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FAECAL ASSAY FOR ^{203}Pb BY THE SAMPLE ROTATION METHOD

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The sample rotation method for the measurement of large inhomogenous samples of biological material was studied using ^{203}Pb. A modified experimental arrangement constructed at this Institute was used for the investigations. The optimal compromise between the sensitivity of our instrument for the determination of radioactivity of samples and the measuring error due to inhomogeneity of samples was determined.

Because of the increasing use of ^{203}Pb in studies of lead absorption more accurate and simpler ways of determining the faecal excretion are continuously being sought. Procedures which require homogenisation of the entire stool collection have not been widely accepted because of their esthetic drawbacks. On the other hand lead compounds are not very suitable to ash due to evaporation at relatively low temperatures, whereas wet ashing is a very laborious procedure.

Therefore we decided to evaluate the sample rotation method first described for use with *Geiger* tubes by *McKenna, Bourne* and *Matzko* (1) and later for use with a sodium iodide crystal by *Dratz* and *Coberly* (2) and *Buchan* (3).

THE APPARATUS

Apparatus for faecal gamma-ray assay for ^{85}Sr and ^{47}Ca using the sample rotation principle has already been described and evaluated by *Harmut* et al. (5). A modified experimental arrangement has now been constructed at this Institute and evaluated for lead (^{203}Pb). The photo-

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^{203}Pb was supplied by the Gustav Werner Institute, Uppsala, Sweden.

graph of the apparatus is shown in Fig. 1. The modified container showing the radioactive source which can be moved continuously radially and vertically is shown in Fig. 2.

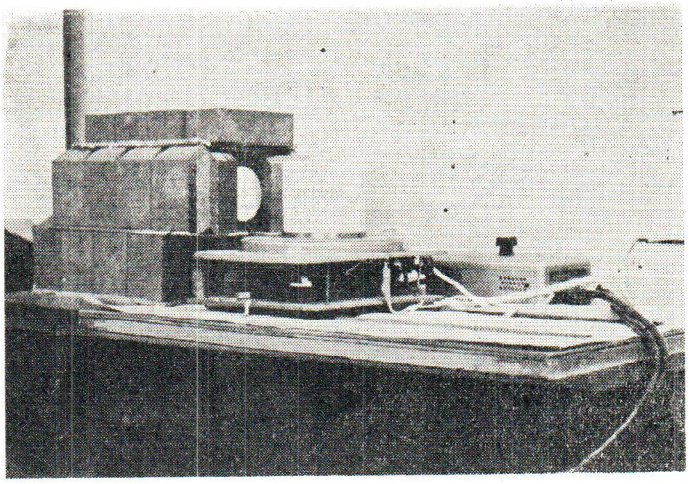

Fig. 1. *The rotating equipment for the determination of radioactivity in large samples of biological material*

DETERMINATION OF ISOCOUNT PATTERNS

A small approximately point source of ^{203}Pb (1 ml and 5 μCi) was counted at various distances from the bottom of a rotating container filled with 700 ml of water at different radii and at different distances H from the face of the crystal. In this way the isocount curves were determined (Fig. 3). Isocount curves drawn from careful interpolation of the counting rate at points shown in Fig. 3 were obtained at 0—4 cm radial distances and 0—4 cm vertical distances.

The counting rate was determined for geometries a, b, c and d (Fig. 4) as counts per minute. The counts per minute were measured for all four geometries for various distances H (8, 10, 12 and 15 cm) from the crystal face, for various channel widths (termed differential counting) and for maximum channel width (termed integral counting).

RESULTS

Table 1 shows the results of comparison of geometries a, b, and c with the ideal d (standard) for ^{203}Pb. It is seen that the results improve with greater channel width (expressed as the percentage of the maximum channel width) and that they are best for integral counting. In double tracer studies, of course, only differential counting should be used.

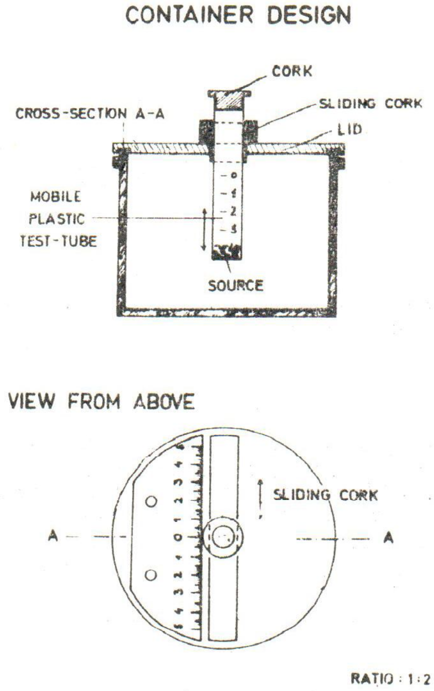

Fig. 2. *The modified container design in which the radioactive source can be moved radially or vertically*

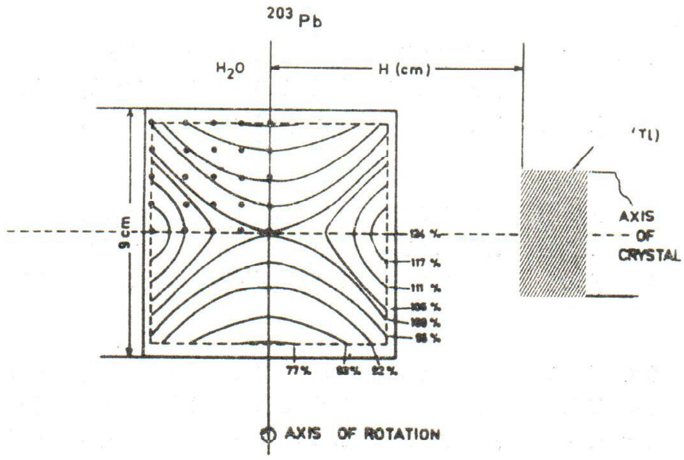

Fig. 3. *Isocount curves obtained at 0—4 cm radial distance and 0—4 cm vertical distance*

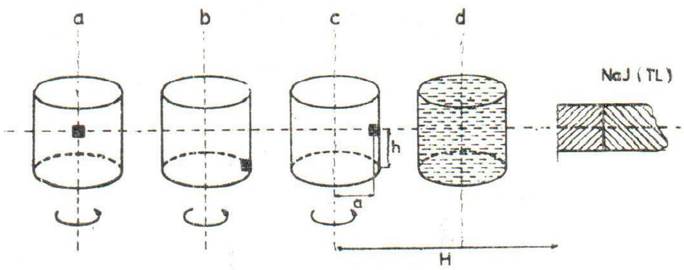

Fig. 4. *Schematic presentation of three different positions a, b, and c of a small source as related to the fixed crystal detector*

Table 1

Comparison of counting rates obtained with the source positioned at a, b and c (Fig. 4) with the ideal uniformly distributed source d for different channel widths W expressed as % of maximum channel width for various distances H for ^{203}Pb

H/cm	W=2V(7%)	W=4V(14%)	W=12V (43%)	W=20V (72%)	W=28V (100%)
H = 8 cm					
a/d	0.82 (0.015)	0.85 (0.014)	0.89 (0.009)	0.92 (0.009)	0.93 (0.008)
c/d	1.12 (0.014)	1.12 (0.018)	1.08 (0.011)	1.08 (0.009)	1.06 (0.009)
b/d	1.08 (0.018)	1.08 (0.017)	1.07 (0.011)	1.06 (0.009)	1.09 (0.009)
H = 10 cm					
a/d	0.85 (0.017)	0.89 (0.013)	0.89 (0.011)	0.95 (0.009)	0.94 (0.009)
c/d	1.11 (0.022)	1.09 (0.015)	1.06 (0.012)	1.09 (0.012)	1.06 (0.010)
b/d	1.12 (0.021)	1.09 (0.015)	1.06 (0.012)	1.07 (0.011)	1.07 (0.011)
H = 12 cm					
a/d	0.87 (0.018)	0.85 (0.015)	0.92 (0.013)	0.94 (0.012)	0.95 (0.010)
c/d	1.04 (0.021)	1.05 (0.018)	1.05 (0.014)	1.02 (0.013)	1.04 (0.012)
b/d	1.08 (0.02)	1.04 (0.018)	1.08 (0.014)	1.07 (0.013)	1.07 (0.012)
H = 15 cm					
a/d	0.85 (0.025)	0.89 (0.018)	0.92 (0.015)	0.93 (0.014)	0.97 (0.012)
c/d	1.01 (0.028)	0.97 (0.022)	1.09 (0.018)	1.09 (0.016)	1.12 (0.014)
b/d	1.01 (0.028)	1.05 (0.021)	1.01 (0.016)	1.04 (0.016)	1.05 (0.013)

The standard error due to counting is given in parentheses.

Sensitivity of the instrument

If the activity necessary to give a pulse rate three times the standard deviation above the background is taken as the minimum detectable sensitivity (6) the lower limit of detectability for ^{203}Pb for integral counting will be 0.01 μCi and for differential counting 0.03 μCi.

DISCUSSION AND CONCLUSIONS

The purpose of this investigation was to evaluate the sample rotation method with ^{203}Pb in order to find out the optimal compromise between the sensitivity of our instrument for the determination of radioactivity of samples and the measuring error due to the inhomogeneity of the sample. From our experiments it is evident that the results of measurements improve with increasing channel width for differential counting and that they are best for wide channel counting. Similar results were obtained by *Buchan* with different isotopes ^{51}Cr and ^{59}Fe under different experimental conditions and by *Harmut* et al. (5) with ^{47}Ca and ^{85}Sr.

From the results obtained for different H values the distance of 10 cm seems to be a reasonable compromise between the sensitivity of the instrument and the measuring error due to the inhomogeneity of the samples. It is important to note that the geometries a, b and c are very unlikely to be found in routine samples so that even closer approximations to unity (Table 1) are to be expected in practice.

ACKNOWLEDGEMENT

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Sažetak

ODREĐIVANJE ^{203}Pb U FECESU METODOM ROTACIJE UZORKA

Zbog sve veće upotrebe ^{203}Pb u studijama olova u organizmu neprestano se traže točniji i jednostavniji načini određivanja fekalne ekskrecije i aktivnosti velikih uzoraka biološkog materijala. Procesi koji zahtijevaju homogenizaciju cijelog uzorka stolice nisu naširoko prihvaćeni zbog svog estetskog nedostatka i teškoća pri mokrom spaljivanju.

U ovom je radu evaluirana metoda rotacije za mjerenje radioaktivnosti velikih uzoraka biološkog materijala pomoću radioaktivnog olova ^{203}Pb s modificiranim eksperimentalnim uređajem konstruiranim u Institutu za medicinska istraživanja JAZU.

Cilj rada bio je naći optimalni kompromis između osjetljivosti mjerenja i mjerne pogreške uvjetovane nehomogenošću uzorka. Valjanost metode provjerena je određivanjem radioaktivnosti ^{203}Pb. Na osnovi dobivenih rezultata može se zaključiti da za određivanje radioaktivnosti velikih uzoraka biološkog materijala (životinje, fekalije i sl.) mogu poslužiti relativno jednostavni aparati pristupačni svim kliničkim ustanovama koje rade s izotopima.

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