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ANALYSIS OF THE EFFECT OF INCREASED CONTENT OF NITRATE-IONS IN DRINKING WATER ON THE HUMAN BODY

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One of the main problems of water quality of decentralized water supply of Poltava region is increased content of nitrates ions. There is no one settlement where this indicator would correspond to the norm. In some samples, excess of the norm is 200 times. Oil and gas extraction complex, use of mineral fertilizers (mainly nitrates), herbicides and pesticides are the main sources of nitrate ions in the first aquifers on adjacent areas. To identify the dynamics of nitrate ions we took and examined samples of water from the mine wells and wells with different depths, checked the impact of technogenic sources and agriculture, investigated the seasonal changes in concentrations. It was established that due to poor quality of drinking water with exceeded content of nitrate ions changes are occurring in the body: energy metabolism is changing; free radical oxidation of lipids in the salivary glands due to the formation of excess nitric oxide occurs. The impact of the increased concentration of nitrate ions in saliva enzyme activity was detected.

Keywords: decentralized water supply, well, nitrate ions, intoxication, salivary glands, lipid peroxidation.

Problem formulation: Water is one of the important components of the environment and human habitat. Experts from the World Health Organization found that 80% of human diseases associated with poor quality of drinking water and violation of sanitary and environmental norms of water supply. The current state of water supply in rural areas of Poltava region is characterized by the dominant presence of decentralized sources, namely mine wells. There are more than 200 thousand of mine wells in the region. More than 605,000 people use well water (decentralized water) with drinking purposes. Up to 30% of consumers are children [1].

However, one of the main problems of water quality of decentralized water supply of Poltava region is increased content of nitrate ions. There is no one settlement where this indicator would correspond to the norm [1-4]. In some samples, excess of the norm is 200 times. [1]. The peculiarity of this type of pollution is that nitric acid salts (nitrates) is well soluble, so they come from different sources, easily diffuse over long distances in aquifers, penetrate on significant depths with seeped water. Their presence in water is impossible to define by organoleptic indicators, it is possible only by chemical methods of analysis [5]. Lack of public awareness is the reason for the use of poor quality water. Some of the owners drill wells in a private order and drink water without preliminary chemical analysis of water. This is not always the problem solution, since according to the results of studies [6-9] the boreholes water often also contains an increased concentration of nitrates. In previous works, we investigated the problem of poor water quality relative to nitrate-ions, and presented possibilities to improve its quality [10, 11].

The aim of our work was to investigate the impact on human health of excessive amounts of nitrate ions that come from drinking water. The drinking water using with excess of nitrate-ions is dangerous to the human body because provokes a number of diseases. The ability of nitrates to be reduced to nitrite ions in the human body leads to the formation of methemoglobin. Prolonged consumption of water with excess of nitrate- and nitrite-ions results in disturbances in the digestive system, cardiovascular system. Under the influence of microorganisms of the gastrointestinal tract nitrozoaminy and nitrozoamidy are formed in the body that can cause cancer, disrupt the nervous and cardiovascular systems, affect the development of embryos [7, 9, 12]. The main regulatory document for water quality set maximum allowable concentration of nitrate ions is not more than 50 mg/l, equivalent to nitrate nitrogen is 11.1 mg/l [13]. In addition, there is a proven fact that for people who live near landfills dumps, where the garbage is burned, frequency of increase of methemoglobin content was 16%. The maximum concentration of methemoglobin of people in this group was reached to 17.5%. In 28% of cases an increasing in the concentration of lactate in the blood was observed. Carbon dioxide and carbon monoxide, hydrogen sulfide, methane and its homologues were detected in the atmosphere. So, in this group of people the methemoglobinemia is accompanied by oxygen deficiency [14].

The general incidence, incidence of the gastrointestinal tract, peptic ulcer, gastroduodenitis and disease of the hepatobiliary system are widespread diseases of Poltava region residents who drink water contaminated with nitrates [1]. Prolonged use of water with excess of nitrite- and nitrate-ions leads to disorders in the gastrointestinal tract and cardiovascular system. For adult the lethal dose of nitrate is from 8 to 14 grams. Acute poisoning occurs from 1 to 4 grams of nitrate. Signs of poisoning are manifested after 1-6 hours after nitrate intake into the body [12].

In this paper, we have focused on the influence of excess of nitric oxide that is formed from exogenous precursors (chronic intoxication by sodium nitrate) on energy metabolism, lipid peroxidation, antioxidant system, activity of the α-amylase enzyme in the salivary glands. The main task was to establish the level of accumulation of nitric oxide in the form dinitrosyl complexes of iron in the tissues of the salivary glands of white rats under chronic intoxication with sodium nitrate and to identify the main biochemical changes. It was found that the level of iron dinitrosyl complexes increased after a 30-day poisoning by 39.2%, after a 60-day - by 51.6% after 90 days - by 68.2% [15].

Results. Raising the level of nitrogen oxide accompanies violations of bioenergetic processes in the tissues of the salivary glands. Compensation processes were noted at short periods of chronic nitrate intoxication. Long-term poisoning leads to persistent disruption of energy metabolism and functional indicators. The inflammation leads to the formation of endogenous nitrogen monoxide. Together with exogenous nitrate intake they create a synergistic effect.

We have performed a series of experiments to study the impact of drinking water with increased content of nitrate ions on the rate of enzyme reactions, namely, the action of amylase. So we have processed the diluted saliva (1:5) by various amounts of nitrate ions of different concentrations. We have studied the effect of not only concentration but also temporal effects. It was interesting and important to explore the possibility of immediate impact, because people using drinking water with increased concentration of nitrate ions creates an instant effect on the enzymes of saliva. It was determined that potassium nitrate solution with a titer of 0.1 mg/cm^3 represents the limit. When processing of saliva with the solution with the lower concentration of potassium nitrate, an immediate decrease in the activity of amylase was not observed.

When the ratio of 1:1:1, i.e., when 1 volume of aqueous solution of potassium nitrate (T = 0.1 mg/cm^3) and 1 part of 1% starch solution are added to 1 volume of aqueous solution of saliva (1:1) is a sharp decrease in the activity of enzymes of saliva.

The dependence of enzyme activity on the duration of contact of saliva and nitrate ions was detected. With prolonged contact, solutions with a lower concentration of nitrates decrease enzymatic activity.

We have performed experiments [10, 11]. Our aim was to reduce the concentration of nitrate ions in drinking water. It was important to maintain the macro-composition of water to meet the standard and physiological needs of humans. The population filters the water, trying to clean it. But cost-effective filter loads do not solve the nitrate problem.

We conducted a study of sorption properties of activated medical carbon of different brands purchased in pharmacies of Poltava relative to nitrate ions. We

investigated the pills of 3 different manufacturers. The results of experimental studies are presented in Figure 1

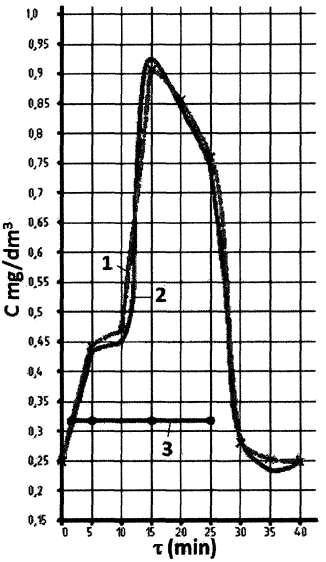

Fig. 1. The dependence of the desorption of nitrate ions in water, depending on the exposure time. 1, 2 – JSC Stoma, Kharkiv; 3 – Pharm-Kholding, Kyiv;

It is obvious that activated carbon does not absorb nitrate ions from solutions with known concentrations of nitrates. Moreover, desorption of nitrate ions begins from the first seconds of contact (manufacturer 1). This means that the maximum concentration of nitrate ions in solution is observed after 15 minutes of contact. This shows a lack of cleaning and preparing of pills. So people get an extra amount of desorbed nitrate ions while using sorbents. Pills of the second manufacturer are qualitative and do not desorb nitrate ions.

Conclusions and recommendations

The use of water with a content of nitrate ions, which exceeds the norm, affects almost on all systems of the human body

The exogenous income of 200 mg of sodium nitrate per 1 kg of body weight leads to the accumulation of nitrogen oxide in the salivary glands as dinitrosyl complexes of iron and to development of chronic nitrate intoxication.

The chronic nitrate intoxication violates energy metabolism in the salivary glands.

The chronic nitrate intoxication causes a disturbance of antioxidant defense in the tissues of the salivary glands of white rats and increases the lipid peroxidation.

Drinking water with high content of nitrate ions deactivates the saliva enzymes.

It is impossible to reduce the concentration of nitrate-ions in the water in the domestic conditions, using activated carbon and other low-cost filters.

It is necessary to carry out regular monitoring of nitrate-ions content in decentralized water supply of rural settlements of Poltava region with mandatory public awareness.

It should recommend for the population the alternative types of drinking water – to buy bottled water for daily use.

It is necessary to create state programs and begin work to provide the population with drinking water of proper quality.

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