METABOLISM OF INGESTED ORGANICALLY BOUND TRITIUM IN ORGANIC MILK CONSTITUENTS AND IN TISSUES OF TWO SPECIES OF RUMINANTS

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Introduction

The important routine releases of tritium to the environment by the nuclear industry have constituted a major reason for the Commission of the European Economic Community to initiate and coordinate a research programme on the radio-ecological behaviour of tritium. In our laboratory, organically bound tritium (OBT) was fed to experimental animals in order to investigate the incorporation and turnover of OBT into organic material of animal tissues and secretions.

Milk formation was used as a model for tritium metabolism studies because incorporation and turnover of tritium in organic milk constituents (milk protein, milk fat, lactose) may be considered representative for tritium behaviour in other tissues. Moreover, milk can be sampled for a long time, the main organic compounds can be separated easily and their tritium content determined. Two species of ruminant animals (cow and miniature goat) were chosen for providing the milk samples.

Material and Methods

Grass was grown under a plastic cover and sprayed regularly with tritiated water (THO). It was cut when full grown and dried to hay. After evacuation of the remaining THO by drying in a vacuum stove at 37°C, the hay was fed to two Frisian cows for 28 days and to several miniature goats for about 160-170 days. All animals were equipped with rumen fistules which insured accurate daily dosing of the same quantity of OBT. They were kept on a dietary regime of good hay without supplements.

Milk was sampled daily in all animals and milk fat, casein, lactose and milk water were separated by conventional methods. Casein was combusted to water in a Packard Sample Oxydizer and the tritium content of the combustion water determined. All other constituents were pipetted directly into the scintillation cocktail and the tritium activity was determined by liquid scintillation counting. More details of the radiochemical procedures adopted are described elsewhere.

Results and Discussion

Figures 1 and 2 show the tritium incorporation in organic milk constituents and in milk water of the cow and goat during and following the administration of OBT. The curves are similar in many respects which is not surprising because cow and goat are both ruminant animals and they are closely related physiologically. However, some differences also exist. For example, the cow incorporates about 2.5 times as much tritium in fat as in casein whereas the tritium content in casein of goat's milk is somewhat higher than it is in milk fat.

The differences and similarities are summarized in Table 1 which shows tritium content in milk constituents of cow and goat for the same daily intake of 1 mCi of OBT. When the figures for casein, milk fat and lactose are considered, it can be seen in the last column of Table 1 that the cow incorporates about three times the amount of tritium into milk fat as does the goat. The differences in tritium content of casein and lactose between cow and goat can be explained by differences in intake of feed. Under our experimental conditions, the cows

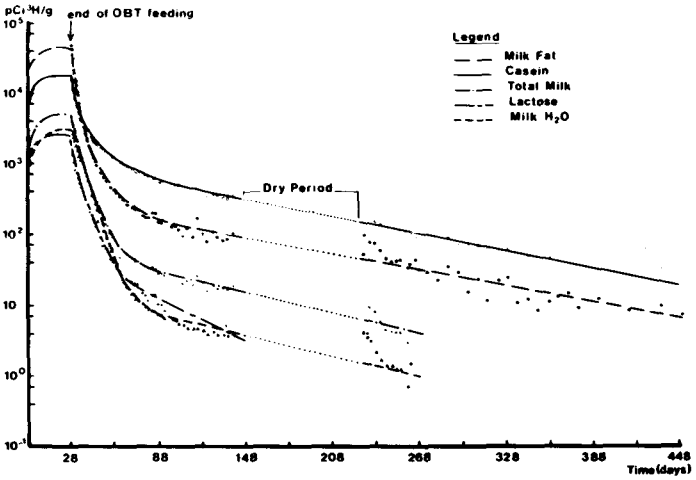

Fig.1 Tritium activity in milk fat, casein, lactose, total milk and milk water during and following ingestion of OBT by a lactating cow for 28 days.

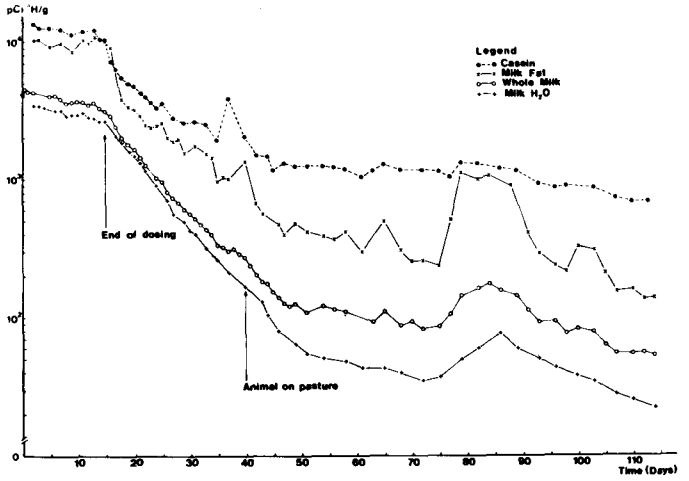

Fig.2 Tritium activity in some milk constituents and in whole milk of the goat, during and following daily ingestion of OBT for 162 days.

ingested about 21 times as much as did the goats. In other words, dilution with organically bound stable H appears to explain satisfactorily the differences in tritium incorporation in casein and lactose between cow and goat. But this is not the case for milk fat. The reason for the much lower incorporation of tritium into milk fat by the goat remains unknown. The higher ^{3}H content of milk water in the goat probably results from the slower turnover of body water in this animal as compared to the cow.

	^3H Activity (pCi/g) at 1 mCi/day Intake of OBT		
	Cow	Goat	Ratio $\frac{\text{Goat}}{\text{Cow}}$
Casein	54250	1240917	22.87
Milk fat	137978	1013730	7.35
Lactose	7998	199754	24.98
Milk H_2O	9299	311276	33.47

Table1 :Tritium activity in some organic milk constituents and in milk water in two ruminant species after continuous ingestion of 1 mCi of organically bound tritium (OBT).

Regression analysis of the curves describing the decrease of tritium activity in organic milk constituents and in milk water (Fig. 1 and 2) has shown that these curves can be resolved into three components with rapid, intermediate and slow half-lives (Table 2). Although equilibrium conditions for the pool(s) of slow turnover were centainly not obtained in the cow, the results for cow and goat show reasonably good agreement. There is a rapid decrease initially, representing uptake of organic precursors for milk synthesis from the animal's feed, followed by a much slower decrease later. The half-life values of the slow components for casein and milk water show higher values in the goat but this may be due to the much longer period of administration of OBT to goats.

	$T_{1/2}$ of Component (days)					
	Cow			Goat		
Milk Constituent	1^{st}	2^{nd}	3^{rd}	1^{st}	2^{nd}	3^{rd}
Milk Fat	1.6	7.6	88.0	2.4	9.0	78.9
Casein	1.5	10.2	82.0	1.5	7.9	133.0
Lactose	0 7	5.1	34.1	–	–	–
Milk H_2O	5.0	67.7	–	6.2	233.1	–
Whole Milk	1.7	5.5	68.0	3.2	7.0	188.0

Table 2: Biological half-life values of different components in some milk constituents of cow and goat after daily administration of OBT.

One of the goats was sacrificed one year after receiving hay containing organically bound tritium. Milk was sampled for about 30 days. The ^3H content was determined in organic milk constituents, in milk water and also in several depots of body fat. The tritium activity per gram of body fat from omentum and from adipose tissue around the kidney was significantly different, and it was 5-10 times higher than that in milk fat.