# *Biokinetics of technetium ($^{95m}$Tc) in marine macroalgae

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Abstract

The biokinetics of technetium were investigated in marine macroalgae using $^{95m}$Tc as a tracer. Green and red algae accumulated the radionuclide to a very low degree (CF ≃ 1-20); however, a much higher affinity for technetium was found in some brown algal species (CF > $10^3$ ). Comparative tests with different species of brown algae revealed that technetium does not behave similarly in all species of this group. $^{95m}$Tc loss rates in two brown algal species were found to be significantly different; for example, the biological half-lives for the slow components in these two species were 19 and 196 days.

Résumé

La biocinétique du technétium a été étudiée dans les macro-algues, utilisant le $^{95m}$Tc comme traceur. Les algues vertes et rouges accumulent le radionucléide à un degré très bas (CF = 1-20). Toutefois, une affinité très supérieure pour le technétium a été décelée dans quelques espèces d'algues brunes (CF > $10^3$ ). Des tests comparatifs sur différents espèces d'algues brunes ont révélé que le technétium ne se comporte pas de façon identique dans tous les cas. Les taux de perte de technétium dans deux espèces d'algues brunes se sont montrés notablement différents, les périodes biologiques pour les composants lents dans ces deux espèces s'étendant de 19 à 196 jours.

The long-lived beta emitter $^{99}$Tc ($T_{1/2}$ = 2.1 x $10^5$y) enters the marine environment from several sources including fallout from nuclear weapon tests, fuel reprocessing plant activities and a variety of pharmecetical uses (Wildung *et al.* 1979; Pentreath, 1981). However, to date only very few studies have been devoted to the behaviour of technetium in marine biota (Fowler *et al.* 1981; Pentreath, 1981; Masson *et al.* 1981; Fisher, 1982). Masson *et al.* (1981) recently found very high concentration factors (> 1000) in a brown alga *Fucus serratus*; however, virtually nothing is known about the factors that control the biokinetics of this radionuclide in either brown algae or other seaweeds. We report here the results of some initial experiments on uptake and retention of the gamma emitter $^{95m}$Tc in selected species of macroalgae from the Mediterranean Sea.

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Brown (Phaeophyta), green (Chlorophyta) and red (Rhodophyta) algae were exposed to $^{95m}Tc$ as pertechnetate in the laboratory under a regime of cyclic light (L:D=14:10 h). Green (Codium vermilara, Ulva sp.) and red (Sphaerococcus coronopifolius) algae did not accumulate the radionuclide to any great degree; concentration factors were low ranging from 1 to 20. However, some brown algal species were found to have a much higher affinity for technetium, with concentration factors typically ranging from 1300 for Sargassum vulgare to 2500 for Cystoseira sp. On the other hand, concentration factors in the brown alga (Colpomenia sinuosa) were two orders of magnitude lower ( $\sim$ 14) indicating that technetium does not behave similarly in all species of brown algae.

The effect of certain environmental factors on technetium uptake was also examined in two brown algal species (S. vulgare and Cystoseira sp.). Bioaccumulation of technetium appears to be metabolically controlled since uptake did not occur in heat - killed brown algae. Furthermore, both light and temperature significantly enchanced the uptake process in the two species.

In order to examine technetium retention S. vulgare and Dilophus spiralis, previously contaminated with $^{95m}Tc$, were transfered to clean sea water. The loss rate for D. spiralis was significantly greater than that for S. vulgare. For example, biological half-lives for technetium turnover in D. spiralis were found to be 2 days for the rapid component and 19 days for the slow component. In contrast, the loss curve of S. vulgare was composed of three exponential rate fonctions. The computed biological half-lives of the three components were 1,3 and 196 days, respectively. Light was found to decrease. the loss rate of S. vulgare.

At the termination of both uptake and loss phases, the relative distribution and concentration (cpm/g) of $^{95m}Tc$ in different parts of S. vulgare were investigated. Following uptake, the air bladder, leaf and small branches displayed a greater fraction of the activity and higher radionuclide concentration than the cylindrical main axes. On the other hand, after several days of loss, the highest concentration and greatest fraction of technetium were noted in the cylindrical main axes, suggesting that retention in this portion of the alga was greater than that in the other tissues examined.

Contrary to the case of marine phytoplankton which show little, if any, uptake of technetium (Fisher, 1982 ), certain species of marine macroalgae accumulate this radionuclide to a relatively high degree, i.e. CF $> 10^3$ . Thus, certain species of benthic brown algae would appear to be excellent "bioindicators" of technetium contamination in the marine environment.

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Paper presented by S. Topcuoglu (Turkey)

## Discussion

C. PAPADOPOULOU: What method did you use to check the chemical state of $^{95m}Tc$?

S. TOPCUOGLU: Technetium was reduced to the IV state for certain experiments. The stability of the reduced form(s) was checked by performing serial precipitation steps with $Fe(OH)_3$. The reduced forms are carried by $Fe(OH)_3$; pertechnetate (VII) is not. See Fowler *et al.* "Experimental studies on the bioavailability of technetium in selected marine organisms." In: Impacts of Radionuclide Releases into the Marine Environment, IAEA, Vienna, pp 319-339 (1981).

N. FISHER: In terrestrial systems, higher plants have been shown to accumulate Tc from soils. $MoO_4^=$ and $SO_4^=$ depress Tc uptake in these plants, suggesting that Tc accumulation by these plants may be mediated by enzymes responsible for $MoO_4^=$ and $SO_4^=$ uptake which cannot differentiate between Tc and these other ions. It is curious that the macrophytic brown algae concentrate Tc substantially while most other forms of algae do not. You might consider investigating the influence of excess $MoO_4^=$ and $SO_4^=$ on Tc uptake in your brown algae to get an idea as to what the mechanism of Tc uptake is in these species.

Also, have you calculated $Q_{10}$ values for Tc uptake in the brown algae?

S. TOPCUOGLU: The influence of $MoO_4^=$ and $SO_4^=$ on technetium uptake will be examined in future work. We did not calculate $Q_{10}$ values for our initial technetium uptake experiment; however, we plan to do this. Thank you for the suggestion.