# Pesticide Used Packaging Management in Portugal: An Analytical Method for the Determination of Contaminant Levels

J. E. Brinco[1], T. Martins[2], J. Cardoso[3], E. P. Mateus[2], A. B. Ribeiro[2], M. D. da Silva[1]

[1]LAQV-REQUIMTE, Departamento de Química, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, 2829-516 Caparica, Portugal.
[2]CENSE - Center for Environmental and Sustainability Research, Departamento de Ciências e Engenharia do Ambiente, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, 2829-516 Caparica, Portugal.
[3]Sigeru, Sistema Integrado de Gestão de Embalagens e Resíduos em Agricultura, 1495-137, Algés, Portugal.
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Presenting author email: abr@fct.unl.pt

Modern agriculture is dependent upon the use of pesticides. With the discontinuation of techniques such as crop rotation, these compounds have become a staple in food production all over the world (Cooper, 1991). Pesticides are commercially available mostly in liquid solutions. In Portugal, the volume of pesticides sold in 2018 translates into more than 740 t of packaging material. Most of these materials are plastic containers, the remainder being mainly paper and metal. After use, the empty packaging can still have a relatively high concentration of these compounds, which are quite hazardous.

In Portugal, there is an organization responsible for the recovery and disposal of empty pesticide containers. Usually, residues classified as hazardous are destroyed by co-incineration in cement kilns. Presently, there is a campaign to promote rinsing of the empty containers by the farmers. This is beneficial for farmers as they get the most amount of compound possible from the container, and on the other hand, the packing will become less contaminated, and thus allowing for other potential uses/reuses.

In order to classify a residue according to Portuguese law, the sum of the amount of toxic compounds present must be under a certain value (usually presented in grams of compound per kg of residue). The values permitted by law vary and are related to each compound´s hazard statements (APA, 2017).

A method is being developed to determine the concentration of thirty-two high use pesticides in the residue: Abamectin, Acetamiprid, Bentazon, Bromoxynil, Bromoxynil butyrate, Bromoxynil Octanoate, Captan, Chlorantraniliprole, Chlorothalonil, Chlorpyrifos, Deltamethrin, Diflufenican, Dimethoate, Fenpyroximate, Fluazifop-p-butyl, Folpet, Indoxacarb, Iprodione, Linuron, Methiocarb, Metribuzin, Mesotrione, Penconazole, Penoxsulam, s-metolachlor, Spinosad, Tebuconazole, Terbuthylazine, Thiacloprid, Thiamethoxam, Triclopyr and λ-Cyhalothrin.

Figure 1 presents the workflow of the procedure used, adapted from Jones & Gordon (2008): The solid matrix was liquid extracted after grounding to 0.5 mm. Extraction was performed using tetrahydrofuran (THF) and a solution of 1,1,1,3,3,3 isofluoro-2-propanol in THF (5% v/v). The analytes were then determined by Gas Chromatography coupled to Time of Flight Mass Spectrometry (GC/TOFMS) and High-Performance Liquid Chromatography coupled to Diode Array Detection, depending on the compounds´ amenability to the chromatographic technique. The coefficient of determination ($R^2$) of the calibration curves was above 0.98 for all analytes, and the limit of quantitation ranged from 2 to 54 ppm (mg/kg).

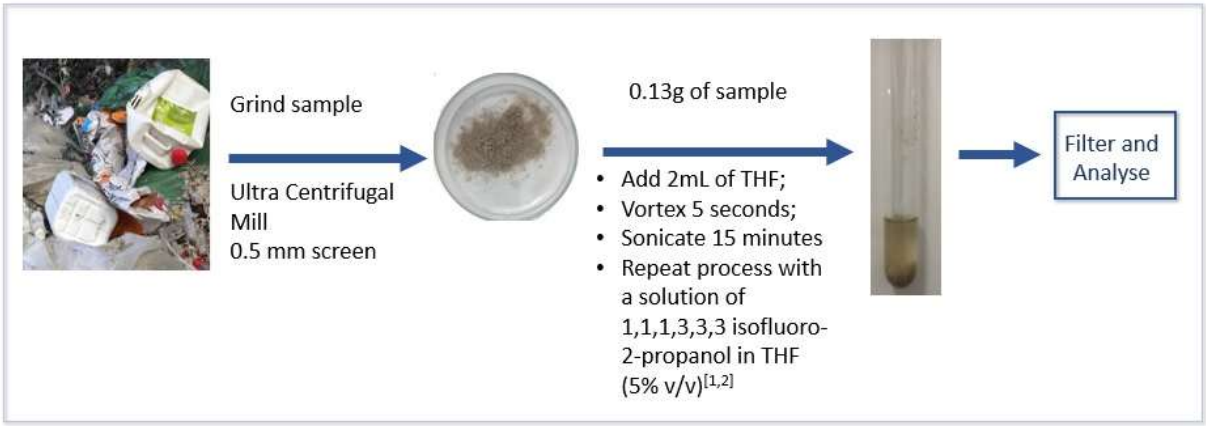


Figure 1. Workflow of the procedure.

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