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BIO-ASSAY PROGRAM  
THE DETERMINATION OF POLONIUM IN URINE OF FILIPINO  
NON-SMOKERS AND SMOKERS

BY

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HEALTH PHYSICS RESEARCH DIVISION

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PHILIPPINE ATOMIC ENERGY COMMISSION  
DON MARIANO MARCOS AVENUE  
DILIMAN, QUEZON CITY

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ABSTRACT

Polonium-210, a natural contaminant of tobacco smoke constitutes a health hazard to smokers. The  $\text{Po}^{210}$  content in twenty urine samples of smokers and in twenty urine samples of non-smokers was compared. The  $\text{Po}^{210}$  was recovered from the urine by centrifugation, radiochemical treatment and electro-deposition on silver (Ag) discs. Quantitative results were obtained by counting both sides of the Ag disc for 24 hours using the Si-surface barrier detector attached to a Multi-Channel analyzer set-up. The  $\text{Po}^{210}$  activity in samples from non-smokers varied from 0.0502 pCi/24h spl. to 0.5697 pCi/24h spl. with mean activity of  $0.1377 \pm 0.1200$  pCi/24h spl. while that from smokers ranged from 0.1301 pCi/24h spl. to 0.6335 pCi/24h spl. with a mean activity of  $0.2673 \pm 0.1077$  pCi/24h spl. The student's t-test performed on the accumulated data indicated that there exists a significant difference in the  $\text{Po}^{210}$  content in urine of non-smokers to that of smokers. More samples will be analyzed to provide for better statistical analysis.

## INTRODUCTION

The bio-assay program, i.e., the determination of internal contamination through radioanalysis of excreted materials, was designed to monitor for unsuspected radioactive uptakes and to check for possible uptake following some incident.

The comparative determination of polonium ( $\text{Po}^{210}$ ) in urine of Filipino non-smokers and smokers is an important phase of the bio-assay program. The concluded phases of the program involve the establishment of a bio-assay laboratory and the determination of  $\text{Po}^{210}$  in cigarettes.  $\text{Po}^{210}$ , a decay product of  $\text{Ra}^{226}$ , is a pure alpha emitter with an energy of 5.3 MeV decaying with a half-life of 138.4 days. The significance of the project to public health arises from reported findings that  $\text{Po}^{210}$  is a natural contaminant of tobacco and hence a health hazard to smokers.

## RELATED STUDIES

Previous study made on the  $\text{Po}^{210}$  content of Philippine cigarettes showed that the average  $\text{Po}^{210}$  activity of local brands is 0.0071 pCi/gm while that of foreign brands is 0.0129 pCi/gm. Studies conducted by Fuchs et.al. reveal that if an individual consumes two packs of cigarettes a day

over a period of 25 years, the volatilized  $\text{Po}^{210}$  inhaled in cigarette smoke is probably at least seven times that from background sources and the amount deposited in the bronchial epithelium could reach a dose of about 1000 rem. Other studies indicate that approximately 0.13 % of the total  $\text{Po}^{210}$  in the body is excreted in the urine daily. Hence, Po urinalysis can serve as a rough index of the body burden of  $\text{Po}^{210}$  and  $\text{Ra}^{226}$  or anyone of its daughters absorbed in case of exposure. In this study, the  $\text{Po}^{210}$  content in urine of smokers is compared with that of non-smokers.

#### EXPERIMENTAL METHOD

Twenty-four hour urine samples were collected from smokers and non-smokers. Each sample is measured volumetrically and divided evenly between two 250 ml. beakers to which is added 5 ml. of 6 N NaOH. The alkaline sample is allowed to stand for 10 min. to provide for sufficient precipitation. The sample is centrifuged at 3000 rpm for 10 min. after which the supernatant is discarded.

The sediments are dissolved with 0.5 N HCl and transferred to a plastic polyethylene bottle. Five ml. of 20 % hydrochloride, 2 ml. of 25 % sodium citrate and 10 mg. of bismuth carrier are added to remove interference of oxidants such as

$\text{Fe}^{+++}$  and  $\text{Cr}^{+6}$ .

The volume is made up to 50 ml. with 0.5 N HCl and the pH adjusted to 2.0 with concentrated ammonia solution for plating. All glasswares used were rinsed with demineralized water to minimize interfering ions which may reduce the recovery. The solution is heated in a water bath and stirred continuously with a motor-driven glass stirrer for 75 minutes. After plating, the disc is washed with demineralized water and ethyl alcohol and then dried. Both sides of the disc were counted for 24 hours using a silicon surface barrier detector. The results are expressed in pCi/24 hr. samples. For the determination of the percentage recovery of the method, 5 spiked samples were plated using a known concentration of  $\text{Po}^{210}$  standard solution. The percentage recovery was found to be 89.04 %.

$\text{Po}^{210}$  is amphoteric and reacts with NaOH to form colloidal hydroxide or basic salts in alkaline, neutral a weakly acidic solutions. Sodium citrate facilitates plating and complexes tellurium which might simultaneously plate out with  $\text{Po}^{210}$ . The  $\text{Bi}^{+++}$  carrier prevents deposition of  $\text{Bi}^{212}$  which was found to plate out simultaneously with  $\text{Po}^{210}$ . The electrochemical potential of  $\text{Po}^{210}$  at 18°C is + 0.77 V which is close to the potential of Ag, + 0.88 V. However, with the

addition of chloride ions to the solution at a temperature of 85-90°C, the normal electrochemical potential of Ag decreases from +0.88 V to +0.22 V due to the formation of the Ag Cl<sub>2</sub> - complex and the low solubility of AgCl. Hence, electrochemical deposition of radiochemically pure Po can be achieved on silver.

#### RESULTS AND DISCUSSION

Twenty samples from non-smokers and twenty samples from smokers were analyzed for Po<sup>210</sup> activity. The Po activity in samples from non-smokers varied from 0.0502 pCi/24 hour sample to 0.5697 pCi/24 hour sample while that from smokers ranged from 0.1301 pCi/24 hour sample to 0.6335 pCi/24 hour sample. The apparent variation within the values obtained for non-smokers may be attributed to the different degree of exposure to other sources of Po which is a naturally occurring radionuclide. The variation within the values obtained for smokers may be due mainly to the person's smoking frequency. The average Po content of the urine of smokers, 0.2673<sup>±</sup>.1077 pCi/24 hour sample, appears to be higher than the mean Po activity in urine of non-smokers, 0.1877<sup>±</sup>0.1200 pCi/24 hour sample (see Tables I and II). The student's t-test was performed to determine whether the two sample means come from the same population. The t-value obtained from the compari-

son of the means was 2.205. This exceeds the t-value at the 0.05 significance level (degrees of freedom equal 19) which is 1.725. Thus there is reason to reject the hypothesis of equality of means. Therefore, there exists a significant difference in the Po content in the urine of non-smokers to that of smokers.

#### CONCLUSION

Further accumulation of data is necessary to clearly establish the difference in the Po activity in samples of non-smokers to that of smokers. Statistical analysis of available data showed that a significant difference exists in the Po<sup>210</sup> activity in urine of smokers with that of non-smokers.

TABLE I: SAMPLES TAKEN FROM NON-SMOKERS

No. of Sample	Volume in ml.	Net cph	Activity Corr. for Efficiency (pCi/24h spl)	Activity Corr. for Recovery (pCi/24h spl)
1	970	.2083	.2763	0.3103
2	440	.1250	.1250	0.1882
3	740	.3750	.3519	0.3952
4	735	.0417	.0447	0.0502
5	1275	.1665	.2157	0.2423
6	725	.1667	.1762	0.1979
7	810	.5000	.5073	0.5697
8	410	.1250	.1564	0.1757
9	1440	.0833	.0944	0.1060
10	1240	.0833	.1042	0.1171
11	720	.1250	.1159	0.1301
12	1500	.1250	.1159	0.1301
13	660	.1667	.1563	0.1756
14	1000	.0833	.0894	0.1004
15	850	.1667	.1374	0.1544
16	910	.1250	.1341	0.1506
17	875	.1667	.1544	0.1734
18	975	.0833	.0521	0.0585
19	940	.2083	.1646	0.1849
20	860	.1667	.1277	0.1434

$$x = .1877 \pm .1200$$

TABLE II: SAMPLES TAKEN FROM SMOKERS

No. of Sample	Volume in ml.	Net cph	Activity Corr. for Efficiency (pCi/24h spl.)	Activity Corr. for Recovery (pCi/24h spl.)
1	890	.25	.2985	.2342
2	950	.4583	.5641	.6335
3	954	.2083	.230	.2583
4	900	.1250	.1159	.1301
5	630	.3333	.2275	.2555
6	820	.1667	.2453	.2755
7	1480	.2500	.3077	.3456
8	980	.2500	.3077	.3456
9	19000	.2500	.3541	.3977
10	1700	.2083	.2651	.2977
11	1040	.2500	.2317	.2602
12	1600	.2083	.1931	.2168
13	1465	.2083	.1931	.2168
14	860	.2917	.1752	.1967
15	340	.2983	.1862	.2091
16	710	.2083	.1884	.2116
17	755	.1667	.1604	.1802
18	700	.1250	.1444	.1621
19	490	.2083	.2443	.2744
20	250	.2083	.2172	.2439

$$\bar{x} = .2673 \pm .1077$$