Evaluation of the radionuclidic purity of ^{123}I and ^{131}I samples

M.F.Catanoso, J.A.Osso Jr.
Instituto de Pesquisas Energéticas e Nucleares
IPEN/CNEN-SP Brazil
marcela.forli@gmail.com

Introduction: Several radioisotopes are used in the medical area both for treatment and diagnostic, in particular ^{123}I and ^{131}I. The radioisotope ^{123}I is used in diagnosis through the SPECT technique. It is routinely produced at IPEN in cyclotron through the reaction: ^{124}Xe (p, 2n) ^{123}Cs -> ^{123}Xe -> ^{123}I. The radioisotope ^{131}I is used both in diagnosis and therapy due to its physical characteristics of decay by B^- and its γ-ray emissions that are softened with the use of specific collimators for diagnosis[1]. It is routinely produced at IPEN using the nuclear reactor through the indirect reaction: ^{130}Te (n, γ) -> ^{131m}Te -> ^{131}Te -> ^{131}I, irradiating compounds containing Te. The radiopharmaceuticals prepared with these radioisotopes go through rigorous quality control tests and the chemical purity of the primary radioisotopes ^{123}I and ^{131}I are within the permissible limits currently defined. However, the presence of some chemical contaminants can prejudice the biomolecules labeling (monoclonal antibodies and peptides), that will produce radiopharmaceuticals of first generation to the oncology area. The objective of this work was to evaluate the radionuclidic purity of ^{123}I and ^{131}I samples produced at IPEN, as part of a project aiming the purification of these radioisotopes, allowing the labeling of biomolecules.

Material & Methods: ^{123}I is produced at IPEN by irradiating enriched ^{124}Xe gas with protons in the CYCLONE 30 Cyclotron. After the irradiation the gas is removed and the ^{123}I, present in the walls of the target holder, is washed with H_2O. This solution is taken to a process cell and is percolated through an anionic exchange resin, adsorbed and further eluted in the form of iodide in a small volume of 1 mol.L^{-1} NaOH. ^{131}I is produced through the irradiation of TeO_2 targets in the IEA-R1m nuclear reactor. After the irradiation, the ^{131}I is separated by dry distillation, where the targets are put in an oven, heated at 760^{o}C for 2 hours and the ^{131}I, volatile, is carried by an O_2 gas stream. This gas runs thought 3 traps: the first, containing H_2SO_4 to retain Te, the second containing 0.1 mol.L^{-1} NaOH at low temperature to retain ^{131}I in the form of iodide, and the last, containing 0.1 mol.L^{-1} NaOH at room temperature to retain any ^{131}I that was not retained in the second trap. Samples of ^{123}I and ^{131}I were evaluated for their radionuclidic purity. First their activities were analysed in a dose calibrator CRC15 from CAPINTEC with positions previously calibrated for the radioisotopes. Then samples were analysed using a hiperpure germanium detector, model CX1518, from CANBERRA in order to perform the qualitative and quantitative determination of the gamma emitters impurities.

Results: The analyses performed with ^{123}I showed the presence of ^{123m}Te (4.5 x10^{-3}%), ^{121m}Te (1.75 x10^{-3}%), ^{121}Te (2.55 x10^{-1}%), ^{95m}Tc (1.1 x10^{-3} %), ^{94}Tc (4.6 x10^{-4}%) and ^{56}Co (1.6 x10^{-1}%) in the filters used in the production and ^{123m}Te (3.14 x10^{-6}%), ^{121m}Te (8.93 x10^{-8}%), ^{121}Te (4.23 x10^{-3}%), ^{95m}Tc (1.45 x10^{-7}%) and ^{96}Tc (3.53 x10^{-5}%) in samples obtained from production. In relation to ^{131}I, it was observed the presence of ^{123m}Te (2.66 x10^{-4} %), ^{121m}Te (1.04x10^{-2}%), ^{121}Te (2, 7x10^{-4} %), ^{129}Te (1.40 x10^{-1} %), ^{131}Te (1.31 x10^{-2} %), ^{95m}Tc (5.86 x10^{-4} %), ^{57}Co (9.72 x10^{-4} %) and ^{60}Co (3.31 x10^{-6} %).

Discussion/Conclusion: Regarding to the purity of the ^{131}I, the radionuclides ^{121}Te, ^{121m}Te, ^{123}Te, ^{129}Te e ^{131}Te come from the neutron activation[2,3] of several Te isotopes present on the targets of TeO_2, while ^{57}Co e ^{60}Co come from the Co activation in the nuclear reactor. For ^{123}I, the ^{121}Te impurity comes from the nuclear reactions such as $^{124}Xe(p,4n)$, while ^{123}Te comes from the decay of ^{123}I. The presence of the radionuclides of Co and Tc is due to the activation of Ni and Mo impurities, from the window material of the target holder. It is very clear that, despite the low level of contaminants, there is the presence of chemical impurities in the samples, that must be separated to allow the proper labeling of the biomolecules of interest.

References: [1] Dias, L. A. P. Development of a method of production of 131I by the technique of dry distillation of tellurium oxide fuel. IPEN [2001] 63p.
[2] European Pharmacopoeia; 5th Edition; Vol. 1; Strasbourg, França; 2004.
[3] The United States Pharmacopeia, The National Formulary. 25th Edition; Vol. 2; USA, 2007.