THE DETERMINATION OF POTASSIUM AND SODIUM CONTENT IN VARIOUS NORMAL HUMAN ORGANS¹⁾

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Normal values of radioactivity in human organs were strongly needed in the preceding paper (Egashira and Sakurabayashi, 1956), especially the value of potassium content. Not enough reliable data has been found so far to calculate the radioactivity of potassium on the basis of its content. Therefore, the author intended to determine the potassium and sodium content of several human organs, such as liver, lung, heart, spleen, kidney and brain by flame photometry.

EXPERIMENTAL

Preparation of samples: Corpses used in this work, obtained from the Tokyo-To Medical Examiner's Office, were listed as sudden death and presumed to have been normal Japanese. Details of the preparation of the samples were given in the preceding paper; by Egashira and Sakurabayashi (1956). Percentage of ash was about one percent of wet organ weights. These varied in color from white to light brown. Samples (18-22 mg) were weighed on a semi-microbalance and were dissolved in 10 cc of 6 N hydrochloric acid. Five out of 77 samples dissolved incompletely were omitted from the experiment; six other samples were discarded, because they were too hydroscopic to be weighed. The acid solution ranged in color from light yellow to yellow, possibly depending on the concentration of iron in the organs.

Flame photometry: A Beckman model DU quartz spectrophotometer equipped with a model 9200 flame photometry attachment and photomultiplier circuit was used. The instrument was allowed to stabilize before any analytical data was taken and three to five readings were taken on each sample. Potassium and sodium were determined at 768 m μ and 589 m μ , respectively. The pressure of the oxygen was 14 psi and that of the hydrogen was 8 psi.

Standard solution and the determination of potassium and sodium: Care was taken to insure the presence of the same elements in the standard solution as was present in the samples. The composition was as follows:

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Potassium chloride	26.6 mg as K
Sodium chloride	27.4 mg as Na
Calcium carbonate	2.1 mg as Ca
Ammonium phosphate	32.0 mg as P

These were dissolved in 100 cc of 6 N hydrochloric acid. Calcium carbonate, potassium chloride and sodium chloride were Merck reagent grade; the latter two were dried at 100°C for 2 hours before weighing. The ammonium phosphate was Mallinckrodt ACS Standard. With the aid of a specially calibrated micropipette, 0.1 cc of standard or sample stock solution was diluted with 4.9 cc of demineralized water and placed in 5 cc beakers for flame photometry; the solutions were atomized directly into the flame. Distilled water which had been treated with ion-exchange resin and then

Fig. 1. The linear relationship between transmission percentage and the amount of the standard solution for potassium and sodium.

Ordinate indicates the concentration of standard solution units. 1 unit means 2.66 mg of potassium and 2.74 mg of sodium respectively.

stored in a tightly stoppered polyethylene bottle was used. All glass-wares used in this experiment were coated with Desicote (Beckman) of silicon-resin. The instrument was set at 50% transmission for the standard solution which was equivalent to the average value of the samples; linear relationship then existed between 30% and 70% transmission (Fig. 1). Transmission percentage will show directly the amount of potassium and sodium contained in the sample solution (see Fig. 1), when compared with the amount in the standard solution. One unit in the ordinate in Fig. 1 means 2.66 mg of potassium and 2.74 mg of sodium, respectively.

RESULTS AND DISCUSSION

Results were shown in Table 1.

After the results of preliminary experiments, the composition of the standard

solution used in this experiment was made as similar as possible to the ashes of the various organs. Therefore, the mutual interference of potassium and sodium with each other and the interference of calcium could be canceled out. The sample solution contained no organic substances so that no enhancement of the value by organic solvent nor the interference of nonspecific organic substances was observed (Kingsley *et al.*, 1952). Mendenhall *et al.* (1953) gave the value of 42.5 mEq. and 74.1 mEq per kg blood-free wet lung for potassium and sodium, respectively, by flame photometry, showing the value of 1.70 g and 1.66 g per kg wet lung for potassium and sodium, respectively. They did not give values for any other organs. The data obtained here gives the value of 1.05 and 1.57 g per kg wet weight of lung for potassium and sodium, respectively,

Table 1. Potassium and sodium content in various human organs

Organ	Number of cases	Potassium* (%)		Sodium* (%)	
		Mean	Standard deviation	Mean	Standard deviation
Liver	10	15.24	1.73	10.77	1.93
Heart	10	20.31	3.11	10.33	2.27
Lung	10	11.89	2.77	17.78	3.19
Spleen	12	18.25	1.67	8.53	2.70
Kidney	12	11.78	1.90	17.71	2.63
Brain	12	17.06	2.97	9.89	1.85

*Figures are percentage against the total ash of the organ

being calculated from the ratio of the amount of ash to the wet weight of organs. The reasons for the difference between the data of Mendenhall *et al.* and of the authors remains obscure. However, a partial explanation may be in the fact that the specimens used in this study were not free of blood and the amount of blood in each specimen was unknown. Other comparisons cannot be made, because there is not sufficient data.

Recently Uyeno and Ohta (1955) described much higher content of potassium in several human organs: 29, 30, 30, 33, 28 and 31% of potassium for liver, heart, lung, spleen kidney and brain respectively on the basis of the amount of ash. This differs from the present data and also contradicts the radioactivity of potassium remaining in the ash shown in the preceding paper by Egashira and Sakurabayashi (1956).

SUMMARY

Potassium and sodium content of Japanese normal human organs were determined by flame photometry. The organs examined were liver, heart, lung,

spleen, kidney and brain. Results were shown in Table 1.

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