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POTASSIUM IN MILK AND MILK PRODUCTS

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ABSTRACT

The amount of potassium in imported processed milk was determined by gamma spectral analysis. The results show that the potassium content of diluted infant formula milk is closest to the reported mean concentration of potassium in human milk while other milk types have potassium values similar to the potassium content of cow milk.

I. INTRODUCTION

As a result of the Chernobyl power station accident in Russia on April 26, 1986, the Philippines has set up acceptable limits of radioactivity in imported foods and food products. To determine compliance with these limits, the Philippine Nuclear Research Institute performs radioactivity analysis on imported samples submitted by the Bureau of Food and Drug, the Meat Inepection Commission, the National Grain

Authority, the Bureau of Animal Industry, the Bureau of Fish and Aquatic Resources and the Fertilizer and Pesticide Authority. The gamma spectral analysis for fall-out radionuclides in these samples has provided opportunities for the gamma measurement of potassium-40 from which the amount of natural potassium in dairy products can be deduced.

Potassium-40 is one of the naturally occurring radioactive nuclides of very long half-life which have persisted since the formation of the earth. Its half-life is 1.27×10^9 years. The radioactive isotope occurs as 0.0117 % in natural potassium (1). It emits a 1460 kev gamma the peak area of which was used in quantitating potassium in the milk samples.

Potassium is one of the major elements in milk. Maintenance of the proper potassium ion concentration of extracellular fluids is essential particularly for proper functioning of the heart. High concentrations of potassium ions cause widespread intracardiac block while low concentrations impair the contractility of heart muscle. Maintenance of proper intracellular potassium concentration is essential for various enzymatic reactions, for the normal contractility of muscle and for impulse transmission and other functions of the nervous system (2).

This report gives the potassium content of the different milk products analyzed in the laboratory.

II. MATERIALS AND METHODS

A. Sample Preparation

The samples were obtained by the Bureau of Food and Drug, Ministry of Health, from imports upon arrival at the Philippine ports. These samples were submitted to PNRI for radioactivity analysis in relation to monitoring of milk and other food products for possible radioactive contamination as a result of the Chernobyl accident on April 26, 1986.

The sample size submitted is usually two kilos or two liters. The sample is mixed and quartered for homogenization. After mixing, a weighed amount of sample is placed in the counting container.

B. Gamma Spectral Analysis

The sample contained in a one-liter Marinelli beaker or Marinelli-type beaker is counted for a specified period of time. The counting system consists of an intrinsic high-purity Germanium detector coupled to an ND-66 multichannel analyzer . Two gamma counters were utilized for the purpose. One system, the CRD counter, has a horizontal configuration on which the Marinelli-type beaker fits (Figure 1). The other system has a vertical configuration and uses a one-liter Marinelli beaker (Figure 2).

The Nuclear Data Peak Search program was used to extract the net peak area of the 1460 kev-gamma of

potassium-40.

A mixed radionuclide standard of composition given in Table 1, was used for efficiency calibration of the detectors (3). The detection efficiency for the 1460 kev-gamma of potassium-40 was extrapolated from the efficiency values obtained at lower energies. The efficiency obtained this way was later confirmed by calibrating the detector with K_2HPO_4. The lower limit of detection is about 3.3 gram potassium per kilogram milk.

C. Sample Information, Coding and Data Computation

Lotus 123 TM, an integrated spreadsheet, graphics and data management program from Lotus Development Corporation was used to calculate potassium activity in the samples. It was also used to generate the database containing information about the sample.

III. RESULTS AND DISCUSSION

Potassium may be regarded as a major element in milk together with calcium, chlorine, magnesium, nitrogen, phosphorus, sodium and sulfur. The relative concentrations of these elements vary among milks from different species. However, the concentrations are, by and large, genetically determined while environmental, nutritional and other related factors affect these only marginally.

Table II gives the values for the major elements in mature human milk, cow milk, and goat milk. It shows that the concentrations of all major elements in animal milk

exceed those in human milk (4). With the scarcity of fresh milk in the Philippines the Filipinos rely on processed milk being imported from Europe, Australia, New Zealand and the U.S.A. The milk imports include the following: milk-based infant formula, non-dairy (vegetable protein) infant formula, full cream milk powder, evaporated filled milk, evaporated full cream milk, condensed milk, skim milk powder, buttermilk powder, and whole milk powder among others.

The average potassium content of each of the milk products are given in Table III. The minimum value (MIN), maximum (MAX), and the standard deviation (STD) are included in the table. The amounts of potassium in milk as consumed based on the recommended dilution is also given. The amount of potassium in milk specifically prepared for infant feeding approximates the amount in human milk. Human mature milk (milk after the fourteenth day of lactation) has potassium values scattered across a range of values between 329 and 705 mg/kg. The initial milk secretion (colostrum) and the succeeding period of lactation prior to the 14th day (transitional milk) contain only slightly higher amounts of potassium than mature milk. Thus the potassium content of human milk is somewhere around 500 mg/kg. Cow milk and goat milk contain higher concentrations of potassium. The mean value for the United Kingdom cow milk (5) is 1600 mg/l. Reported values in the literature range from 1300 to 1700

mg/kg. For goat milk the mean values range from 1500 to 1900 (4). The potassium values for the other types of milk are close to the mean values of cow milk reported in the literature. Thus, consumption of these types of milk by infants would mean consumption of potassium in amounts exceeding that in human milk. Although the imbalance in potassium intake may not be as important as the imbalance in other nutrients in milk resulting from feeding the infant with non-formula milk, the results reported here affirm the importance of following the doctor's advice on infant feeding.

Only potassium values are given in this report as the data reported here were obtained along with ^{137}Cs and ^{134}Cs gamma activities. It may be useful to compare the concentrations of other elements and nutrients in processed milk samples to breast milk and/or fresh animal milk.

References:

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2. Sombrito, E.Z., M. dela Cruz-Tangonan and A. dM. Bulos, "Detector Efficiency and Energy Calibration of the CRD HPGe Gamma Spectrometer System", Technical Report, PNRI-B(RC)89003, 1989.
3. West, Edward L., W.R. Todd, H.S. Mason and J.T. Van Bruggen, "Textbook of Biochemistry", New York, McMillan Co., 1966.

4. Iyengar, G.V., "Elemental Composition of Human and Animal Milk", IAEA Tecdoc-269, Vienna,1982.

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Table I. Composition of Mixed Radionuclide Standard
(Reference Date: 08-01-84)

ISOTOPE	MASS (g)	HALF-LIFE	ACTIVITY microCi
Cd109	0.13999	464 d	211
Y88	0.12403	106.6 d	205
Co57	0.00928	270.9 d	229
Co60	0.01894	5.27 y	243
Cs137	0.02139	30 y	167
Ba133	0.1687	10.7 y	223

Table II. The Concentration of Major Elements in Different Milk Types, mg/kg
(Ref.: Iyengar, G.V., "Elemental Composition of Human and Animal Milk", IAEA Tecdoc-269, Vienna,1982.)

ELEMENTS	HUMAN MILK	COW MILK	GOAT MILK
Calcium	320	1200	1400
Chlorine	420	1100	1500(mg/l)
Magnesium	40	100	200
Nitrogen	1900	5000	5000
Phosphorus	150	1000	1200
Potassium	500	1500	1700
Sodium	150	500	300
Sulfur	140	300	160(mg/l)

Table III. Potassium Content of the Milk Products

MILK TYPE	K CONC mg/kg	STD DEVN	MIN	MAX	N	K as consumed mg/l
INFANT FORMULA,COW MILK	6800	2000	3500	14000	133	890
INFANT FORMULA,NON-DAIRY	6500	940	4400	9000	58	1100
INSTANT FULL CREAM	12000	1900	6100	28000	288	1600
SWEETENED CONDENSED	4400*	600	3000	5600	39	1500
EVAPORATED FILLED MILK	3100*	340	2400	3700	9	1600
FULL CREAM EVAPORATED	2300*	830	840	3500	83	1200
SKIM	16000	2000	4400	2.000	158	
BUTTERMILK	16000	1200	13000	28000	83	
WHOLE MILK	12000	1000	10000	14000	10	

* mg/l

Figure 1 - Marinelli Type Bottle Used In Low-Level Counting With Side Looking Detector.

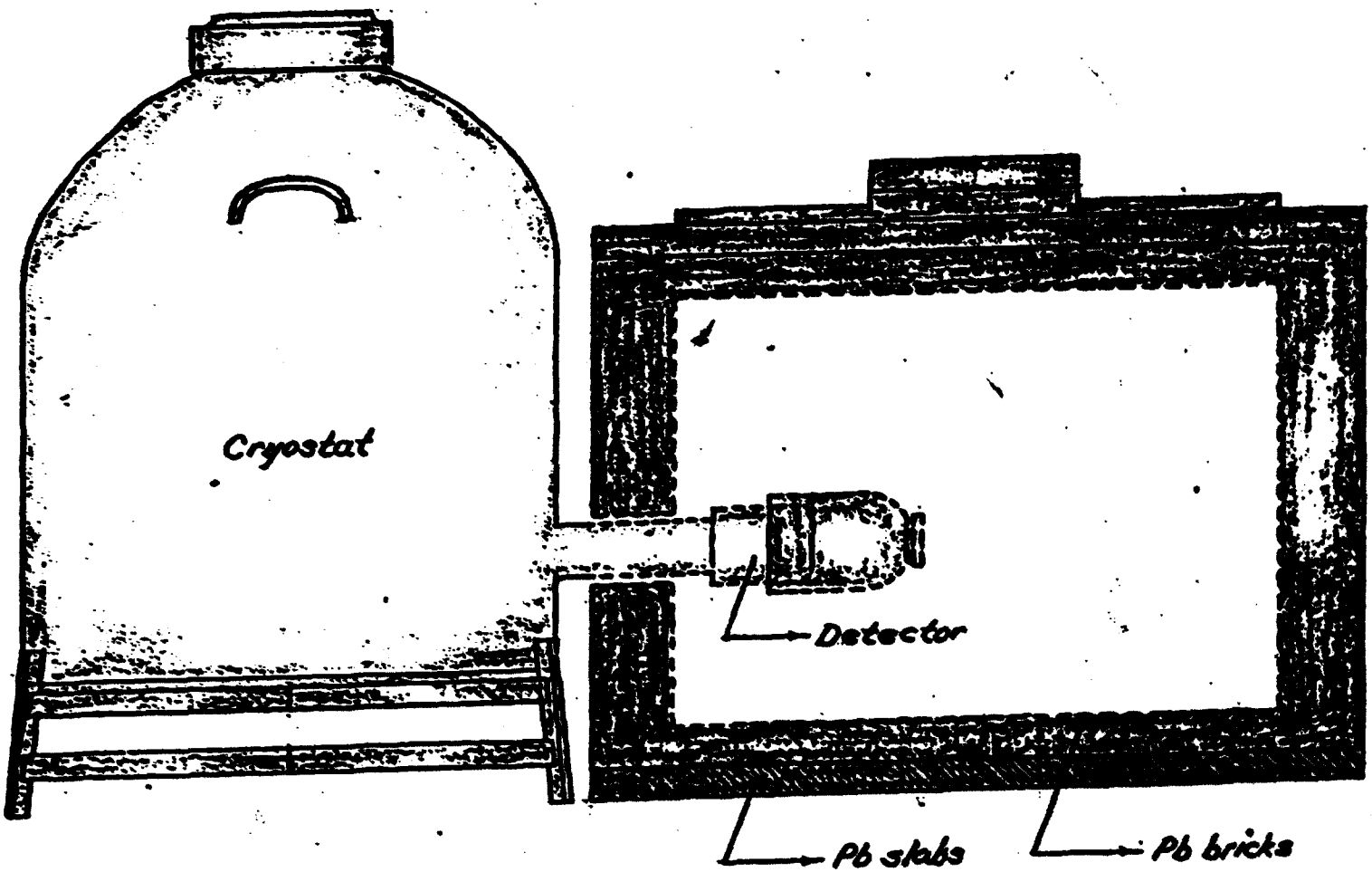

Figure 2. Marinelli beaker used in low-level counting with vertical-looking detector.