Critical Review

The Importance of Source-Dependent Bioavailability in Determining the Transfer of Ingested Radionuclides to Ruminant-Derived Food Products

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The transfer of radioactivity to the milk and meat of farm animals is likely be a major exposure pathway of human populations, following an environmental release of radioactivity The importance of source-dependent bioavailability in determining absorption from the ruminant gastrointestinal tract of the radiologically significant radionuclides (radiocesium, radiostrontium, radioiodine, and plutonium) is reviewed The requirements for and suitability of in vitro methods of determining bioavailability for absorption of these radionuclides is also assessed Radiocesium absorption varies over a 50-fold range, depending upon dietary source Source-dependent bioavailability is therefore an important factor in determining the radiocesium contamination of ruminant-derived food products, and reliable in vitro techniques have been developed to rapidly determine its bioavailability In contrast, under conditions of adequate calcium intake, the absorption of radiostrontium will not be greatly influenced by the dietary source Results of in vitro extractions of radiostrontium could be misleading, as they indicate differences in bioavailability that are not observed in the animal Absorption of radioiodine is complete and independent of source There is currently a lack of data on plutonium absorption in ruminants However, on the basis of the limited data available, in vitro incubations provide a measure of the relative bioavailabilities of plutonium from different sources The applicability of the techniques reviewed to the study of other radionuclides and heavy metals is discussed

Introduction

Following a release of radioactivity into the environment, the potential for transfer of deposited contaminants, such as radioisotopes of cesium, strontium, iodine, and plutonium through food chains to humans may be of major concern Predictive models used to estimate the likely contamination of food products derived from grazing animals tend to use default transfer values with no distinction being made for different ingested sources (*1*–*3*) Many of these transfer values are derived from studies using ionic tracer radioisotopes or herbage contaminated by root uptake However these may not always be applicable For instance, the availability of radiocesium from the initial deposit of Chernobyl fallout for transfer to grazing animals was considerably lower than values derived for ionic radiocesium or for that incorporated into grassy herbage via root uptake (*4*–*6*) To enable robust predictions of the transfer of radionuclides to milk and meat, the potential importance of source-dependent bioavailability needs to be fully understood

In this paper, we review the results from a series of experiments designed (i) to assess the importance of source-dependent bioavailability in the transfer of radiocesium, radiostrontium, radioiodine, and plutonium to ruminant-derived food products and (ii) to develop rapid in vitro and in vivo methods of assessing the bioavailability for absorption in the gut of these radionuclides which could be used to provide realistic parameters for predictive models in the event of a deposition of radioactive fallout

Bioavailability

For the purposes of the following discussion, we have defined the *bioavailability* of a radionuclide for transfer to animal products as the degree of absorption across the gastrointestinal tract, as determined by characteristics of the ingested source We have determined this as the true absorption coefficient (A_1), which has previously been defined as the fraction of ingested radionuclide that is transferred across the wall of the gut (*7*) In all of the studies discussed here, A_1 has been estimated by using dual isotope techniques By these methods, one isotope of a radionuclide is administered as the dietary source (e g , ^{137}Cs), and concurrent to this, a second isotope (e g , ^{134}Cs) is infused into the jugular vein By collecting excreta and/or milk the rate of endogenous fecal excretion (EF) of the dietary radioisotope or its rate of turnover in blood plasma can be determined The true

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