Autoradiography: a Didactical Experiment*

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ABSTRACT

This is a report on didatical uses of autoradiography.Autoradiograms are here used to exploit the following aspects: i) handling, stockage and disposal of radioactive materials; ii) the absorption of chemicals from their water solutions out of living organisms: a tomato tree and an aquarium fish; iii) the preparation of specimens for irradiations and the assemblage of their parts onto the sensitive film; iv) handling and processing X-ray dental films with the images created by beta and gamma ray emissions from atoms in the sample. Results suggest the experiment, besides quite exciting, is of great value to bring the subject of the applications of nuclear energy down to the pedestrian level, at the reach of most secondary school students.

1. Introduction

Autoradiography is a well known technique used for different purposes since the beginnings of radioactivity studies. Although its uses for teaching are expected to be of great value, owing to the optical images obtained, the inclusion of such practices in the class room do not seem to show proportional acceptation. It is possible that the reasons are related to the excessive caution with which nuclear matters are currently treated in the communication's media and to the prejudice that students, particularly in secondary school, lack the necessary self-control to deal with such dangerous components.

The aim of this note is to show that not only autoradiography can be produced in the class room, even for secondary school students, but that, on the contrary , practical sessions may develop under the most strict safety conditions without significant effort. Besides the attractiveness of the visual images obtained, the sessions are quite useful to illuminate many accompanying questions, such as nuclear lifetimes, range of nuclear radiations, special cares in handling radioactive sources and radioactive wastes disposal.

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2. Two Model Experiments

•The branches of a small tomato tree *(Lycopersicum Esculentum)* and an ornamental fish (*Tilapia*) were selected as structural materials for autoradiography. The point here is not to focus upon any botanic or zoological analysis but to show how the radiations emitted by radioactive isotopes absorbed systemically may be used to generate an optical image of the dominant aspects of those structures.The branches of a tomato tree, freshly removed from the soil, absorb sizeable amounts of most salts diluted in aqueous solution and the fish bones are particularly akin to Phosphor compounds.

•The radioactive isotope, emitting radiations used in the radiograms, are ($\approx$10μCi) each, ^{131}I and ^{32}P, as Sodium Iodide and Sodium Phosphate, respectively.

•The work requires: two hypodermic seringes for extraction of radioactive solutions throughout the protective rubber corks closing the bottles; two 6-inch test tubes ; aluminized plastic sheets; Saran wrap; dental X-ray film,400 ASA photografic film, a pair of rubber gloves; a pair of tweezers and chemicals for processing exposed X-ray and standard 400 ASA films in a dark room.

•Specimen Exposures :

a) tomato leaves

Put on rubber gloves.

Use the aluminized plastic sheets to delimit an area on the work bench where the whole preparations will take place so that droplets of radioactive solutions that drip down will not contaminate the bench. Using one of the seringes extract the Sodium Iodide solution out of the bottle and transfer the contents to one of the 6-inch test tubes; dilute, by adding distilled water so as to fill up the 4/5 of the tube height. Use a tweezer to hold the tomato branches and shove them into the test tube. No matter if they get completely immersed in the solution or not; the free ends of the stems will provide the suction required to raise the radioactive solution up to the ending thinner branches. Keep the branches into the solution during 4 hours.

b) for the fish

Remove the contents of the bottle as above and inject the 10 μCi Sodium Phosphate solution, using the spare seringe, into an aquarium with a fish specimen. For an aquarium with dimensions 20cm x 50 cm x 25 cm a 5 day long exposure will be enough.

•X-Ray film exposures

Put on rubber gloves.

After exposure remove the tomato branches, dry them up with cleaning , soft paper; meanwhile use the seringe to remove the Sodium Iodide solution from the test tube, injecting it back into the protected bottle. Wrap the residues (unused branches), used soft paper,test tube and seringe with the aluminized plastic sheet used for bench protection; put the lot in a paper bag and lock them and the bottle containing the radioactive solution in a box or drawer in a separate room, warning the eventual usuary of the premises about the presence of radioactive materials with the international symbol .

Take the exposed branches to the dark room,using a bag made with the aluminized plastic sheet, stretch them up against a wooden board covered previously with Saran foil. Use another piece of Saran foil to cover completely the specimen, thus avoiding any direct contact with the X-Ray film . Under complete darkness open the X-Ray film and press gently the wooden board containing the specimen onto the free surface of the X-Ray film. Any face of the X-Ray film will do, no matter if the one containing the sensitive emulsion faces the specimen, or not; both X-rays and β-rays emitted from radioactive atoms within the specimen are hard enough to go through the thin Saran foil (<5μ thick) and the X-Ray film plastic backing (a few mm thick). The exposure time is found by trial and error; the images shown here were obtained after a 16 hour exposure. The radiograms indicate that Phosphorus, rather than Iodine, is absorbed more rapidly by the tomato plant; the autoradiogram for Phosphorus absorption is somehow overexposed while a faint image shows up for Iodine.

Fish bones are handled much in the same way, except that previous dissecting is necessary; besides, exposure time to X-Rays is a little longer: 24 hour. In this case we have also tried an exposure to standard 400 ASA film involving only one of the fish swimming fins , that concentrate an exceptionally large amount of radioactivity; the exposure lasted 24 hours also in this case.

Development of X-Ray films is standard, but special attention has to be paid to the wole assembly wrapped in Saran foils, containing the irradiated tomato branches and fish bones.Those wastes are handled and kept in much the same way as the hardware used for preparing the samples, mentioned above. Results are shown in figs. 1 and 2, for tomato leaves and the fish bones, respectively; fig. 3 shows the autoradiograph of one fin, taken with the standard 400 ASA photografic film.

The whole procedure touches many important subjects and is used to motivate discussions and new lessons about :

- Radioactive sources
- Contamination by systemic absorption of chemicals;
- The passage of γ- and β-rays in matter
- Safe handling of materials containing radioactive elements
- Disposal of radioactive wastes

This kind of laboratory work is in course of application to a group consisting of secondary school teachers in a special class looking for opportunities to improve their professional standards.

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FIG 1

FIG 2

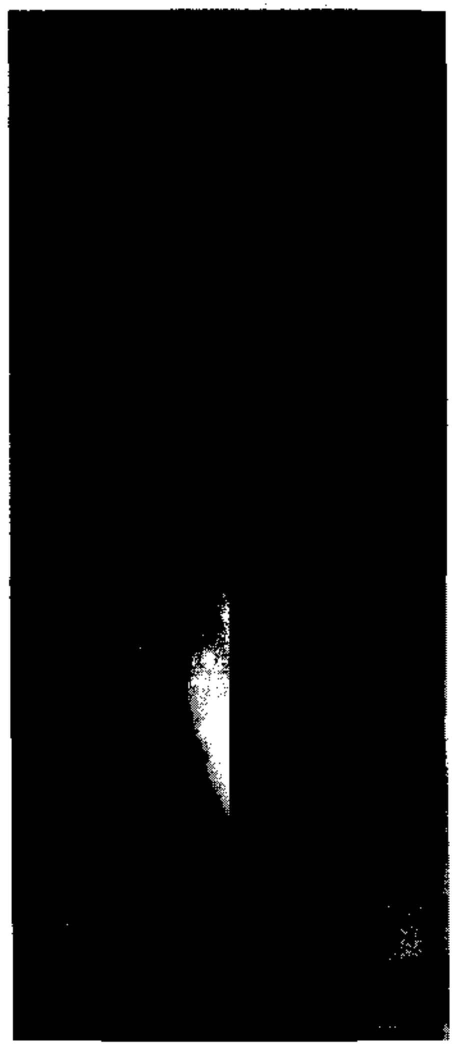

FIG 3