2011 International Nuclear Atlantic Conference - INAC 2011
Belo Horizonte,MG, Brazil, October 24-28, 2011
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
ISBN: **978-85-99141-04-5**

EVALUATION OF ^{131}I RETENTION IN SEVERAL ADSORBERS

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ABSTRACT

Several iodine radioisotopes are used in nuclear medicine for treatment and diagnostic purposes. The radioisotope ^{131}I is used both in diagnosis and therapy due to its physical characteristics of decay by β^- and its γ-ray emissions suitable for diagnosis. It is routinely produced at IPEN 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. The aim of this work was to evaluate the retention and elution of ^{131}I samples produced at IPEN in several adsorbers as part of a project aiming the purification of these radioisotopes, allowing the labeling of biomolecules. Samples of ^{131}I were used for retention and elution studies with the following adsorbers: commercial cartridges, anionic resin columns and cationic resin column. The results showed that Ag cartridges and anionic resins Dowex 1X8, Dowex 3 and IRA 400 had a great iodine retention but no elution after using specific eluents. The QMA light, acid alumina, neutral alumina and cationic resin Dowex 50WX4 showed high retention and elution and QMA plus and cationic resin Dowex 50WX8 and Dowex 50WX12 had a good retention but lower elution. Regarding to the better retention and elution, Ag cartriges and resins showed a higher percentage of iodine retention but lower elution yield and QMA light, acid and neutral alumina cartridges showed better results.

1. INTRODUCTION

Nuclear medicine is a medical area based on the use of radioactive isotopes as open radioactive sources for diagnosis and therapy[1].

Iodine radioisotopes are commonly use in nuclear medicine in both diagnosis and therapy for several diseases and can be used as unique tracer or labeled with organic compounds[2]. The main iodine radioisotopes are ^{123}I for thyroid study and diagnostic through the SPECT technique and ^{131}I used both in diagnosis and therapy due to its physical characteristics of decay by β^- and its γ-ray emissions that are softened with the use of specific collimators for diagnosis[1]. Currently, the use of ^{124}I for PET techniques has been studied because of its positron emission[3].

The ^{131}I production occurs mainly from nuclear reactor as ^{235}U fission product[4] or by the indirect method by irradiating ^{130}Te compounds[4,5,6] with the following nuclear reactions: ^{130}Te (n, γ) $\rightarrow$ ^{131m}Te $\rightarrow$ ^{131}Te $\rightarrow$ ^{131}I ($t_{1/2}$ ^{131m}Te= 30 hours and $t_{1/2}$ ^{131}Te = 25 minutes). It can also be obtained by cyclotron through the $^{130}Te(d,n)$ ^{131}I reaction.

The ^{131}I is routinely produced at IPEN through the irradiation of TeO_2 targets in the IEA-R1m nuclear reactor, where these targets are pressed and irradiated inside Al capsules with 7cm height and 2cm diameter. After the irradiation, the ^{131}I is separated by dry distillation, where the targets are put inside 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 through 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[7].

The radiopharmaceuticals produced routinely at IPEN-CNEN/SP go through rigorous quality control tests where chemical and radionuclidic purity of the primary radioisotopes are within the permissible limits currently defined. However, the presence of some contaminants can prejudice the biomolecules labeling that will produce radiopharmaceuticals of first generation to the oncology area in nuclear medicine.

The aim of this work is to evaluate the retention and elution of ^{131}I samples produced at IPEN in several adsorbers as part of a project aiming the purification of ^{123}I and ^{131}I radioisotopes, allowing the labeling of biomolecules.

2. MATERIALS AND METHODS

2.1 Samples

^{131}I samples were obtained directly from IPEN´s production. The first step was check the activity of the samples through a dose calibrator and further dilution in 0.1mol.L^{-1} NaOH if necessary for fractionation and use in each stage of the study.

2.2 Evaluation of ^{131}I retention and elution in several adsorbers

The best adsorber for ^{131}I purification was chosen through an iodine adsorption study performed in several adsorbers and subsequent elution using specific solutions.

Table 1 and Table 2 describe the adsorbers used in the study: commercial cartridges (QMA light, QMA Plus, Sep-Pak Plus acid alumina and Sep-Pak plus neutral alumina from Waters e Ag 1.0cc from Dionex), anionic resin columns (Dowex 1X8, Dowex 3 e IRA 400) and cationic resin columns (Dowex 50WX4, Dowex 50WX8 and Dowex 50WX12) previously activated with 0.1mol.L^{-1} HCl and 0.1mol.L^{-1} NaOH.

Table1: Commercial cartridges used to study the ^{131}I retention/elution

Cartridges	Cromatography	Matrix	Particule size (μm)	Flow (mL/min)
SepPak Plus Acid Alumina	Normal phase	Al oxide	50-300	4.3
Sep-Pak plus neutral Alumina	Normal phase	Al oxide	50-300	2.2
SepPak Plus Acell Plus QMA	Strong anionic	Polymer	37-55	3.0
SepPak Light Acell Plus QMA	Strong anionic	Polymer	37-55	2.8
Dionex Onguard II Ag 1.0cc	Cationic	-	-	3.3

Table 2: Anionic and cationic ion exchange resins used in the study of ^{131}I retention/elution

Sorbent	Resin type	Matrix	Particule size (mesh)	Flow (mL/ min)
50WX8	Strong acid cationic	Polystyrene	200-400	0.8
50WX4	Strong acid cationic	Styrene-DVB Gel	100-200	1.8
50WX12	Strong acid cationic	Styrene-DVB Gel	200-400	1.0
Dowex 1X8	Strong basic anionic	Styrene-DVB Gel	100-200	2.2
Dowex 3	Weak basic anionic	Styrene-DVB Gel	20-50	3.3
IRA 400	Strong basic anionic	Styrene-DVB Gel	16-50	4.0

Initially, the same methodology was used for all adsorbers: loading solution containing 1.0mL of ^{131}I with known activity and elution with 10mL of 0.1mol.L^{-1} NaOH, in fractions of 1.0mL. The loading solution and the elutions were analyzed in a dose calibrator in order to evaluate the retention and elution profile of ^{131}I.

3. RESULTS

3.1 Retention and elution studies

Figures 1 and 2 shows the ^{131}I retention and ^{131}I elution results in several adsorbers, respectively and Table 3 shows the eluents used on the study.

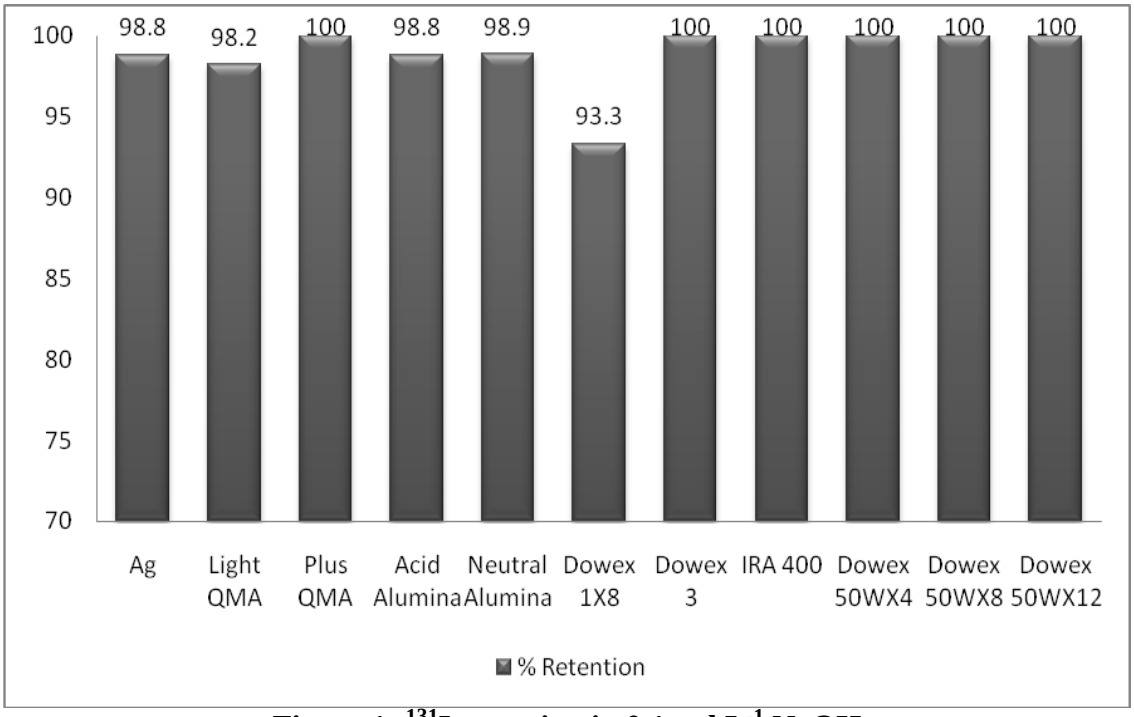

Figure 1: ^{131}I retention in 0.1mol.L^{-1} NaOH

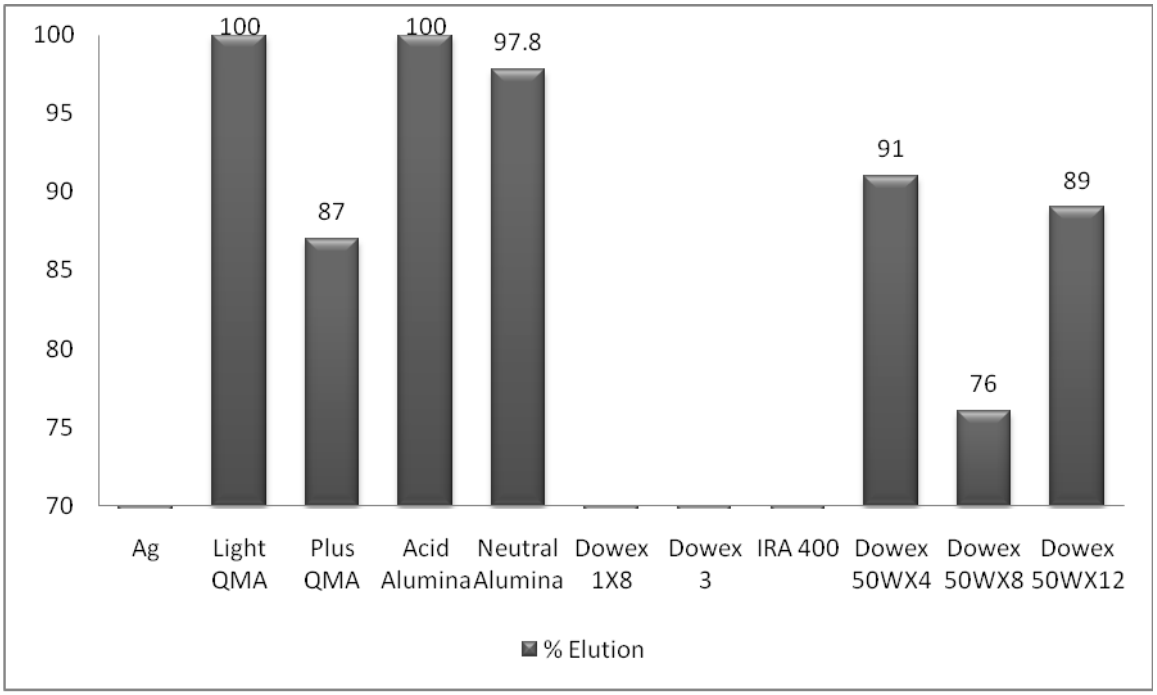

Figure 2: ^{131}I elution in 0.1mol.L^{-1} NaOH

Table 3: Eluents and volume used in ^{131}I elution from several adsorbers

Adsorber	Solution (mol.L^{-1})	Elution volume (mL)
Acid alumina	0.1 NaOH	7.0
Neutral alumina	0.1 NaOH	5.0
Plus QMA	0.1 NaOH	5.0
Light QMA	0.1 NaOH	4.0
Ag	0.1 NaOH	5.0
Dowex 1X8	0.1 NaOH	10.0
	2.0 NaOH	5.0
	0.1 Sodium Citrate	5.0
Dowex 3	0.1 NaOH	5.0
	2.0 NaOH	5.0
	0.1 Sodium Citrate	5.0
IRA 400	0.1 NaOH	10.0
	2.0 NaOH	5.0
	0.1 Sodium Citrate	5.0
Dowex 50WX4	0.1 NaOH	5.0
Dowex 50WX8	0.1 NaOH	4.0
Dowex 50WX12	0.1 NaOH	20.0

The results showed that Ag cartridges and the anionic resins Dowex 1X8, Dowex 3 and IRA 400 had high iodine retention (98.8%, 93.3%, 100% and 100%, respectively) but no elution (0%) in all eluents studied. The QMA light, acid alumina, neutral alumina and cationic resin Dowex 50WX4 showed high retention (98.2%, 98.8%, 98.9% and 100%, respectively) and elution (100%, 100%, 97.8%, 91%, respectively) in 0.1 NaOH mol.L^{-1} and QMA plus and cationic resin Dowex 50WX8 and Dowex 50WX12 had high retention (100% for both) but lower elution in 0.1 NaOH mol.L^{-1} (87%, 76% and 89%, respectively).

4. CONCLUSIONS

The most promising results were achieved with the 50WX4 cationic resin but it is necessary to check the behavior of the impurities in this system.

ACKNOWLEDGMENTS

The authors wish to thank CNEN for granting a fellowship for this work.

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