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**MODERN APPROACHES TO THE METHODOLOGY  
OF DETERMINING RESIDUAL QUANTITIES OF PESTICIDES  
IN SOIL AND PLANT RAW MATERIALS**

**СУЧАСНІ ПІДХОДИ ДО МЕТОДИКИ ВИЗНАЧЕННЯ  
ЗАЛИШКОВИХ КІЛЬКОСТЕЙ ПЕСТИЦИДІВ У ҐРУНТІ ТА  
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Today, pesticides, fungicides and herbicides are used in Ukraine and around the world in intensive crop cultivation methods in order to in order to obtain high yields. As a result, there is an increasingly high incidence of soil contamination. This is a problem on a large scale, as some pesticides in the soil are highly persistent and highly toxic [1, p. 1532].

Pesticides are classified as persistent organic pollutants and are one of the most widespread pollutants in the world. It has been proven that pesticides, fungicides and herbicides can affect soil functions. The ability of soils to accumulate (absorb) pesticides depends on the type of soil

(pesticides accumulate more quickly in clay soils than in sandy soils), the temperature and humidity [2, p. 1462].

According to researchers who monitored 317 soil samples of topsoil from 11 countries of the European Union, it was found that 80% of the Union and the European Union, it was found that more than 80% of the soils studied contained pesticide residues. Of these, 25% of the samples contained residues of one active ingredient, 58% of the samples contained residual amounts of two or more plant protection products. Glyphosate and its metabolite AMPA and DDT and its metabolites were detected most often. Very often in agricultural soils the fungicides boscalid, epoxyconazole and tebuconazole were detected [1, p. 1533].

Pesticides are very toxic to living organisms, they have carcinogenic and mutagenic effects; they have a negative impact on the respiratory endocrine, immune, and nervous systems. The degree of toxicity of pesticides is determined by the degree of ease of their penetration through the skin, the ability to accumulation in the body, the degree and speed of neutralization and removal from the body. That is why the maximum permissible levels of their content are clearly defined in the regulatory documents of Ukraine and the EU [3, p. 87].

The danger of soil contamination with pesticides is that the latter through soil and water can accumulate in agricultural and medicinal plants during their growth and development. Thus, there is a high risk of pesticides getting into food and animal feed [4, p. 2; 5, p. 126594].

The standard sample-extraction methods routinely employed for pesticide residues from soil include the Soxhlet extraction (Environmental Protection Agency (EPA) method 3540), automated Soxhlet extraction (EPA method 3541), pressurized liquid extraction (PLE) (EPA method 3545), microwave-assisted extraction (MAE) (EPA method 3546), ultrasonic solvent extraction (USE) (EPA method 3550), and supercritical fluid extraction (SFE) (EPA method 3562), as well as solid-phase extraction (SPE), solid-phase microextraction (SPME), matrix solid-phase dispersion (MSPD), and accelerated solvent extraction (ASE) [6, p. 4323]. These methods are labor-intensive, take a long time to implement and have a high costly.

Today, modern analytical laboratories (including the Ukrainian Laboratory of Quality and Safety of Agricultural Products) for the comprehensive measurement of pesticide residues pesticide residues in agricultural products use the method of sample preparation QuEChERS: Quick, Easy, Cheap, Efficient, Rugged, Safe in combination with GC/MS and LC-MS/MS. Advantages of this method: fast and relatively simple technique implementation, cheapness, reliability, high accuracy and resolution [7, p. 400; 8, p. 596].

Employees of the Ukrainian laboratory of quality and safety of agricultural products NULES of Ukraine on the basis of modified sample preparation QuEChERS developed working methods for determining pesticide residues in soils, cereals and plant materials. The studies are performed on chromatographs LC-MS/MS (DIONEX-Summit 3200-Q-TRAP) and GC/MS (Agilent).

In 2022, 21 soil samples were collected for residual pesticide testing in Kyiv region, 21 soil samples were taken from the areas where crops were grown. These crops were treated once during the growing season with plant protection products. Active ingredients of the applied pesticides: biscafen, spiroxamine, trifloxystrobin, fluxypyroxad and pyraclostrobin. Application rates were according to the recommendations of the manufacturers.

In the studied soils, a screening search was conducted using the database of mass spectra of chemical compounds, pesticide active ingredients and their metabolites (250 components). It was found that the content of the above pesticides was below the limit of quantification (LOQ), i.e. <0.01 mg/kg.

The most commonly found residues in soils are those of pesticides used to treat crops.

With the proper use of plant protection products (compliance with the norms application rates declared by the developer), it is possible to prevent the excess of pesticides in the soil.

The most effective and accurate arbitration methods today, characterized by high resolution are liquid and gas chromatography (LC-MS/MS and GC-MS) in combination with the QuEChERS.

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