended to be put in the mouth an migration limit of 0.1 $\mu g\ L^{-1}$

http://www.lagunawholesale.com/assets/Image/Product/detailsbig/Henfamily.jpg

http://www.greenpeace.org/international/community_images/84/2284/119356_201458.jpg

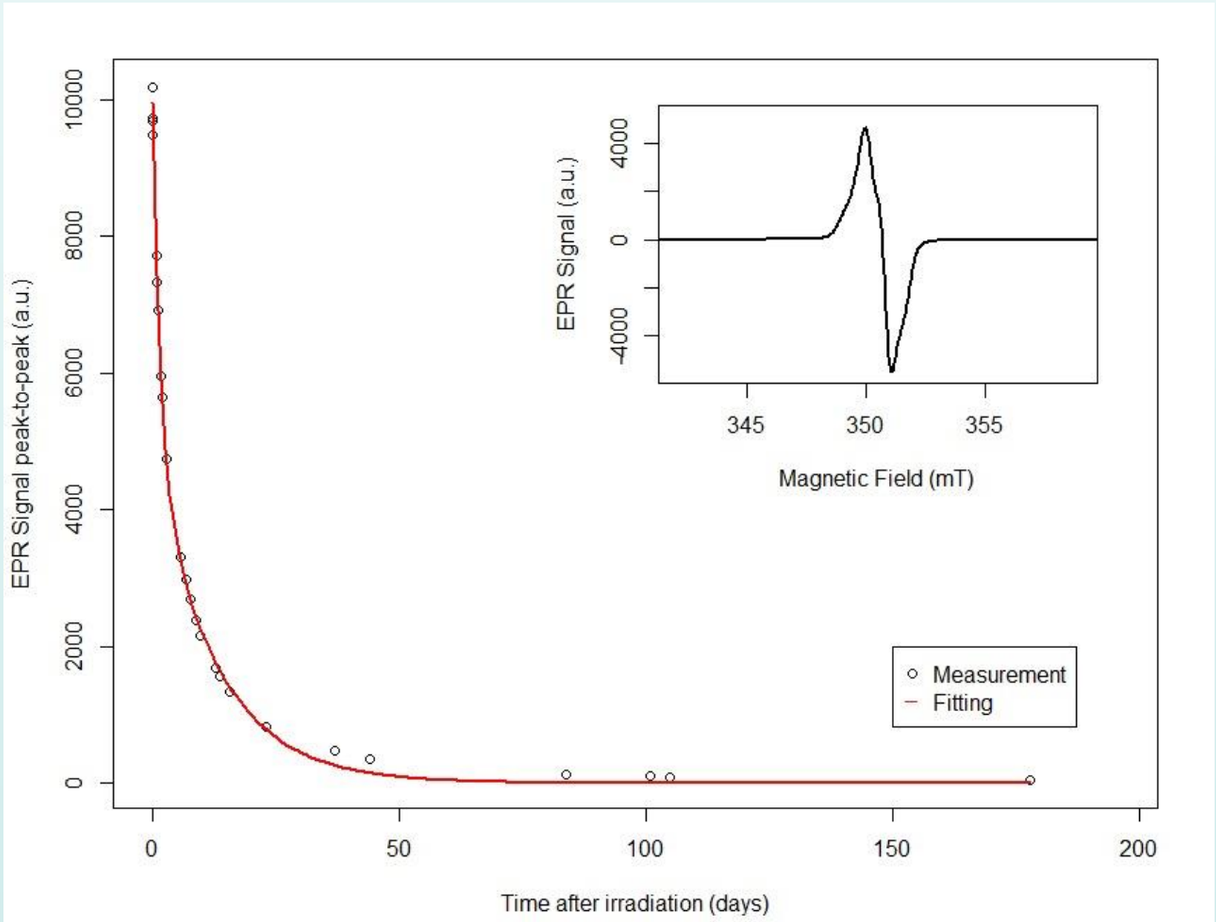
THIS STUDY...

- The goal of this study was to characterize the irradiated PC column in saline solution to simulate a $^{99}Mo/^{99m}Tc$ generator in real condition of use, taking into account that saline solution eluted in the PC column will be injected in patients of any age receiving ^{99m}Tc from ^{99}Mo generator.

METHODS

- Electron paramagnetic resonance spectroscopy (EPR)
- Infrared spectroscopy (FTIR)
- Ultraviolet spectroscopy (UV)
- Differential scanning calorimetry (DSC)
- Wide-angle X-ray diffraction (WAXD)
- Gamma irradiated PC column in presence of saline solution was studied using high performance liquid chromatography (HPLC) coupled with fluorescence detection in order to investigate the chemical phase diffusion of BPA from PC column.

PC phenoxyl radical decay as relative EPR signal intensity

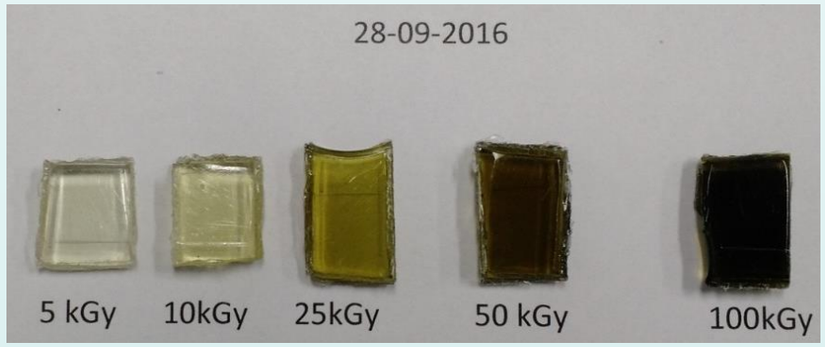


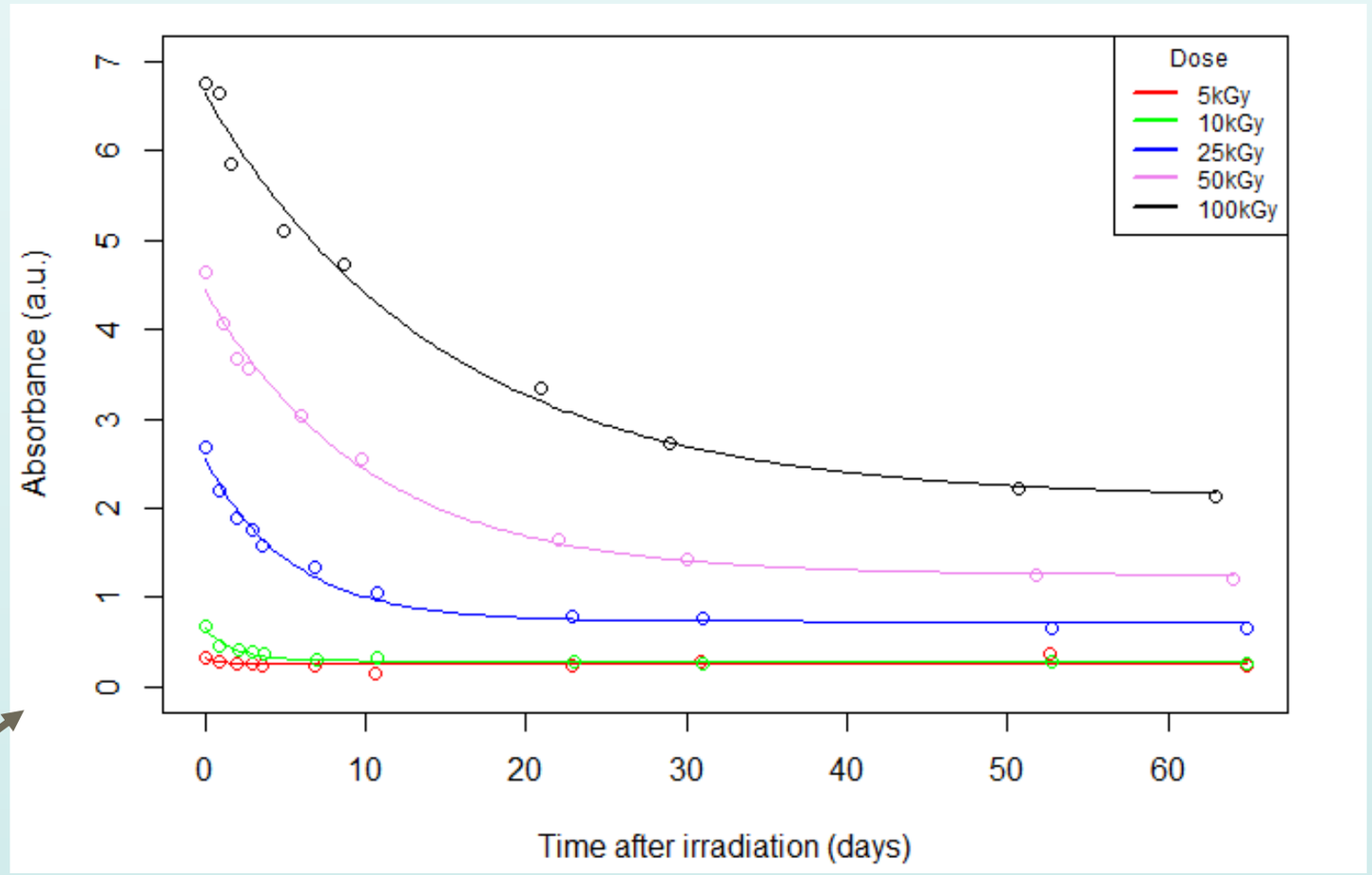
PC phenoxyl radical decay as relative EPR signal intensity at 0.35 T (peak-to-peak) after time of irradiation. Figure inset shows EPR spectrum of PC gamma irradiated in saline solution, first measurement (considered time=0).

Multipurpose Gamma Irradiator CTR-IPEN with absorbed radiation dose of 25 kGy, dose rate 15 kGy h^{-1}

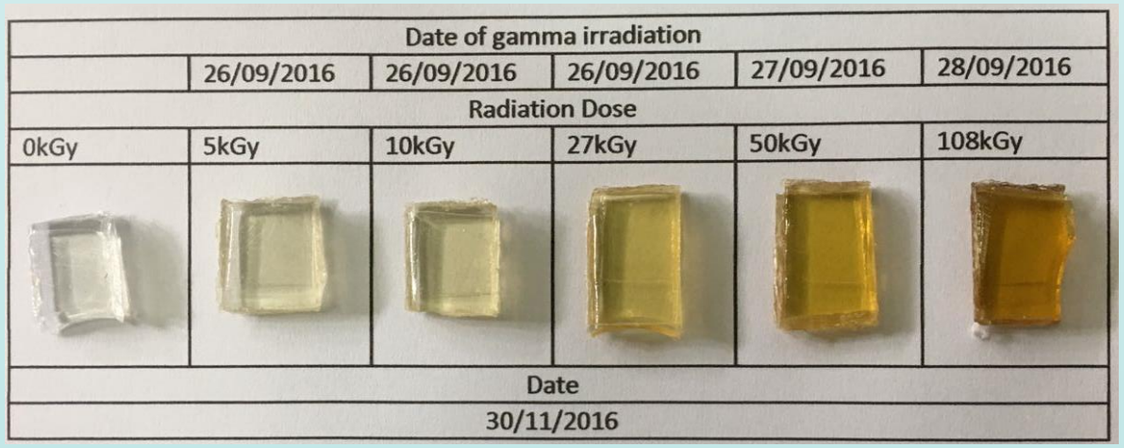
Bruker EMX spectrometer operating at X-band (9.8 GHz). Microwave power of 0.6325 mW, modulation amplitude of 0.4 mT, center field of 352.5 mT and sweep field of 50.0 mT.

UV-Vis relative absorbance variation with time after irradiation



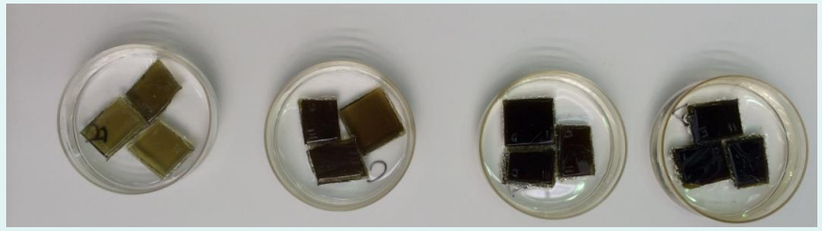


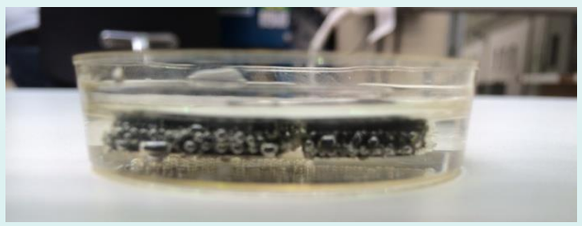
UV-Vis relative absorbance at 400-413 nm peak of gamma irradiated PC plates with radiation absorbed doses 5, 10, 25, 50, and 100 kGy.



FTIR, WAXD patterns, DSC results

FTIR Perkin Elmer, Spectrum 100, ATR

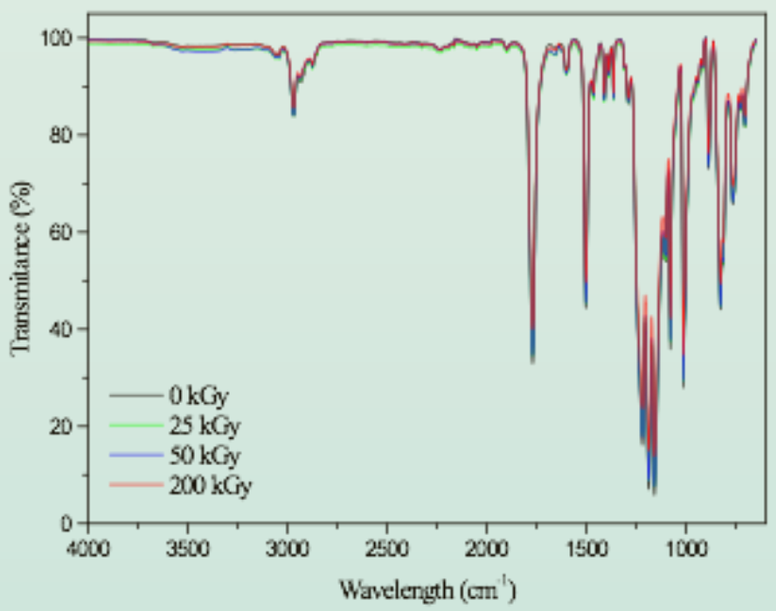




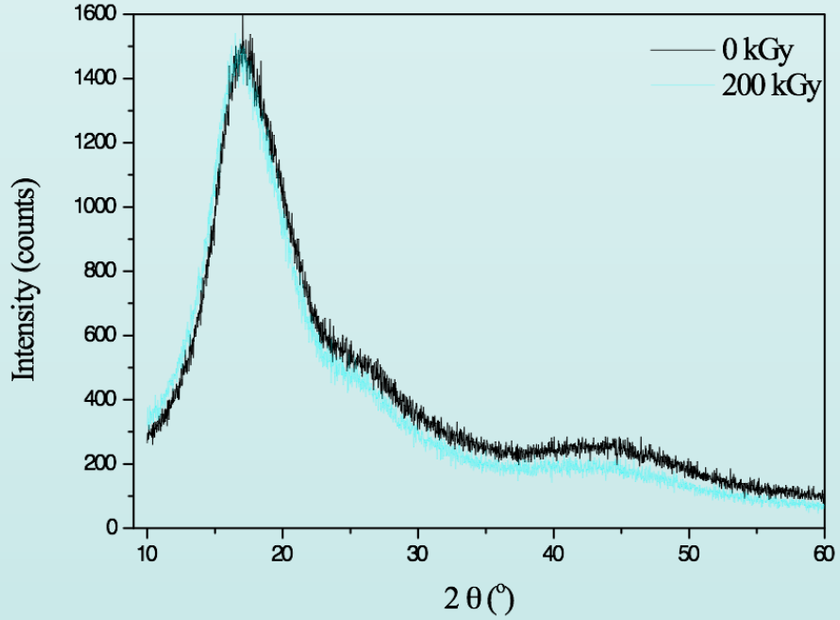
Rigaku Denki Co. Ltd., Multiflex model, Cu Ka radiation (l=1.5406 Å)

Dynamitron (E = 1.5 MeV) Radiation Dynamics, Inc. Doses of 25, 50 and 200 kGy,dose rate of 22.4 kGy s^{-1}

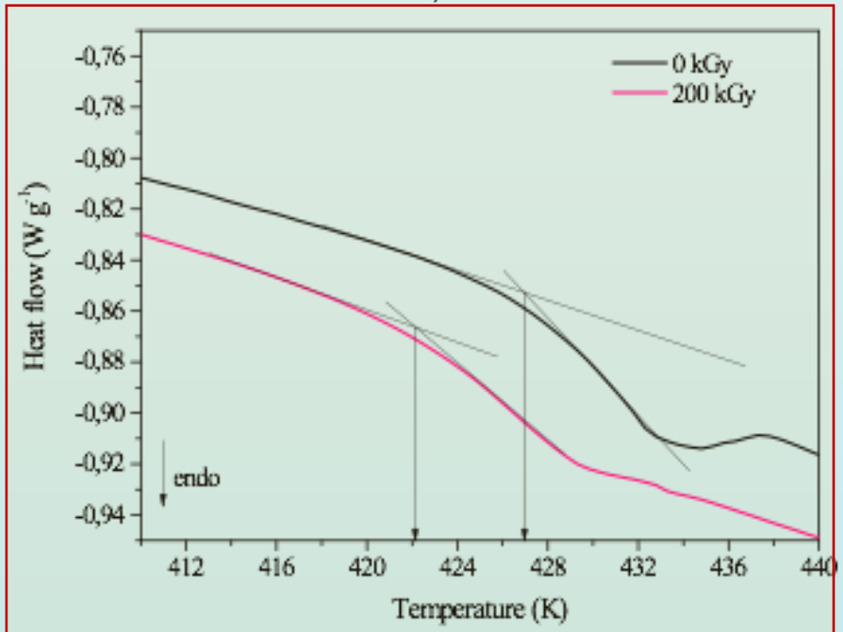
Mettler Toledo, DSC822e, 298 – 623 K, 10 K min^{-1}



FTIR spectrum of PC non-irradiated and EB irradiated with radiation absorbed doses of 25, 50 and 200 kGy.

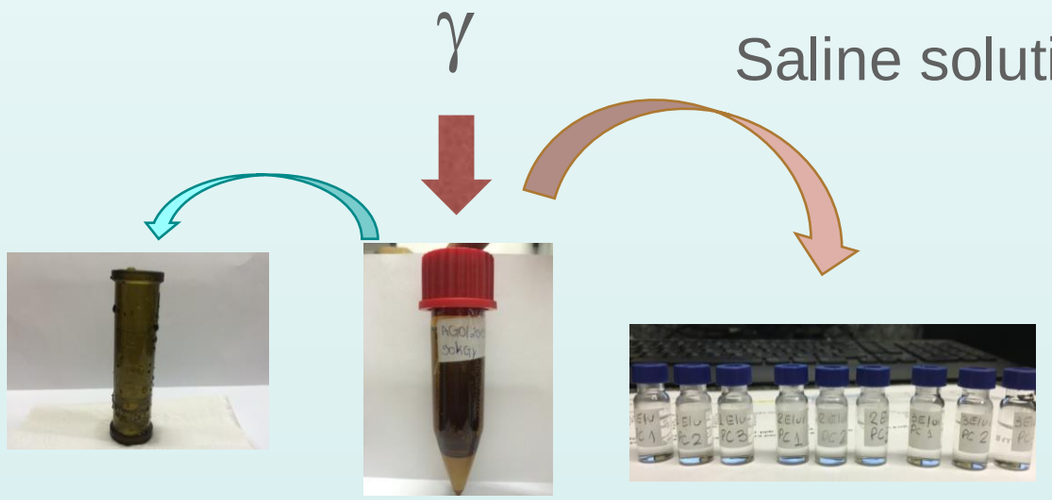


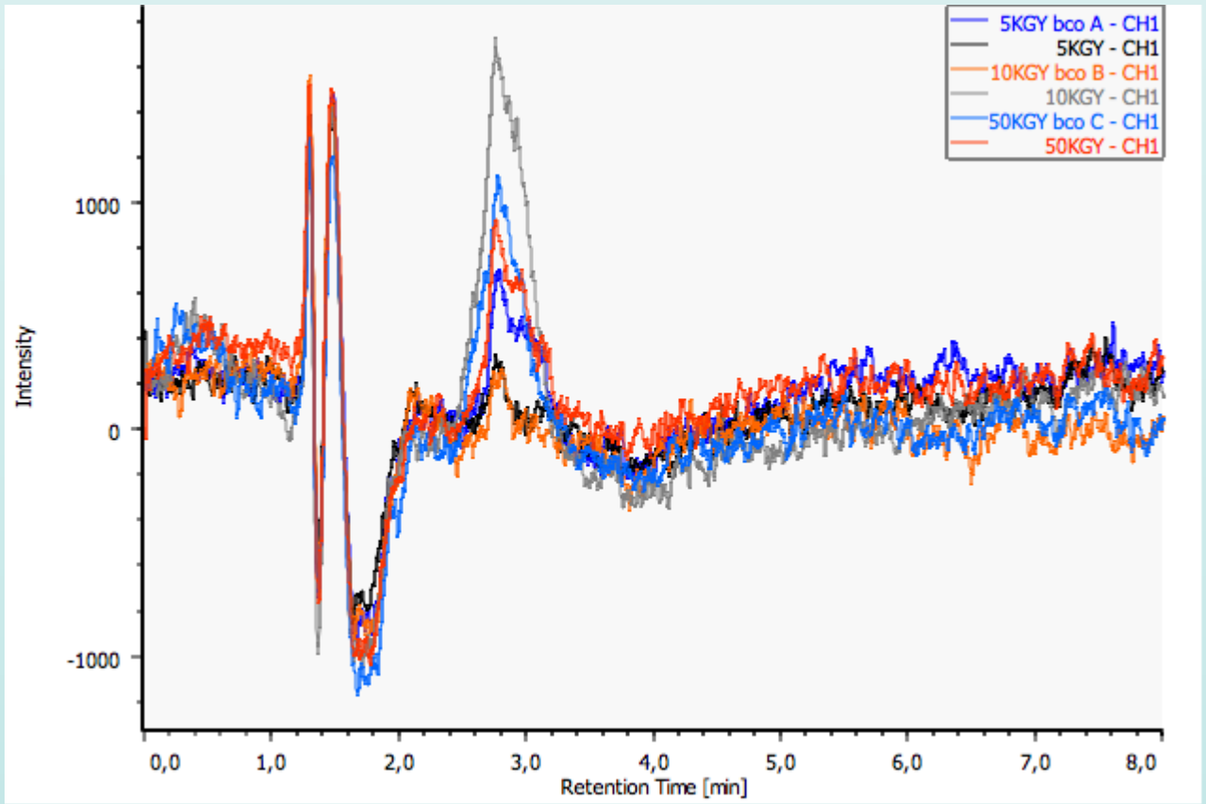
WAXD patterns of PC non-irradiated and EB irradiated with 200 kGy, in saline solution.



DSC curves of non-irradiated and EB irradiated PC plate in saline solution, radiation absorbed dose of 200 kGy

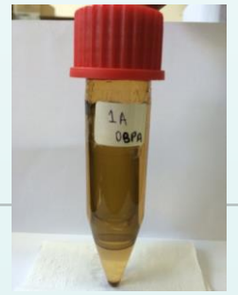
HPLC



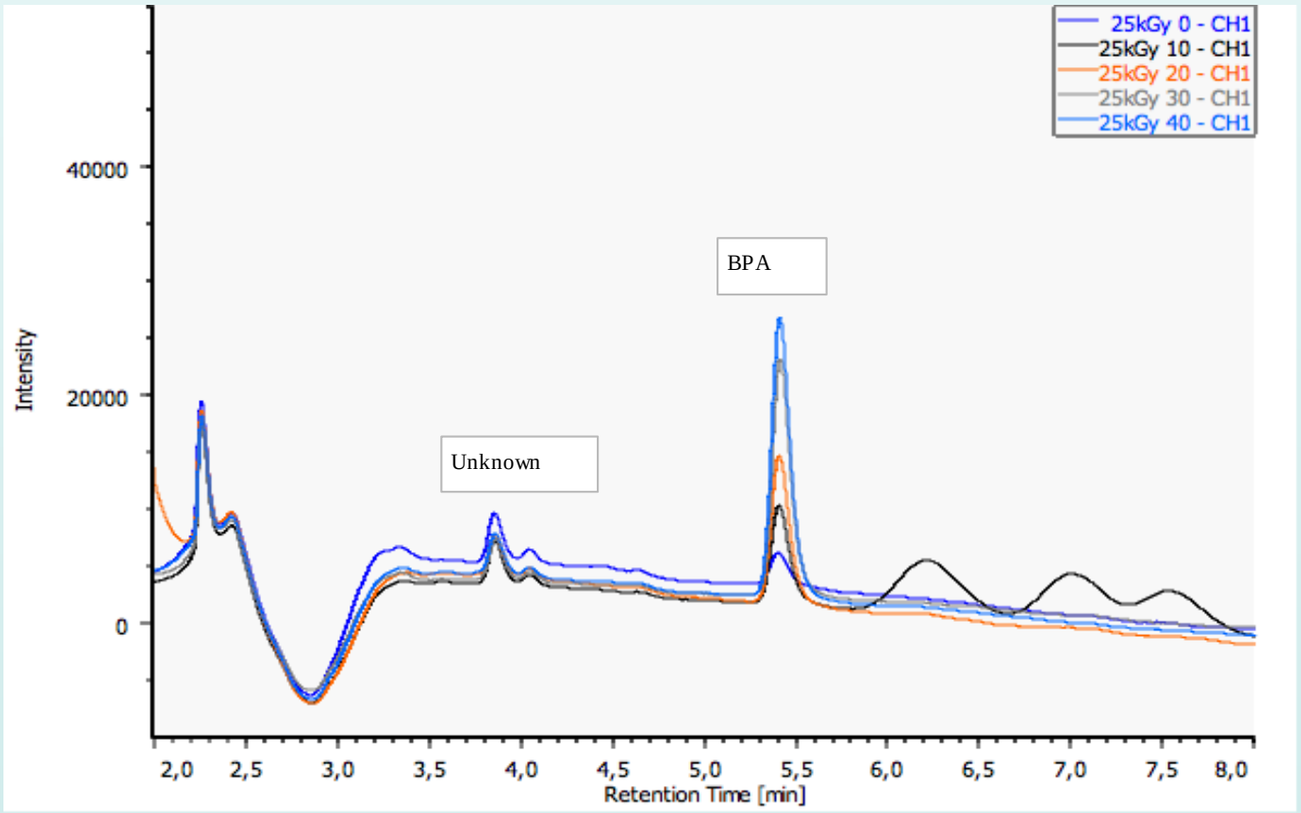


HPLC Jasco
- automatic injector (AS-2059),
- volume injected 20 μL;
- quaternary pump (PU-2089); column oven (CO-2060); fluorescence detector (FP-2020): excitation 280 nm, emission 330 nm;
- chromatographic column SHODEX C18-4D (4,6 mm ID x 150 mm L);
- mobil phase acetonitrile:water, 70:30 (v:v);
- isocratic programmed for 7 minutes and flow 1 mL min^{-1}.

HPLC



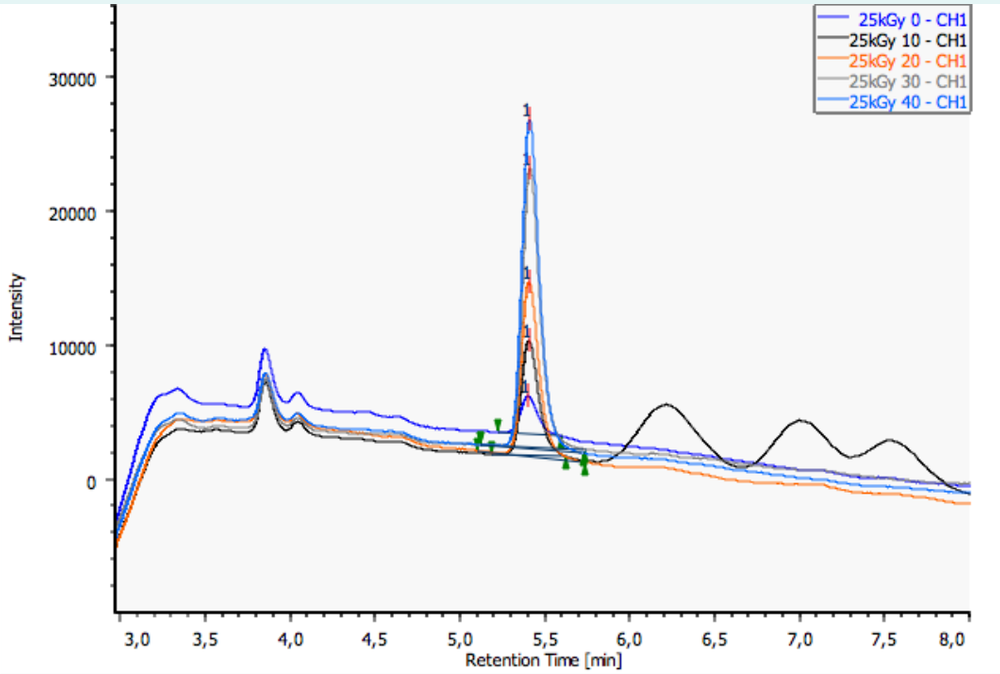
BPA

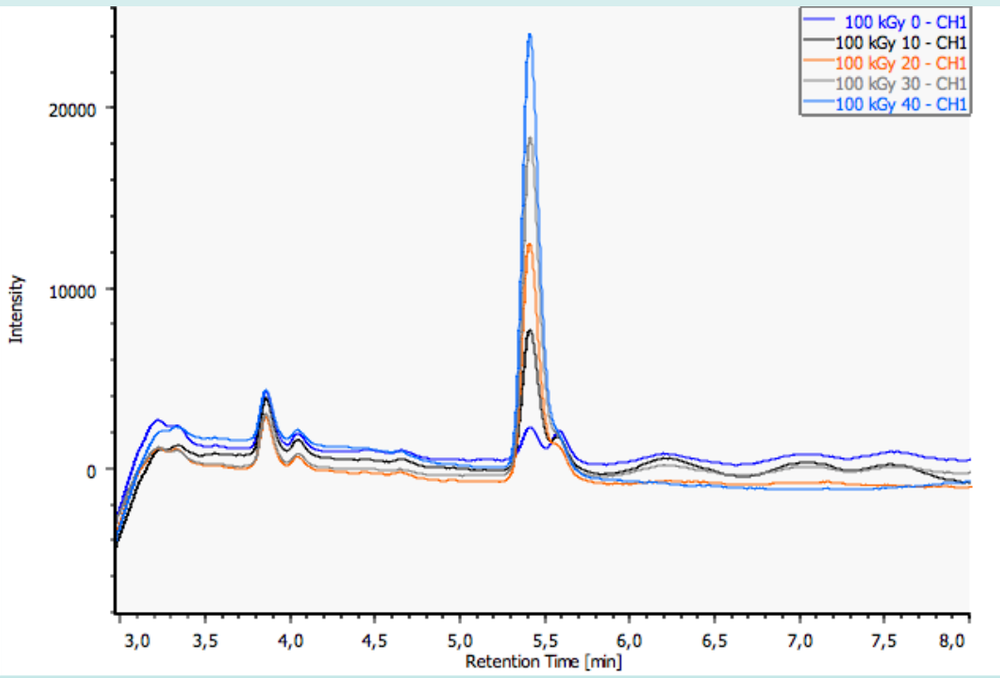


Chromatograms of saline solution with BPA (Bisphenol A) added in different concentrations (0, 10, 20, 30 and 40 ng L^{-1}) to saline solution with PC column gamma irradiated with radiation absorbed dose of 25 kGy.

HPLC Jasco
- automatic injector (AS-2059),
- volume injected 40 μL;
- quaternary pump (PU-2089); column oven (CO-2060); fluorescence detector (FP-2020): excitation 280 nm, emission 330 nm;
- chromatographic column BDS Hypersil (250 mm x 4.6 mm, id) 5μm C18 (Thermo Scientific);
- mobil phase acetonitrile:water, 50:50 (v:v);
- isocratic programmed for 8 minutes and flow 1 mL min^{-1}.

HPLC results of BPA of gamma irradiated saline solution with PC column



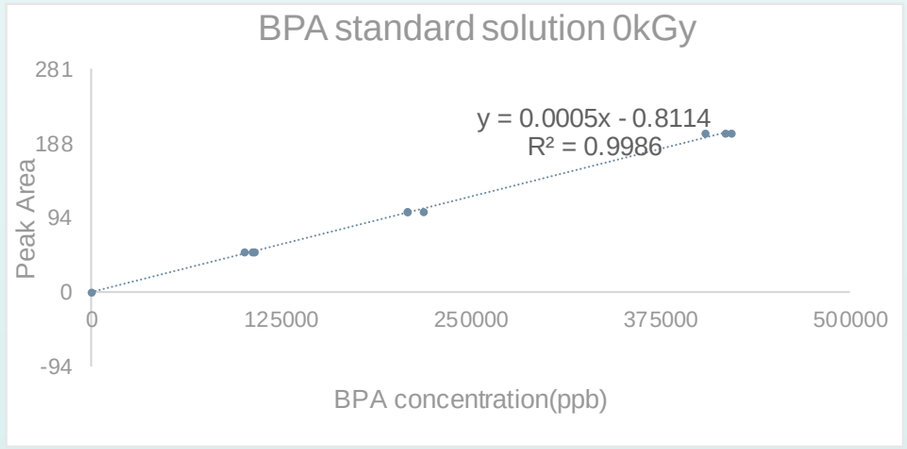


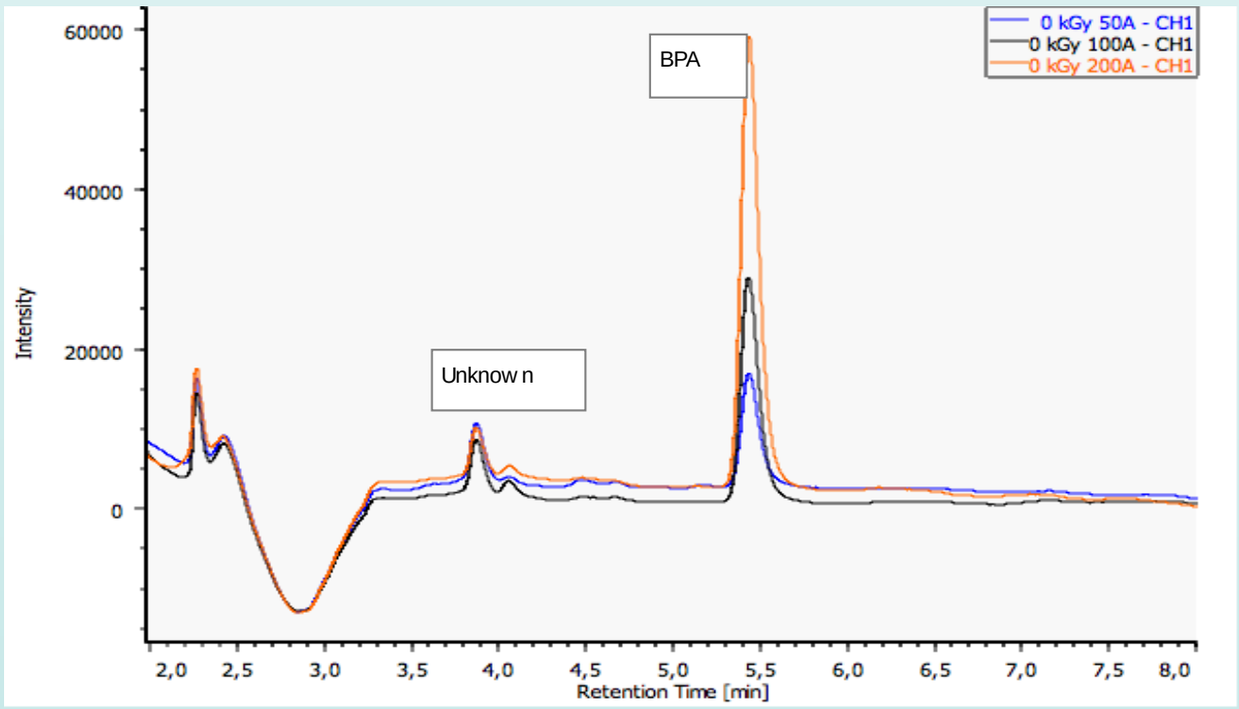
HPLC results of BPA of gamma irradiated saline solution with PC column, radiation absorbed doses of 25, 50 and 100 kGy.

Sample	**Radiation absorbed dose (kGy)**	**BPA (ppb)**	**BPA (μg g^{-1} column)***
PC column A	25	93.12	0.48
PC column B	50	26.19	0.14
PC column C	100	11.19	0.06

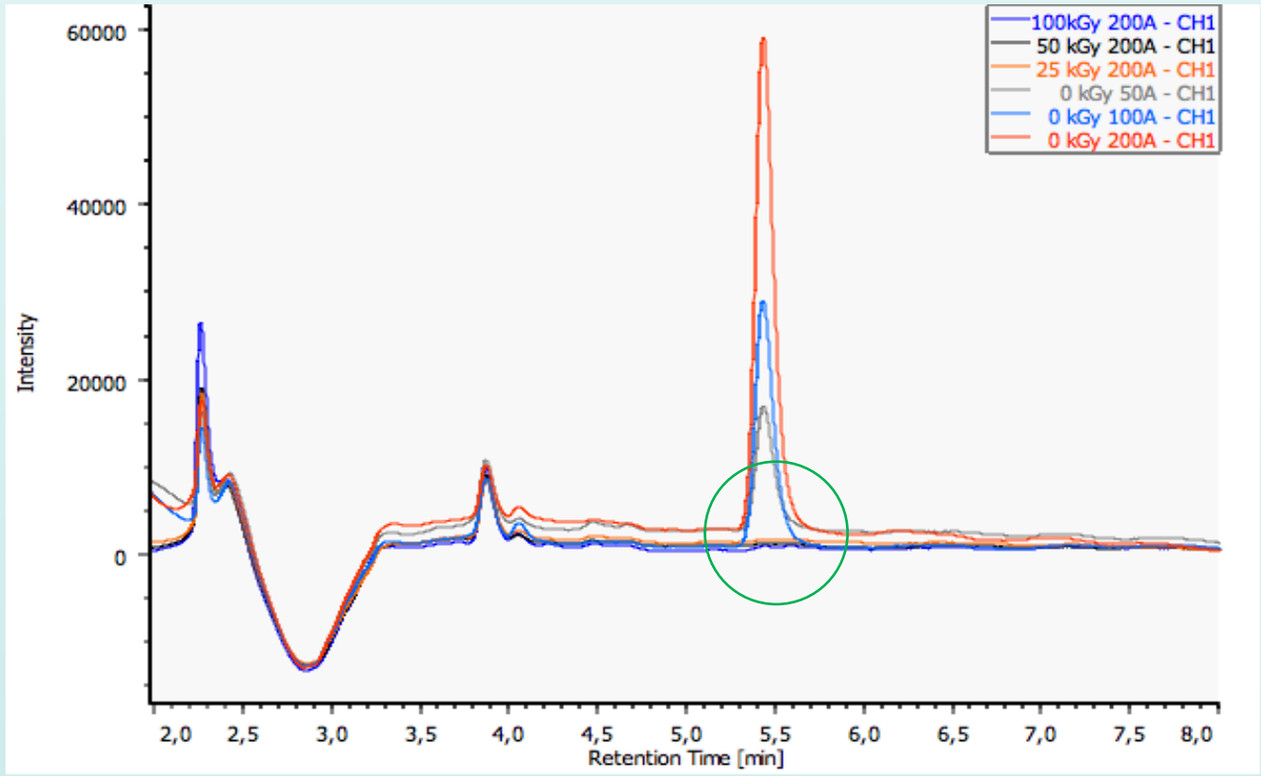
Column mass 9.63±0.05 g

BPA standard solution





Chromatograms of saline solution prepared with BPA (Bisphenol A) in different concentrations (50, 100 and 200 ng L^{-1}) without irradiation (0 kGy).



HPLC Chromatograms of saline solution with BPA (Bisphenol A) in different concentrations (50, 100 and 200 ng L^{-1}) without irradiation (0 kGy); and saline solution prepared with BPA in concentrations of 200 ng L^{-1} after irradiation, with radiation absorbed doses of 25, 50 and 100 kGy.

CONCLUSIONS

- For sterilization absorbed dose, results shown no significant changes on the studied properties that way can be recommend to use PC columns instead borosilicate glass column in the $^{99}Mo/^{99m}Tc$ generator.

- The protocol via HPLC with fluorescence detection used in this work can be employed to detect the chemical phase diffusion of BPA from PC column in saline solution at ppb concentration.

- A competition of BPA release and degradation by ionizing radiation was observed.

- Ionizing radiation caused greenness of the original clear PC samples. This discoloration confirms the formation of phenoxyl radicals that disappear in 75 days after irradiation.

ACKNOWLEDGMENTS

- MSc. Paulo S. Santos for the irradiation at Multipurpose Gamma Irradiator
- Eng. Elizabeth Somessari for irradiation with EB Accelerators.
- Msc. Jorge Gabriel dos Santos Batista for DSC measurements of Environmental Science and Technology Center, CQMA
- Rene Ramos de Oliveira for WAXD measurements, CCTM
- Radiopharmacy Center for the opportunity to develop this study as collaboration
- Peterson Lima Squair for figures of radiation absorbed dose calculation on alumina

IAEA
International Atomic Energy Agency
Atoms For Peace

ipen

DANKE

Thank you for your attention!