

PHOTON ACTIVATION METHOD TO THE INVESTIGATION OF BIOOBJECTS CONTENT FOR JUDICIAL-BIOLOGICAL EXAMINATION

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Possibilities of the use of nuclear-physical methods for definition of element composition of biological objects (hair of animals) with the target of receipt of additional evidentiary information at the decision of diagnostics and identification problems within the limits of forensic-biological examination are shown.

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1. INTRODUCTION

For strengthening of struggle with criminality the forensic-expert establishments actively use achievements of scientific and technical progress, introducing in the expert practice highly sensitive instrumental methods of research of material evidences. The purposeful, scientifically grounded studying of signs and properties of objects, based on achievements in different areas of science, raises reliability of conclusions and quality of expert researches. However, some modern instrumental methods, which already have strongly taken root in the various areas of science and technique, presently did not find its application in the expert practice, in particular to the forensic-biological examination. There are hair of animals often by the objects of the forensic-biological examination, carrying out on various categories of criminal cases (to the crimes against the person, to plunders, poaching, road traffic accidents, to the thefts of animal, fur products and so further). Thus, at investigatory agencies for reception of the search or evidentiary information there is a necessity in carrying out of research with the target of establishment of the taxonomic belonging hair of animals and their comparative researches.

2. RESEARCH HAIR OF ANIMALS

Development of methods of research hair of animals are devoted the numerous works of scientists different countries. In the most works of experts-biologists of forensic-expert establishments of Ukraine and countries of the former USSR questions of definition of the taxonomic (family, genus, form) belonging of hair of animals on the concrete morphological signs: color, length, thickness of hair, and also structure of cuticle, cortical layer and core are

explored. However to decide identification task on establishment of belonging of hair to concrete animal unit, to concrete fur product until now is not possible.

Now sharply interest rose to the profound studying of exchange of macro- and microelements in organism in norm and at pathology. The researches in this direction have the particular significance, caused by a versatile role, which play macro- and microelements in the warm-blooded organism. They are indispensable participants of all biochemical processes, entering in the composition of metalenzymes, vitamins, hormones, stimulate and normalize a metabolism, influence on blood formation, reproduction, growth and execute the great number of other functions. Thus the use of the special methods of research of hair enables to find out elements during the protracted identification period (days, months, years). Valuable attribute of hair as an object of researches is their endurance to influencing of different factors. In spite of great number of data about meaning of biogenic elements in the warm-blooded organism, qualitative and quantitative macro- and microelement composition as a major informative index at carrying out of forensic-biological researches, presently is available not enough information about maintenance of elements in hair of animals. At the decision to one of main tasks of forensic-biological research hair of animals - establishment of them taxonomic belonging - morphological methods are as yet basic at examination of such objects. Establishment of taxon on the guard hair of animals, as a rule, does not cause complications. In these cases the known methods are used, which include processing of hair by the hot solution of alkali and studying of character of disintegration of medullary cord [1].

However sometimes enough it is difficultly to set

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a taxon hair of animals by only this method, similarity of morphological structure hair of some animals complicates their differentiation. In addition, for research of downy hair without core, quite often meeting in the expert practice, morphological method not enough, because, as is generally known, exactly core has a specific structure for concrete taxon. Obviously not enough also the use in the expert practice of only morphological tests hair of animals, which were subject to the definite technological treatment (modified hair - fur). For the comprehensive decision of expert tasks there is a necessity in research of element composition of hair. At the such complex research morphological data will be complemented by information about macro- and microelement composition of the studied objects. Chemical elements can be determined in different organs and tissues. In relation to maintenance of macro- and microelements in organism hair are a more reliable source of the information. Metabolism of hair is slow, and only the long infringements of concentration of elements in organism can be displayed in their maintenance in hair.

Hair are tissue, consisting of the protein (keratin), steady to action of external factors, warning penetration of external pollutions into hair, and also preventing a loss of internal components. This provides constancy of chemical composition. A keratin is protein, containing the rests of cysteine. This amino acid, thanks to the presence of thiol groups (SH), possesses linking properties in relation to the elements of transitional groups. It leads to that concentration of elements of insignificant maintenance in hair approximately in 50 times exceeds their concentration in blood and urine.

By chemical and spectrophotometrical methods of research in hair a generous amount of elements are exposed, such as Cu, Fe, Mo, Au, Ni, As, Ag et al. It being known that combination of macro- and microelements depend on many factors and is characteristic for every individual. If in the hair of human element composition is individual, that is characteristic only for the still human individual in norm (except for the pathological states of organism, when a disbalance can be of those or other elements), for hair of animals, which are in similar terms, it can be delivered to the general group signs, to give possibility of establishment of belonging of animals to one herd, to one habitat etc. However possibility is not excluded also of establishment of distinctions on the individual features of animals owing to presence different conditions of their maintenance, features of feed, state of organism, environment et al. Interconnection of indexes of health of man and animals with the state of environment, in particular by its chemical composition, is well known. However in the forensic-biological examination, unlike medicine, the study and use of the given knowledges is limited.

3. NUCLEAR-PHYSICAL METHODS OF RESEARCH

On today some cases are known only of research

hair of animals in relation to the element composition, thus the researches spent just spectral methods [2]. Such researches successfully are used in the forensic-medical practice in relation to the hair of human [3], but in the forensic-biological examination hair of animals they did not find the due more application. In addition, during conducting of emission spectral and atomic-absorption analysis one of important requirements to such researches is not observed, consisting of saving of properties of objects as material evidence, acting on examination, that is an analysis should be not destroying, that will give possibility of conducting of repeated or some other researches, and methods indicated higher do not meet this requirement. Therefore important place at research of macro- and microelement composition in norm and at pathology in the biological objects of a different level of organization occupy highly sensitive and more exact nuclear-physical methods, which open new possibilities and have not considerable limitations in relation to the quantitative composition of the revealed elements. Nuclear-physical methods - one of the best among the existing modern methods of research of macro- and microelement composition of objects of biological origin. To them concern: method of characteristic X-radiation, which excited by protons and heavy ions; activation analysis (gamma- and neutron); method, using an prompt radiation from the nuclear reactions; method of Rutherford scattering on of heavy ions et al. [4]. As in composition tissues of biological origin almost all chemical elements are present, for understanding of role of each of them the substantial meaning acquires establishment of quantitative descriptions and levels of concentrations of the revealed components.

The basic advantages of nuclear-physical methods are the following: high sensitivity (μ/g); possibility of simultaneous analysis more than 20 elements; ability to analyze microquantity of substance (about 1 μg); not destroying analysis (that especially important at the expert researches); simple process of preparation of sample of hair for the analysis; possibility of application of express-analysis (about 10 minutes on one target); possibility of automation of process of measuring and treatment of results of researches. The use of the characteristic X-radiation, excited by protons or multicharge ions for the determination of element composition of biological objects, has the most acceptable technical and economic characteristics (especially if the matter is about research of a few hair, up to one or its parts). This method allows to determine practically all elements - from Na to the end of the periodic system of elements. In addition, the most important preconditions of use of this method in an expert practice are the following: possibility of research of hair during the long identification period, calculated for years even; constancy of chemical composition hair of animals; changeability of quantitative maintenance of macro- and microelements depending on the state of organism, time of days, character of the used food et al.; reproduced of results.

The analysis of easy elements is executed with the use of prompt radiation from the nuclear reactions. Most widely the nuclear reactions are used at the decision N, F, C, N, B, Li, Be, Mg, Al. In this case the γ -radiation is registered, rarer - charged particles and episodically - neutrons. For N, basic element of proteins and amino acids, a detection limit makes 10^{-3} g/g in the reaction of $^{15}\text{N}(\text{p},\alpha\gamma)^{12}\text{C}$. More low detection limits (10^{-6} g/g) obtain for the B, Be, Na and on two orders higher for C, Li, Mg, Al - 10^{-4} g/g.

The use of Rutherford scattering for the analysis of biological objects allows to lower of detection limits of such elements, as Pb, Mn et al. about 10^{-9} g/g. Essence of method consists in the analysis of the targets, got by means electrolytic deposition of elements on padding from pirographite, through the resilient dissipation of accelerated particles. The γ -activation analysis, which can be applied for the decision of large number of elements, has a row of advantages before other types of analysis, for example, absence of effect of self-screening, high penetrability, express-analysis.

4. GAMMA-ACTIVATION ANALYSIS BIOLOGICAL SAMPLES

Presently gamma-activation analysis (including biological objects) on the high-intensity electron accelerator is developed and is successfully used [5]. A spectrum of γ -radiation is registered by Ge(Li)-detector. The absolute values of concentrations of macro- and microelements are determined by the method of preparation of standard samples. For measuring of isotopic ratio of Ca the nuclear reactions $^{48}\text{Ca}(\gamma,\text{n})^{47}\text{Ca}$, $^{44}\text{Ca}(\gamma,\text{p})^{43}\text{K}$, caused by the bremsstrahlung from the electron accelerator with $E=25$ MeV and by current $700 \mu\text{A}$. A detection limit of elements makes $10^{-4} \dots 10^{-7} \%$ the masses. During conducting of research works with the target of accumulation of statistical material expediently to use the gamma-activation analysis for the exposure of interspecific distinctions hair of animals under the maintenance of elements and to the isotopic relation $^{44}\text{Ca}/^{48}\text{Ca}$.

Samples of hair for the analysis were prepared on the method P. J. Barlow [6]: them separately twice washed by the distilled water with the further treatment by the mixture of alcohol with the diethyl ether (1:1), dried out at the temperature 25°C , weighed on the analytical scales and packed in the aluminum foil. Further samples placed in the chamber for studying nuclear reactions. In the gamma-activation analysis for action on the nuclei of elements are used γ -quanta of high energy. As sources of γ -radiation use, as a rule, the bremsstrahlung from the electron accelerator. The bremsstrahlung is got by acceleration of electrons to the high energies with the subsequent direction of them on target from the heavy metal (W, Pt, Ta, et al.). During of the radiative deceleration of electrons in substance does form stream of γ -quanta, having continuous distribution on energy. At research hair of various kinds the animals most often meeting in an expert practice were used: a dog domestic

(order Predatory, family Wolfish, genus Wolves), a cat domestic (order Predatory, family Feline, genus Cats), a sheep domestic (order Artiodactyl.es, family Hollow-horned, genus Ranis), a goat domestic (order Artiodactyles, family Hollow-horned, genus Goats), a mink European (order Predatory, family Mustelids, genus of Weasels and Polecats). And to the analysis were exposed both native (hair of definite animal), and modified (fur of a cap, collar and so on) hair. For comparison hair of human also were investigated.

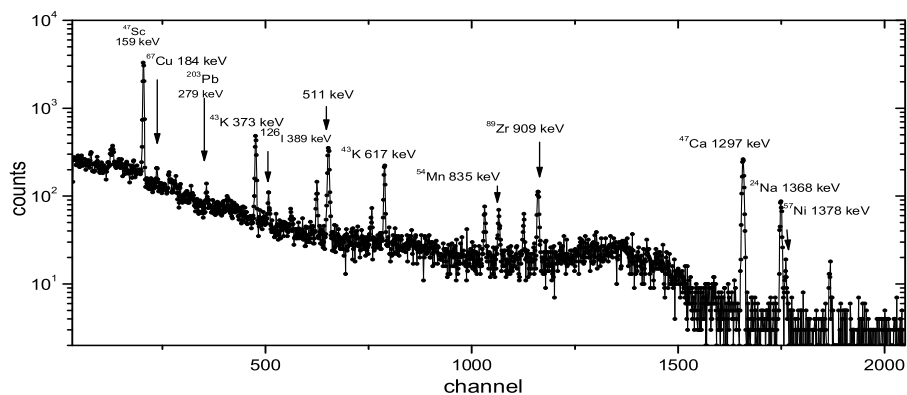
5. EXPERIMENTAL RESULTS AND DISCUSSION

As a result of research it is received more than 30 spectrum s of samples of hair in which are found out such elements: Ca, Na, Mn, Cr, Zn, Pb, Sr, Ni, Zr, I (see figure). It is obviously possible to reveal and more elements under condition of reduction of term of the beginning of registration on the detector. The analysis of the received result's on absolute values with a root-mean-square deviation has shown that there are definite differences on maintenance Ca both between the kind of animals, and between the individuals of one form. So, in the hair of dog domestic and cat domestic maintenance of calcium almost twice higher, than at mink European, and at sheep domestic and goat domestic - in 1,5 times higher, than at human. The maintenance essential elements Mn and Zn in their hair had no authentic differences. Quantity of halogen I in the hair of human in 6 times, and Ni in 1,2 times higher, than in other samples. The toxic elements Pb and Zn are found in all samples. In the hair of dog domestic and cat domestic maintenance Pb below, than in the hair of human. Isotopic relation $^{44}\text{Ca}/^{48}\text{Ca}$ for the hair of dog domestic and cat domestic did not expose substantial differences, however it less in the hair of sheep domestic and mink European in relation to the samples hair of other animals.

The correlation analysis of the investigated samples hair of human and animals is lead. The closely-coupled correlation Mn with Ca, Na, Cr, Zn, Ni, Zr in the hair of human and almost complete absence of correlation of the given elements in the hair of dog domestic is exposed. The closely-coupled correlation $KK = (-0, 7) \dots (-0, 9)$ Cr with Ca, Na, Mn, Zn, Ni, Sr in the hair of human and almost complete their absence for the hair of dog domestic is marked. The closely-coupled correlation Zn with Ca, Na, Mn, Ni for the hair of human is marked, however in the hair of dog domestic full absence of correlated connection of these elements is revealed. Concentration conditionally toxic element of chrome in the modified hair of animals, which were exposed to the definite technological treatment (fur), almost in 20 times higher, than in the native hair. In the modified hair of animals also the raised maintenance of toxic element of lead and lowered - zirconium is exposed. This it is possible to explain to those, that at the existing technology of making (etching) of fur bichromic acid is used, and at dyeing - salts of metals. Consequently,

on maintenance such elements, as a Cr, Pb, Zr, it is possible to set, native or modified (fur) hair of animal were given on research. As for dyeing of fur different dyes are used, which composition includes different under the qualitative and quantitative content ele-

ments, from data signs can set not only belonging presented on research hair of animals to natural or modified, but also, that fully it is possibly, to decide identification tasks on establishment of belonging of hair to the concrete fur good.



Gamma-spectra of hair

6. CONCLUSION

The offered methods allow not only to conduct the repeated researches of objects (if necessary), as they are not destroying, but also enable multiple removal of spectrum s through different, even considerable, intervals of time, that is important during conducting of expert researches.

The application of nuclear-physical methods of research will allow to get additional objective criteria at the comparative research hair of animals, that will promote expansion of a circle of questions, which are subject to permission during conducting of forensic-biological examination.

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ОПРЕДЕЛЕНИЕ МИКРОЭЛЕМЕНТНОГО СОСТАВА ВОЛОС ЖИВОТНЫХ ЯДЕРНО-ФИЗИЧЕСКИМИ МЕТОДАМИ

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Показаны возможности ядерно-физических методов для определения элементного состава биологических объектов с целью получения дополнительной доказательной информации при решении диагностических и идентификационных задач в рамках судебно-биологической экспертизы.

ВИЗНАЧЕННЯ МІКРОЕЛЕМЕНТНОГО СКЛАДУ ВОЛОССЯ ТВАРИН ЯДЕРНО-ФІЗИЧНИМИ МЕТОДАМИ

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Показано можливості використання ядерно-фізичних методів для визначення елементного складу біологічних об'єктів (волосся тварин) з метою одержання додаткової доказової інформації при вирішенні діагностичних та ідентифікаційних завдань у рамках судово-біологічної експертизи.