DETERMINATION OF PLATINUM AND GOLD IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS

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A procedure for platinum and gold determination utilizing neutron activation combined with radiochemical separation, has been developed. The reaction $^{198}\text{Pt}(n, \gamma)^{199}\text{Pt} \rightarrow ^{199}\text{Au}$ is used for Pt determination. Four procedures for gold separation are examined: (1) adsorption on untreated polyurethane foam (UPF), (2) extraction with dibutyl sulphide, (3) reduction of gold to elementary state in conc. $\text{H}_2\text{SO}_4$, and extraction of gold as diethyl-dithiocarbamate complex. The extraction with Cu(DDC)$_2$ is chosen as the most suitable process and applied to platinum and gold determinations in Bowen's Kale and mice organs, previously treated with Biocisplatinum® specimens.

Introduction

Since antitumor activity of some platinum and gold compounds has been discovered, investigation of their properties, metabolism, pharmacokinetics, toxicity etc. has permanently expanded. Therefore the necessity of the determination of those elements in biological materials arose. Neutron activation analysis is a sensitive method and, combined with radiochemical separation, it can be utilized for the determination of Au and Pt at ultratrace level. Literature data and our own experiments show that for Pt determination the reaction $^{198}\text{Pt}(n, \gamma)^{199}\text{Pt} \rightarrow ^{199}\text{Au}$ is the most suitable one. $^{199}\text{Au}$ is separated together with $^{198}\text{Au}$ and the latter is used for determination of gold. Thus platinum determination is reduced to separation of gold. The separation procedure has to meet the following requirements: (1) the sample must be dissolved without residue ensuring complete isotope exchange with the carrier, (2) gold separation has to be selective enough to eliminate the interfering impurities and to obtain the lowest possible counting statistical error, and (3) the procedure should be simple, rapid and cheap.

In this work trace experiments for Pt and Au determination in biological materials are carried out using several separation techniques. Four different techniques are com-
pared, namely (1) adsorption of gold on untreated polyurethane foam, 9 (2) liquid extraction with dibutyl sulphide, 10 (3) reduction of gold to elementary state in concentrated \( \text{H}_2\text{SO}_4 \), 7 and (4) liquid extraction with Ni-diethyldithiocarbamate 6 and with Cu-diethyldithiocarbamate.

All the techniques are tested in trace experiments with \(^{198}\text{Au} \) tracer and animal muscle as a matrix. For adsorption and extraction techniques \(^{82}\text{Br} \) tracer is used to control the purification from bromine. Gold extraction with copper diethyldithiocarbamate is chosen from the techniques tested. Substoichiometric extraction of gold using \( \text{Cu(DDC)}_2 \) is examined. Bowen's Kale, as one of the best standard reference materials, is analyzed to check the procedure. Some organs of BDF laboratory mice with transplanted L1210 leukemia and treated with Biocisplatinum (Bioelectronica, Sofia) are analyzed for platinum, using the procedure chosen.

**Experimental**

**Tracer experiments**

Tracer solution with \(^{198}\text{Au} \) concentration 500 \( \mu \text{g/ml} \) and activity about \( 10^4 \) cpm/ml (\( \text{AuCl}_3 \)) and tracer solution with \(^{82}\text{Br} \) activity about \( 10^4 \) cpm/ml (KBr) are prepared. One ml of each, \(^{198}\text{Au} \) and \(^{82}\text{Br} \), tracer solutions are added to a 100 ml Kjeldahl flask and dried. The samples are added and decomposed with a \( \text{HNO}_3 \) and \( \text{HClO}_4 \) mixture (10:1). The flask is heated until clean solution is obtained. The solution is dried and dissolved in a few ml aqua regia to achieve complete isotopic exchange of gold. Nitrates are removed from the solution by double evaporation with 10 ml of 6M HCl. The residue is dissolved in 10–15 ml of 1M HCl + 0.1M HClO\(_4\) mixture. The dissolution procedure is common for all the separation techniques tested.

**Adsorption on untreated polyurethane foam**

A glass column with 10 mm internal diameter and 150 mm height is filled with about 600 mg of untreated polyurethane foam, cylinders with 12 mm diameter and 25 mm height. In order to remove air bubbles from the foam, it is squeezed several times into the column with distilled water. The column is washed with distilled water and equilibrated with 25 ml of 1M HCl + 0.1M HClO\(_4\) mixture. The dissolved sample passes through the column, it is then washed with 20 ml of the same acid mixture and gold is eluated with 10 ml of acetone. One ml fractions of the eluate are collected and counted for \(^{198}\text{Au} \) activity, in order to obtain the eluation curves. Two eluation flow rates are used: 0.9 and 0.4 ml \( \cdot \text{cm}^{-2} \cdot \text{min}^{-1} \). The eluation curves are presented.