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The Prevention of Radiocarbon Loss in Liquid Scintillation Counting of Solutions Containing ^{14}C-$NaHCO_3$

Summary

A METHOD is proposed for determination of the exact amount of ^{14}C introduced in the incubation flasks for primary productivity studies: vigorous shaking, in a tightly closed vial, and instantaneous counting during a short period. Nearly 100% of the activity is counted in these conditions.

Introduction

The note by IVERSON *et al.* (1976) is very interesting because it deals with an important problem which concerns all aquatic ecologists involved in primary productivity studies: the knowledge of the exact amount of ^{14}C activity initially introduced in the incubation flasks. This apparently simple problem has not been definitively solved.

Methods and Results

I have performed the same experiment as Iverson *et al.*, with a different premixed cocktail: Instagel, a product of Packard Instrument, instead of Aquasol (New England Nuclear Corporation). The initial ^{14}C-$NaHCO_3$ solution was dissolved in seawater (pH = 8) and an aliquot part (0.5 ml) was mixed with 6.5 ml Instagel. In these proportions, the mixture is clear. As Iverson *et al.* did, we obtained a regular decrease of the ^{14}C activity with time (Fig. 1). After 5 hr, the sample contained 68% of the initial counted activity, instead of 66% found by Iverson *et al.* (computed from their Fig. 1). Therefore, the results are very similar from one cocktail to the other. But after 5 hr, the scintillation vial was vigorously shaken and radioactivity immediately recounted for a short period (0.1 min); 96% of the initial ^{14}C activity was then recovered. There would be a rapid, nearly total redissolution of the $^{14}CO_2$ in Instagel.

In order to be quite clear on this phenomenon, another experiment was done. Two series of triplicates, with the same amount of radioactivity, were counted every 2 min. A regular decrease was found, as in the first experiment. In series a, 100% of the initial ^{14}C activity was recovered after 12 min, with vigorous shaking (Fig. 2). In series b, after 10 min, the vials were opened, ventilated to renewing the air above the cocktail, closed again and vigorously shaken: only 40% of the initial activity was recovered (Fig. 2).

The vials were stored for 1 month. After this period, a new count was made; 61.9 and 22.9% of the initial activity were found in the vials of series a and b respectively, before shaking. After shaking, 100% of the radioactivity was recovered in series a and 37% in series b (against 40% a month before).

Discussion

Therefore, there are two ways for standardizing ^{14}C-$NaHCO_3$ solutions for primary productivity measurements. (1) The method recommended by Iverson *et al.* is to add redistilled phenethylamine to a xylene-based cocktail, and phenethylamine + methanol to toluene-based cocktail. (2) Our method is to shake vigorously the mixture in a tightly closed scintillation vial; this point is extremely important in order to avoid the loss by the screw cap (series b). However, the last procedure makes automatic counting of a large number of samples impossible; but standardization seldom requires a great number of samples. On the other hand, it presents the advantage of simplicity and eludes the problems of solubilization.

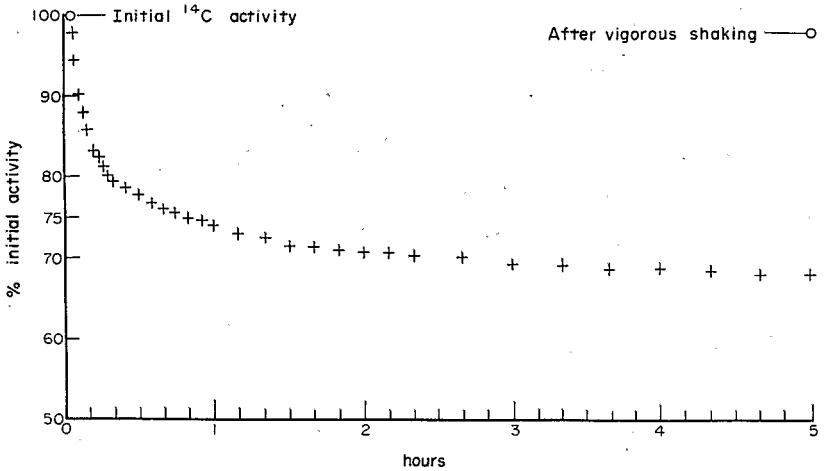

FIG. 1. The evolution with time of an aqueous solution (0.5 ml of seawater) of ^{14}C-$NaHCO_3$ in 6.5 ml of Instagel.

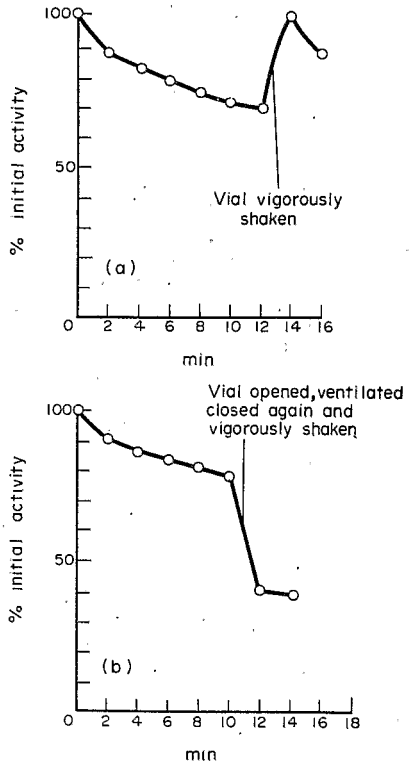

FIG. 2. Comparison of ^{14}C activity evolution with time using series a (vials closed) and series b (vials opened).

quenching and chemiluminescence due to the diverse bases used to retain $^{14}C\ CO_2$ in liquid scintillation cocktails.[3,4]

The counting must be instantaneous to obtain the correct signal. This would not be a problem, because if radioactivity in the incubation flasks is high enough to be detected through organism's uptake, it is necessarily high enough to be counted during a short period.

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