Radioiodination of embolic agents for prostate cancer theranostic

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Theranostic refers to the combination of diagnosis and therapy properties of one radioisotope or a pair of similar radioisotopes in the same molecule. The theranostic concept emerged to offer an innovative and personalized medicine approach for cancer patients [1,2]. Molecules labeled with theranostic radioisotopes provide clinically meaningful information for the diagnosis, the suitability of radionuclide therapy, dosimetry, and post-therapy planning. This information allows personalized medicine for cancer patients [1,2]. The Argonauta research reactor, located in the Nuclear Engineering Institute (IEN) of the Brazilian Nuclear Energy Commission (CNEN), started up in 1965 and has been utilized mainly for R&D in the areas of nuclear technology as well in education and training of human resources for the Brazilian Nuclear Program [3]. The Argonauta Research Reactor, located in Rio de Janeiro, Brazil, has been developing the labeling of embolic agents for tumors theranostic [3,4]. There have been substantial interest in vascular embolization (VE) procedures for the treatment of prostate cancer. Essentially, VE is a clinical procedure where an embolic agent is carried through a catheter to the desired target. Once in the target, the embolic agent stops the blood flow. Without blood flow, the tumor shrinks due to the lack of nutrients until its complete disappearance. Dextran, hydroxyapatite, and polymeric microspheres are examples of materials used as an embolic agent [4].

Therefore, the design of radioembolic agents for theranostic allows both the embolization procedure imaging and tumor therapy. In this way, the insertion of radioisotopes in the embolic agent structure will provide SPECT or PET/CT imaging to monitor particles' distribution in the veins with high-resolution images, in addition to therapy with a beta or alpha particle. Recent results showed that an embolic agent based on a polymeric matrix was successfully labeled with iodine 123 [4]. The next step is to attach iodine 131 to this polymer backbone as a theranostic approach for prostate cancer embolization. Currently, the Argonauta research reactor is undergoing a modernization process. In a couple of years, the current fuel (uranium oxide 20 % enriched in uranium 235) will be replaced by uranium silicide that will increase neutron flux in one decade, reaching 10^{11} $n \cdot cm^{-2} \cdot s^{-1}$. This new potency will allow the proper activation of natural tellurium (enriched in 33.8 % of tellurium 130) to produce tellurium 131. Low activities of tellurium 131 are sufficient to perform the labeling studies with iodine 131, its decay product. The Argonauta research reactor contains an operational Nuclear Instrumentation laboratory to perform gamma spectrometry.

Moreover, the laboratory for developing neutron-activated radioisotopes is being equipped to allow this project to run. This work presents a proposal for the synthesis of iodine 131 and labeling a polymeric embolic agent with this radioiodine. First, studies for the separation of non-activated tellurium and iodide will be performed. The methodology consists of a chemical separation using the solid-phase extraction technique. Mobile phase and solid phase must be selected to result in the maximum eluted iodine and retained tellurium. Unfortunately, no experiments were performed due to the limitations imposed by the pandemic situation. In march 2021, this proposal was presented in the event named 'Technical Meeting on State of the Art Research Reactor Based Radioisotope and Radiopharmaceutical Production' promoted by the International Atomic Energy Agency.

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