28) SPENT LITHIUM ION BATTERIES AS A SOURCE OF INCOMING OF LITHIUM AND HEAVY METALS IN HUMANS AND ANIMALS BODIES

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Abstract
Lithium is a chemical element that, due to its unique properties has proven to be most suitable for rechargeable batteries. The industry of lithium-ion batteries is developing rapidly. New types of lithium-ion batteries are being developed. "The Nobel Prize in Chemistry 2019 rewards the development of the lithium-ion battery. This lightweight, rechargeable and powerful battery is now used in everything from mobile phones to laptops and electric vehicles. It can also store significant amounts of energy from solar and wind power, making possible a fossil fuel-free society." - published on the official website of the Nobel Committee (www.nobelprize.org). Ukraine is actively importing mobile devices with lithium-ion batteries. There is no industry for collecting, processing and recycling lithium-ion batteries in Ukraine. Lithium-ion batteries are thrown to the trash. The batteries are destroyed and lithium can enter into the human and animals body through drinking water and food. Lithium is a vital element, but its excess supply can cause disease and death.
This work is devoted to the study of lithium-ion batteries as one of the ways in which excess lithium is supplied into human. The applied purpose of work was to study the content of macro and microelements of organs and tissues of adult rats under the influence of lithium salt solution. Lithium salts were added to the drinking water of rats. After withdrawal from the experiment, the content of macro and microelements in the tissues and organs of rats was determined by atomic absorption and atomic emission spectrometry. Studies have shown that lithium quickly penetrates tissues and organs. It change the content and ratio of the body's major electrolytes: potassium, sodium, calcium and magnesium, which can lead to disruption of biochemical processes and diseases.
Keywords: lithium, lithium-ion batteries, atomic absorption spectrometry, macro- and microelements, organs and tissue of rats

Introduction
Lithium is the lightest alkali metal of the periodic table of chemical elements. In recent decades, lithium has been widely used for the production of lithium ion batteries, along with heavy metals such as copper, cobalt, nickel, manganese, cadmium, lead and others. Today, the industry of lithium ion sources of electric current is developing rapidly (Mahmut Dirican, 2019). The major part of lithium ion batteries requiring recycling falls from consumer mobile devices, not electric vehicles. By the most modest forecast for 2025, about 75% of lithium will be used for the production of lithium ion batteries. Lithium production will increase significantly. According to the calculations of the International Energy Agency (IEA), if humanity goes the way of implementing the decisions of the Paris Climate Agreement, there will already be 140 million electric cars on earth by 2030. This increase will result in the accumulation of spent Li-ion batteries by the end of 2030 up to

11 million tons. Recycling lithium ion batteries is a complex multi-stage process that requires the construction of specialized industrial facilities.

In addition, lithium-ion battery manufacturing technologies are evolving and new, more efficient technologies are being introduced. Battery recycling technologies are also evolving, but far behind in time. In addition, there are currently no standards for production and proper recycling of lithium batteries. This will, over time, lead to the accumulation of spent lithium ion batteries manufactured with different technologies that require different technological approaches to recycling and disposal.

To date, no lithium battery recycling plant exists in Ukraine. Therefore, the next ways of spent lithium batteries are as follows: either they will be collected and taken to other countries for recycling, which is economically unprofitable, in the second variant they will be stored for further recycling or they will be thrown to the trash, which is being done now and will be done along the next years.

Modern lithium ion batteries can contain or contain the following metals and their compounds: lithium, copper, cobalt, manganese, nickel. Lithium is an active alkali metal with a small ion radius high mobility and high polarizing ability. It can easily get through drinking water into humans and animals bodies. Lithium easily penetrates through cell membranes, quite easily overcomes the blood-brain barrier.

From 1974 to 1984, it was proved that Lithium is a vital element for humans and animals (Anke et al., 1984). Lithium - is an essential microelement with a wide range of biological and medical effects (Findling, 2019; Moradi, 2019; Shakaroun, 2019). It has a physiological effects if the concentration in the blood plasma from 0,14 to 1,4 mmol/l and pharmacological effects if the concentration more than 1 mmol/l. If the concentration of lithium more than 2 mmol/l the toxic effects are present. Blood lithium levels above 3,5 mmol/l are fatal (Thomas et al., 2018). The most serious pathology of the effect of lithium is the progression of renal failure to the terminal stage (Harald Aiff, Per-Ola Attman, 2019). Lithium causes calciuria, phosphaturia and a decrease of phosphorus in blood serum (Neugarten et al. 2018). Due to hypercalcemia, obstructive uropathy, and hypokalemia caused by lithium drugs, nephrogenic diabetes insipidus develops (Dania Shakaroun, Hassan Nasser, 2019).

The target organs for lithium are the kidneys, brain, thyroid gland, liver and al. Like heavy metals, lithium accumulates in bone and can deposited in the muscles. Lithium homeostasis mechanisms are absent in humans and animals, so its content in the body should be controlled (Kiełczykowska, 2017).

Aim Given the above, the purpose of the our work was to trace the ways in which lithium enters the human and animal body. To study the content of the macro and microelement of the organs and tissues of adult rats under the influence of lithium salt solution.

Materials and methods

The studies were conducting on male rats' intact and experimental groups of adult age, of six individuals in each. Food and drinking regimens for both groups were standard. In the standard drinking water of the experimental group, a solution of lithium citrate was added to the lithium ions content of 10 mg/L, which corresponds to the pharmacological concentration and can be given to animals for a long time without a marked toxic effect (Konstantinos N. Fountoulakis, 2019). The animals were withdrawn from the experiment by an overdose of anesthesia on day 30.

All animal studies were carried out in accordance with the provisions: of the European Convention for the Protection of Vertebrate Animals Used for experiments and other scientific goals "(Strasburg, 1986), "General ethical principles of animal experiments "approved by the First National Congress on Bioethics (Kyiv, 2001), "DIRECTIVE 2010/63 / EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 September 2010 on the protection of animals used for scientific purposes".

The samples of the organs and tissues were withdrawn to determine the sodium, potassium, calcium, magnesium and lithium content further. Determination of the elements was carried out according to generally accepted methods (Jose A. C. Broekaert, 2002).

The contents of the macroelements were determined in an oxidative flame of acetylene-air on the atomic absorption spectrophotometer S-115 M1 (JSC "Selmi", Ukraine) in emission and absorption modes. The concentrations of the microelements were determined on a CAS 120.1 atomic absorption complex (JSC "Selmi", Ukraine) with deuterium background correction. The radiation source was a Buck Scientific, Inc. (USA) hollow cathode lamp. An A-5 electrothermal atomizer 28 mm long with an inner diameter of 6 mm with a standard graphite-coated furnace was used. The analytical wavelengths: Li – 670.8 nm, Na – 589.0

nm, K – 769.9 nm, Ca – 422.7 nm, Mg – 285.2 nm were used. Spectral measurement conditions and temperature-time modes for all elements were standard (Analytical Methods. Agilent Technologies, Inc., 2017). The analytical signal has scanned in increments of 0.016 s and processed by the software "AAS-SPECTR3".

Results

The results of the studies showed a significant increase in the level of lithium in serum, kidneys, brain, wool, femur bone, liver. Significant changes in the content and ratio of potassium, sodium, calcium and magnesium in the organs and tissues of experimental animals were shown compared with the intact group. Samples of organs were selected for histological examination of the influence of lithium salts on the macro and microscopic structure of tissues and organs. The high content of lithium ions in the organs and tissues of animals can be explained by the high permeability of lithium ions through the biological membranes. Such changes in macronutrients contents can cause disruption of biochemical processes and the functioning of vital organs and systems. First of all, it are kidney, brain, thyroid gland, liver.

Conclusions

Thus, the strong influence of lithium ions on the content and ratio of major electrolytes was revealed. Increased concentrations of lithium were found in all tissues and organs that were examined. Further studies will focus on histological examination of the specimens obtained. Studies will be conducted regarding the monitoring of lithium content in environmental objects: soil, reservoir water, drinking water, plants and their residues, humus.

These studies require the use of an atomic-absorption analysis using a hollow cathode lamp for Li Buck Scientific, Inc. (USA) and a graphite A-5 electrothermal atomizer to determine the lithium content of natural samples. In the future, it is planned to carry out projects to determine the content of lithium and heavy metals in fallen leaves and the feasibility of composting use as fertilizer.