Determination of Salt Forms of Amphetamine Using X-ray Fluorescence Analysis [1]

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The possibility of non-destructive separation of salt forms of amphetamines by the X-ray fluorescence analysis method is highlighted in order to obtain additional data necessary to carry out comparative studies on amphetamine-containing objects seized from illegal circulation.
Keywords: *amphetamines; x-ray fluorescence analysis; salt forms; hydrochlorides; phosphates; sulfates.*

Визначення солевих форм амфетаміну за допомогою рентгенофлуоресцентного аналізу

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Висвітлено можливість неруйнівного розрізнення сольових форм амфетамінів методом рентгенофлуоресцентного аналізу з метою отримання додаткових даних, необхідних для проведення порівняльних досліджень вилучених із нелегального обігу об'єктів, які містять амфетамін.
Ключові слова: *амфетаміни; рентгенофлуоресцентний аналіз; сольові форми; гідрохлориди; фосфати; сульфати.*

Nowadays, amphetamines have become increasingly widespread on the global illegal drug market. The expertise of materials and substances within the expert specialty "Research of narcotic substances, psychotropic substances, their analogs, and precursors" includes the examination of objects containing amphetamines.

Amphetamines are most often seized from illegal trafficking in powdered form as sulfates, hydrochlorides, and phosphates. In addition to establishing the qualitative composition and quantitative

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determination of amphetamine in the objects submitted for examination, the expert is often faced with the need to determine the degree of similarity or identify their differences.

Objects can be compared based on organoleptic characteristics, quantitative content of amphetamine, qualitative content of micro-impurities, presence of residual solvents, and their salt form. The standard method for determining the salt form involves using qualitative chemical reactions, which requires consuming the material submitted for examination.

According to Article 5 of the Law of Ukraine "On Forensic Expertise," there is a requirement for maximum preservation of research objects during forensic examinations. In this regard, during the forensic examination within the above-mentioned expert specialty the need to implement non-destructive methods has become the aim of this study.

A commonly used non-destructive method for determining the elemental chemical composition in modern laboratories of the Scientific Research Forensic Centers of the MIA of Ukraine is X-ray fluorescence analysis.

The X-ray fluorescence analysis method allows to detect of elements from sodium to uranium in the periodic table but doesn't take into consideration for the presence of carbon, nitrogen, hydrogen, and oxygen. Thus, the X-ray fluorescence analyzer, when examining samples of phosphates, hydrochlorides, and sulfates of amphetamine, hypothetically should detect phosphorus, chlorine, and sulfur, respectively.

To confirm this hypothesis, within the framework of forensic examinations, samples of amphetamine sulfate, phosphate, and hydrochloride were studied using X-ray fluorescence spectral analysis on the XRF «ElvaX Pro». The samples were pre-ground in porcelain mortars, thoroughly homogenized, and placed in analytical cuvettes.

The research was carried out under the conditions listed in Table.

Research conditions by the XRFA method

Spectrometer	ElvaX PRO
Tube anode material	Rh
Task type	light
Voltage at the anode of the tube	8 kV
Primary X-ray radiation filter	no filter
Tube current	automatic selection
Collimator	№ 5 (7,5 mm)
The range of analyzed elements	from $_{11}$Na to $_{92}$U;
Analysis time	60 s, real time

Decoding of the spectra by the method of fundamental parameters was carried out using the program ElvaX ver. 4.7 (results are shown in images 1—3).

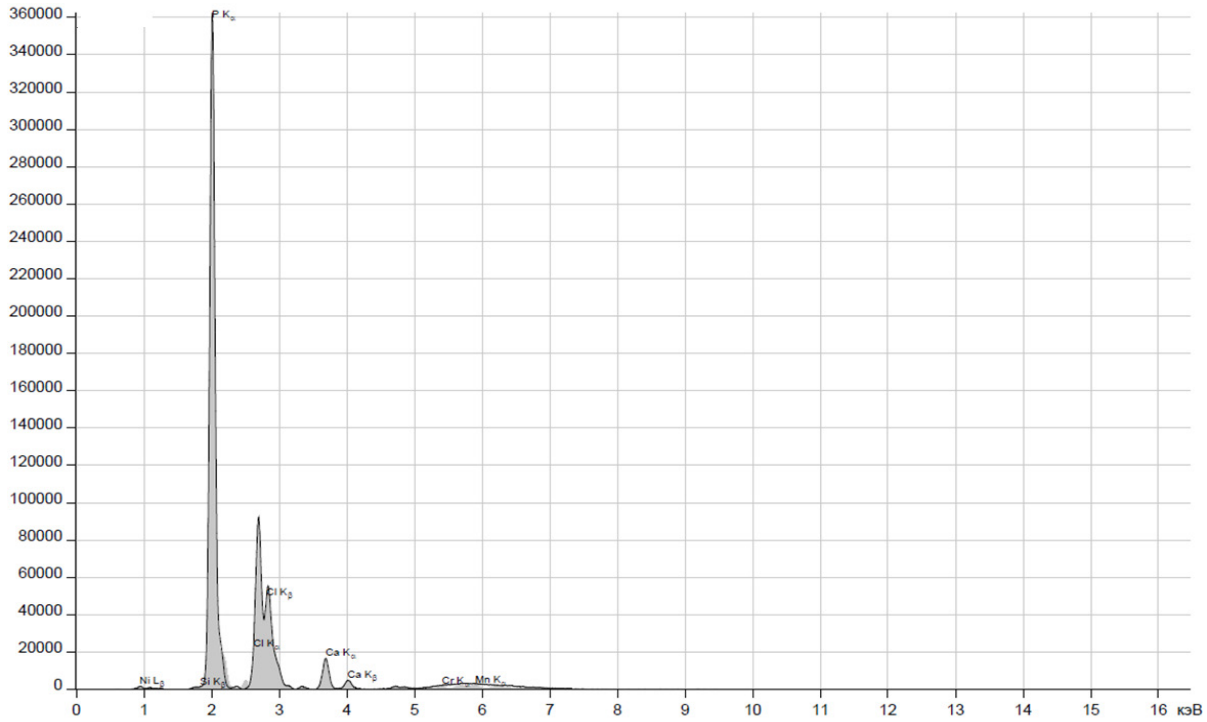

Image 1. The spectrum obtained during the study of a sample of amphetamine phosphate

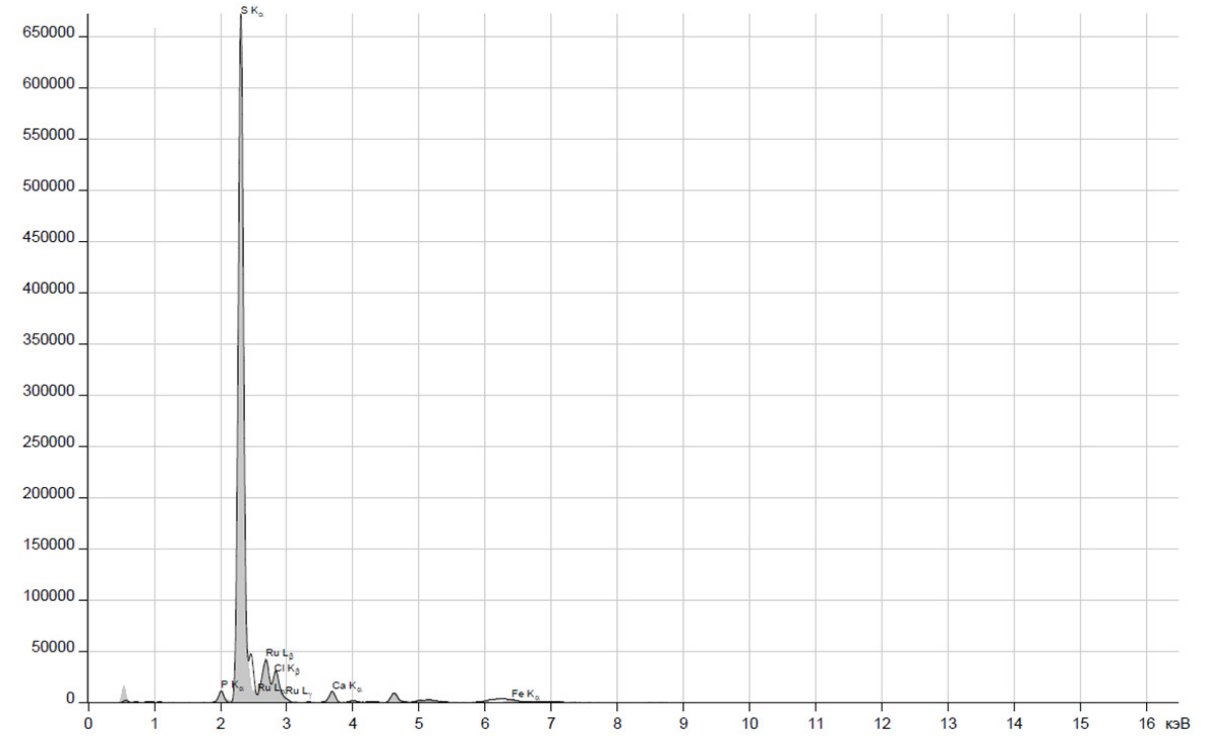

Image 2. The spectrum obtained during the study of a sample of amphetamine sulfate

Summarizing the results of the conducted research, it is possible to conclude that the use of X-ray fluorescence analysis is a convenient, non-destructive method that, during comparative studies of narcotic drugs and psychotropic substances, allows distinguishing salt forms of amphetamine.

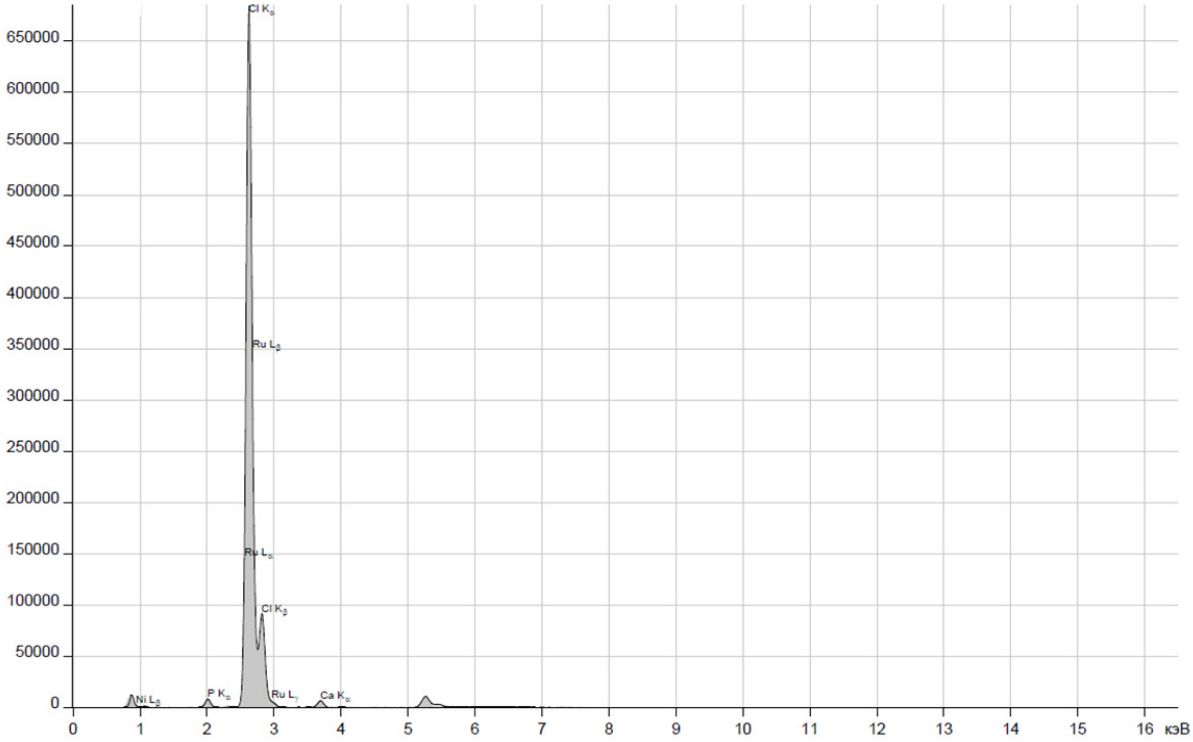

Image 3. The spectrum obtained during the study of a sample of amphetamine hydrochloride

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