Biological half-lives for farm livestock which contribute to the human food chain

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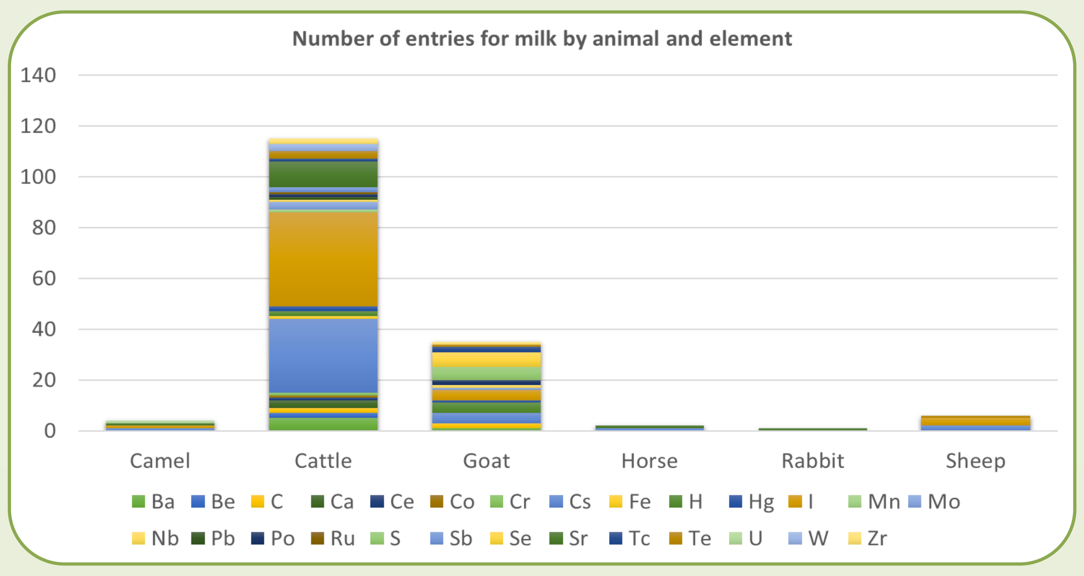
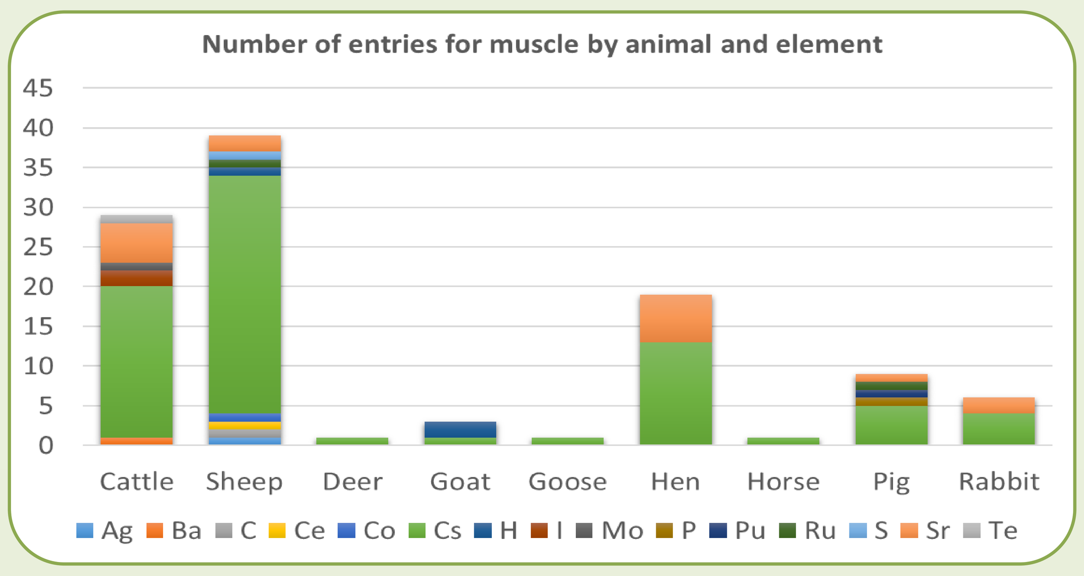




Background

International compilations of radiological data (e.g. IAEA TRS 472) have not collated information on biological half-life values for farm animals utilised for human food production. However, many predictive models use them to describe the rate of loss of radionuclides from animal tissues and products.

To address this we have conducted a review of published biological half-life values and compiled the values into a dataset of quality controlled entries.

Dataset description

The dataset comprises almost 650 entries for 32 elements (relevant to radiological protection) encompassing 12 animal types (e.g. cattle, sheep, pigs, goats, deer, geese, hens, ducks, grouse, rabbits, horses and camels).

The majority of the data (~75%) are for tissues used in the human food chain (muscle, liver, kidney), eggs or milk. The remainder are for tissues which generally are not consumed (e.g. bone, thyroid) and excreta; these values were collated as they appeared in the same references as data for edible tissues etc..

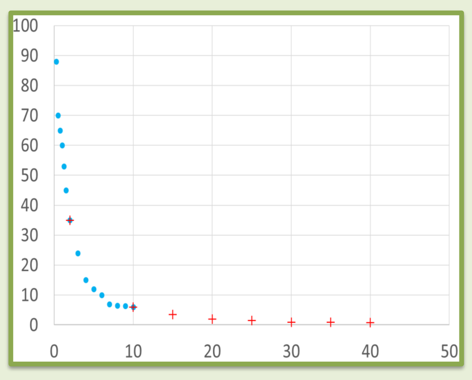
Approximately 60 % of all entries are for the radioisotopes of caesium, strontium and iodine.

Data overview

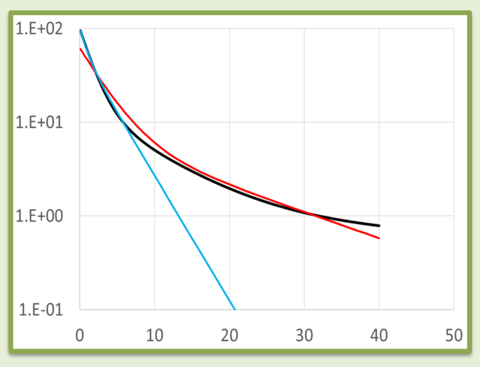
Milk: Values for milk represent approximately 30% of all the data; half of these being for Cs, Sr and I. Almost 70% of the entries for milk are for cow milk with 25% being for goat milk and <1% for sheep milk. Data are limited for other animals.

Muscle (meat): Values for muscle comprise approximately 20% of the dataset; almost all of these data (~87%) are for Cs and Sr. Data for cattle comprise ~30% of all the data; sheep ~32%, hens 19% and pigs 8%.

Eggs: Values for eggs comprise approximately 5% of the dataset with almost half of these being for the whole egg. All of the data are for hens eggs.



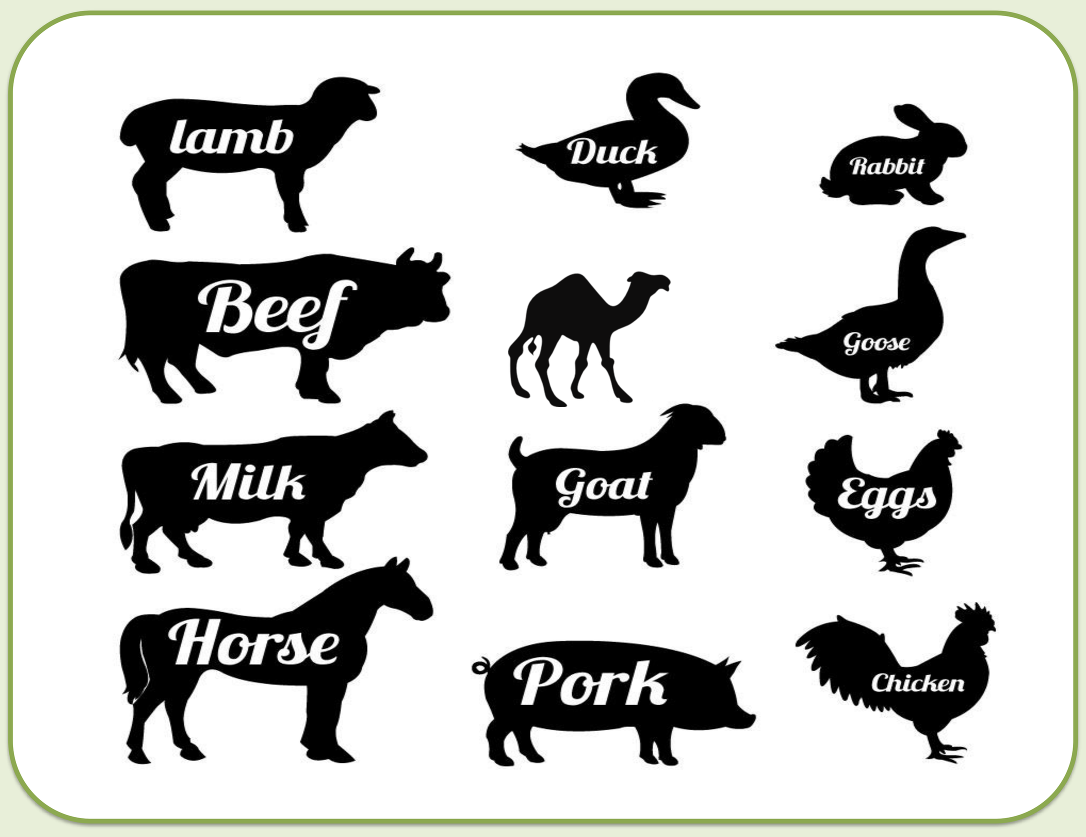
Data



Fits to data

Estimated biological half life curves:
Activity concentration for Po in cow milk (Bq/kg)
(based on Johnson & Watters, 1972)

Red line = Predicted using fit to 'red' data
Blue line = Predicted using fit to 'blue' data
Black line = Predicted data using fit to all data



Summarising biological half-life values

Is not straightforward ….. and care should be taken when analysing the biological half-life values presented within the dataset (see figure above).

This is because source references often report differing numbers of components of loss (e.g. for Cs in milk between 1 and 5 loss components are reported) which means it is not possible to derive means and associated probability distribution functions (i.e. a degree of interpretation will be required when trying to derive 'best estimates').

However, looking at data for milk for all elements and species, the majority of loss appears to takes place rapidly with a biological half-life in the range 1-3 days. This likely reflects a relatively rapid change in radionuclide activity concentrations in blood following cessation of a contaminated diet. Longer-term biological half-lives for milk will reflect those in the main storage compartment (which is element dependent).

Recommendations

Some initial best estimate recommendations:

Cs cow milk - two components of loss
1.7 days (80%), 17 days (20%)
I cow milk - single component of loss
1 day
Cs hen eggs - single component of loss:
yolk 5 days; albumen 3 days
Cs sheep muscle - single component of loss:
lamb 17 days; adult 23 days
Sr adult cattle muscle - two components of loss
4 days (50%), >200 days (50%)
Cs deer wholebody - two components of loss
1 day (30%), 15 days (70%)

Data access

The entire dataset and a list of all source references will be made available from the Environmental Information Data Centre (EIDC)

Allometry (biological scaling)

We have attempted to fit allometric (mass dependent) relationships to the data for the most abundant element-product combinations (e.g. Cs and milk) with the aim of providing extrapolation approaches to predict half-life values for species-element combinations for which we have no data.

However, whilst it looks like allometric relationships may exist, data are insufficient to establish robust models and we were unable to derive a generic relationship across elements (as we have done for wildlife).

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