

SAFETY INDICATORS OF DRINKING WATER FOR ANIMALS IN BIOGEOCHEMICAL AREAS OF UKRAINE

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There were studied the sanitary and hygienic quality indices of drinking water for animals taken from water supply sources on twenty dairy farms out of eighteen farms located in the North-Eastern, Western, Central and Southern biogeochemical areas of Ukraine. It was established, that on organoleptic, bacteriological and sanitary-chemical indicators of drinking water for animals did not meet the requirements of the state hygienic standards. The total quantity of mesophilic aerobic and facultative anaerobic microorganisms and the content of iron, manganese and mercury in the water exceed the standard's limit.

Key words: *drinking water for animals, sanitary and hygienic indicators, biogeochemical areas of Ukraine*

The water exchange in animals is associated with the functions of various physiological systems, as well as with the feeding keeping system, species, age and breed of cattle, its productivity and performance [1-3]. Therefore, providing animals with high-quality water in sufficient quantity is the key to their good health and performance. At the same time, water can be one of the sources of exposure to harmful chemical agents [4-6].

Solving scientific and practical issues regarding the quality of water for watering animals, the ability to influence the processes of metabolism and transformation of hazardous substances getting into food products have been covered in the works of many scholars and practitioners [7,8]. However, the data on the study

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of water composition formation, indicators of water safety and quality, sanitary assessment of water supply sources and water supply network in farms in different biogeochemical zones of Ukraine are limited in the scientific literature. In this regard, the main aim of our work was to study the hygienic and sanitary indexes of the quality and safety of water used for watering animals in different regions of Ukraine.

Materials and methods of investigation. The study was conducted during 2011 – 2012 in 18 agricultural enterprises of Volyn, Vinnytsia, Dnipropetrovsk, Zhytomyr, Kirovohrad, Kyiv, Lviv and Chernihiv regions, four biogeochemical zones of Ukraine. Samples of water used watering animals were taken from two points (wells and drinking points) seasonally, according to the methodology described by V.V. Voroniak et al. [9]. The water was tested by the methods of parallel samples (n=3) in the certified state laboratories of veterinary medicine. The chemical composition of water was determined by the Kurlov's formula [10,11]. Assessment of water with respect to its quality and safety was conducted in accordance with the requirements of the State sanitary rules and norms "Hygienic requirements for drinking water intended for human consumption" (DSanPiN 2.2.4-171-10) [12].

The research results and their discussion. Our previous research suggests that the assessment of water quality and water system should be an important component of the monitoring of veterinary and sanitary well-being of animals in modern livestock farms, which will ensure high quality and safety of animal products [13]. Animals must drink water, the quality of which should not be lower than that of water which is consumed by people. While assessing the quality and safety of water the experts in the field of livestock feeding are governed by the State sanitary norms and rules "Hygienic requirements for drinking water intended for human consumption". The SDA 41.00-37-422:2006 (Standard of organizations of Ukraine) there has been also developed in Ukraine and used for the assessment of surface and underground water in livestock and poultry production [14].

In general, on the most of the farms where research was carried out there was used the centralized water supply. The groundwater from different aquifers is used as a source of water supply. For example, in Western biogeochemical area the water

comes from the fractured rocks of Marcelino-Cretaceous thicker of Canon-Turon Volyn-Podolsk artesian basin. The farms from the North-Eastern region of Ukraine are using the water from fractured Precambrian rocks of the Ukrainian crystalline shield. Only on the one of the farms the animals consume water from open reservoirs during the pasturing period. In the farms of the Central biogeochemical zones the main source of water are fractured Precambrian rocks of the Dnieper artesian basin. On the three dairy farms of the southern region, the dairy cows are provided with water that comes from interstitial water of the Precambrian rocks of the Dnieper upland. Along with this the two participated farms used for watering the animals the surface water of Kakhovka reservoir of Dnipro river.

Groundwater is considered to be the most reliable source of the farms water supply, but it not always meet the requirements for drinking water and is generally characterized by a high level of salinity and water hardness, high concentration of iron, silicon and manganese. These indexes not only affect the organoleptic characteristics of the water, but also may pose a risk to human and animal health [4,15].

The qualitative composition of groundwater is formed by the interaction of a number of natural factors, the main of which include climate (precipitation, temperature, evaporation, and so on) and geological structure (the composition of rocks, tectonics, hydrogeological conditions). Depending on the combination and sequence of the occurrence of these factors it is formed the main spatial patterns of the natural composition of groundwater. But in recent decades, natural qualitative composition of the water has deteriorated significantly due to the influence of intensive human activity.

According to research results of many local scientists, the underground water of active water exchange zones on the territory of Ukraine, have a clear natural hydrochemical zonality, which consists in modifying the chemical type of water and the increase in the concentration of all ions, except bicarbonate, from North-West to South-East of Ukraine [18]. The use of underground sources for centralized water supply on farms has many advantages in comparison with the surface water supply.

In particular, the underground water sources are protected from outside contamination, safe in epidemiological terms, have a constant chemical composition and flow rate. During the hygienic assessment of the quality of artesian water we considered the influence of artificial factors due to anthropogenic impacts along with natural factors shaping its composition.

The drinking water on the investigated farms were from artesian wells. On one of the farms in the southern region as the source of water supply served the mine pit. The depth of water withdrawal from aquifers ranges from 9 to 160 meters. Water system (pump stations, water mains), in accordance with the technical documentation, has been operated within 25 – 40 years. The water supply networks of steel tubes, which are exposed to corrosion, wear out and leak. In addition, two dairy farms in Eastern and Central biogeochemical zones are using galvanized pipes in the water supply network of their premises. All of the above factors cause deterioration of the quality of water used in agriculture.

Water wells are mainly located on the territory of dairy farms. According to the results of our research showed a number of violations of sanitary requirements as to their placement and operation. The area designated water source is not landscaped, not fenced, no green plantations available. There areas have a free access of both people and animals. In addition, the sanitary protection zones are not observed (close placement to the livestock buildings, premises for the storage of silage or beet pulp, walking grounds for animals, tanks of waste and so on), These contributes to the pollution of the exploited aquifers themselves.. All of the above factors contribute to the deterioration of water quality used on farms, and this, in turn, has a negative impact on animal health and product quality.

The results of the research gave the opportunity to review the state of the sources and water supply systems and to evaluate the quality and safety of water for watering animals on twenty dairy farms of eighteen farmstead located in the North-Eastern, Western, Central and Southern biogeochemical zones of Ukraine. The results of the research and their analysis were described in previous articles [18, 19, 20]. Thus, the study of water on organoleptic (smell, taste, colour intensity, due to the

content of organic substances, suspended solids) showed that in the majority of farms, except farm of the West biogeochemical zones, the water did not meet sanitary and hygienic requirements. Excess of maximum permissible concentrations (MPC) averaged 1.2 to 4 times, especially in the farms of the North-Eastern region. This was mainly due to the high turbidity index. The last one was due to the presence of suspended solids of organic and bacterial origin.

Permanganate oxidation of water indicates the amount of oxygen required for chemical oxidation with permanganate of potassium easy-oxidized organic and inorganic substances (salts of ferrous iron, sulfide, ammonium salts, nitrites, and so on). The index of permanganate oxidation of water on the farms of different biogeochemical zones of Ukraine are shown in the diagram 1. In the spring, on farms of all zones permanganate oxidation does not exceed 0.6 - 0.7 MPC, in the summer it has grown in the farms of the Western area and reached the verge of MPC. At the same time in other areas the index was higher than the MPL 1.1 - 1.8 times. In the autumn its level went down and was the same as in the spring time, with the exception of the farms of the Southern zone, where it markedly exceeded the MAC. In the winter time, the permanganate oxidation index rose to the level of the MPC.

For microbiological indicators, water samples did not meet sanitary and hygienic requirements. The total number of mesophilic aerobic and facultative anaerobic microorganisms (MAPAM) in water all farms exceeded the permissible values of 1.1 - 1.5 times in water sources and 3 - 7 times in drinking bowels. The value of the coli-index exceeded the permitted values in water from artesian wells on the farms of Northeast of biogeochemical zones. Increased bacterial contamination of water in drinking bowels were observed on farms of all biogeochemical zones and it was higher during the summer and autumn periods of the year. The obtained results indicate the increased contamination of water with microorganisms not only due to distance it travels from wells (spatial factor), but also due to the high ambient temperatures (seasonal factor).

On the farms where the water source is an artesian well the eggs of adolescent trematodes and helminthes were not detected. In one of the farms of the North-

Eastern biogeochemical zones during the grazing period (May - September) the water was supplied from surface sources. In this particular farm the laboratory examination of water revealed adolescent trematodes (fasciolae and parafistomas), as well as eggs *Tenia* that lives as a parasite in the small intestine of carnivores.

The degree and duration of pollution with organic substances can be assessed by the presence of nitrogen compounds (ammonium, nitrate and nitrite) in water (their amount and ratio). The source of their entry into aquifers are domestic and commercial sewage, migration of nitrogen fertilizers in soils. During the study of water samples it was established that the content of ammonium nitrogen was slightly increased during the year in the farms of the North-Eastern region. The double excess of nitrite content was detected in the water on the one of the farms of the Central biogeochemical zones, and four time excess – on one of the farm of the Southern region. In the first case, artesian well and water tower on the farm were located near waste pump and biogas plant, in the second case – the water is pumped to the tower from the mine pit of 9 m deep, which is near the pond.

The growth of anthropogenic load leads to contamination of water sources. Among the large number of pollutants those of special importance are heavy metals, pesticides and radionuclides. The study of the possible risks of their negative impact on the animal, and through them on the food products and on the human health are very important [19, 21-22, 23].

The results showed that the content of lead, cadmium, arsenic, copper, zinc in water does not exceed the allowable values, and for lead was not more than $1 \mu\text{g}/\text{dm}^3$, cadmium – not more than $0.1 \mu\text{g}/\text{dm}^3$, arsen – an average of $2 - 4 \mu\text{g}/\text{dm}^3$, cuprum – from 10 to $40 \mu\text{g}/\text{dm}^3$, zinc – $5 - 40 \mu\text{g}/\text{dm}^3$. Along with this there was found the excess level of mercury, manganese and iron in all biogeochemical zones (Fig. 2 - 4).

Indicators of the content of mercury in water are shown in the diagram on figure 2. The concentration of mercury in the water varied seasonally and ranged from 0.3 to $0.9 \mu\text{g}/\text{dm}^3$. Its highest concentration was observed during the spring and summer period on the farms of the West and South of biogeochemical zones where it exceeded the MPC on average 1.2 times. At the same time in the Central and North-

Eastern areas it was on the verge of MPC. In autumn and winter time, the mercury concentration was 0.6 - 0.8 MPC, except for the farms of the Southern zone, where it was slightly higher.

The content of manganese in the drinking water of the farms in all biogeochemical zones mostly did not change seasonally and ranged from 110 to 192 $\mu\text{g}/\text{dm}^3$, which is 2 to 4 times greater than the specified maximum of allowable limits (Fig. 3). The highest concentration was in the water on the farms of the Southern zone in summer, autumn and winter season.

The results of the study of the content of iron in water are shown in the diagram of figure 4. The concentration of iron in water from wells ranged from 120 to 680 $\mu\text{g}/\text{dm}^3$, and from drinking bowels - from 105 to 513 $\mu\text{g}/\text{dm}^3$. The highest level has been detected in the spring when it 1.5 - 3 times exceeded the MPL, and the lowest in autumn – 0.6 - 0.8 MPC. In the spring time on all farms the iron content in the water was 1.8 - 2 times higher in drinking bowels than wells.

Studies of the radionuclides ^{137}Cs and ^{90}Sr in drinking water for animals from underground sources of all farms showed that their activity is low and is not more than 2 mBq/dm^3 . It's a thousand times below the allowable levels of specific activity of these radionuclides for drinking water.

The results of these studies indicate the safety of the water as to the content of pesticides. The concentration of organochlorine pesticides in water did not exceed 0.001 mg/dm^3 and organophosphorus not more than 0.01 mg/dm^3 . According to the obtained data it can be argued that the admission of these toxicants into the body of animals with drinking water does not pose a real danger to their health. However, in order to determine the real threat of pesticides to animal health it should be taken into account their total number, coming in not only with water but also with feedstuff.

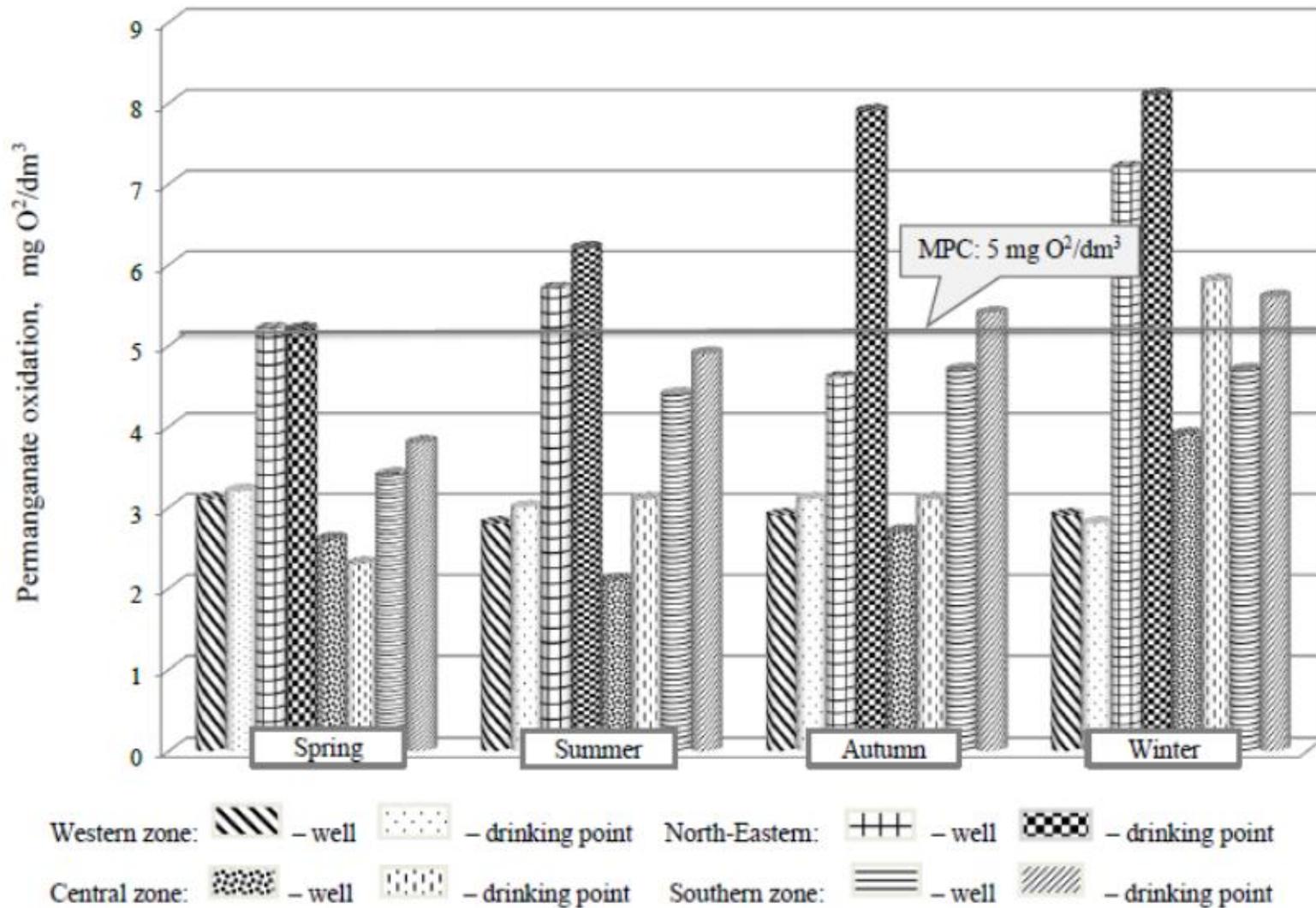


Fig. 1. Permanganate oxidation of drinking water for animals in biogeochemical zones of Ukraine

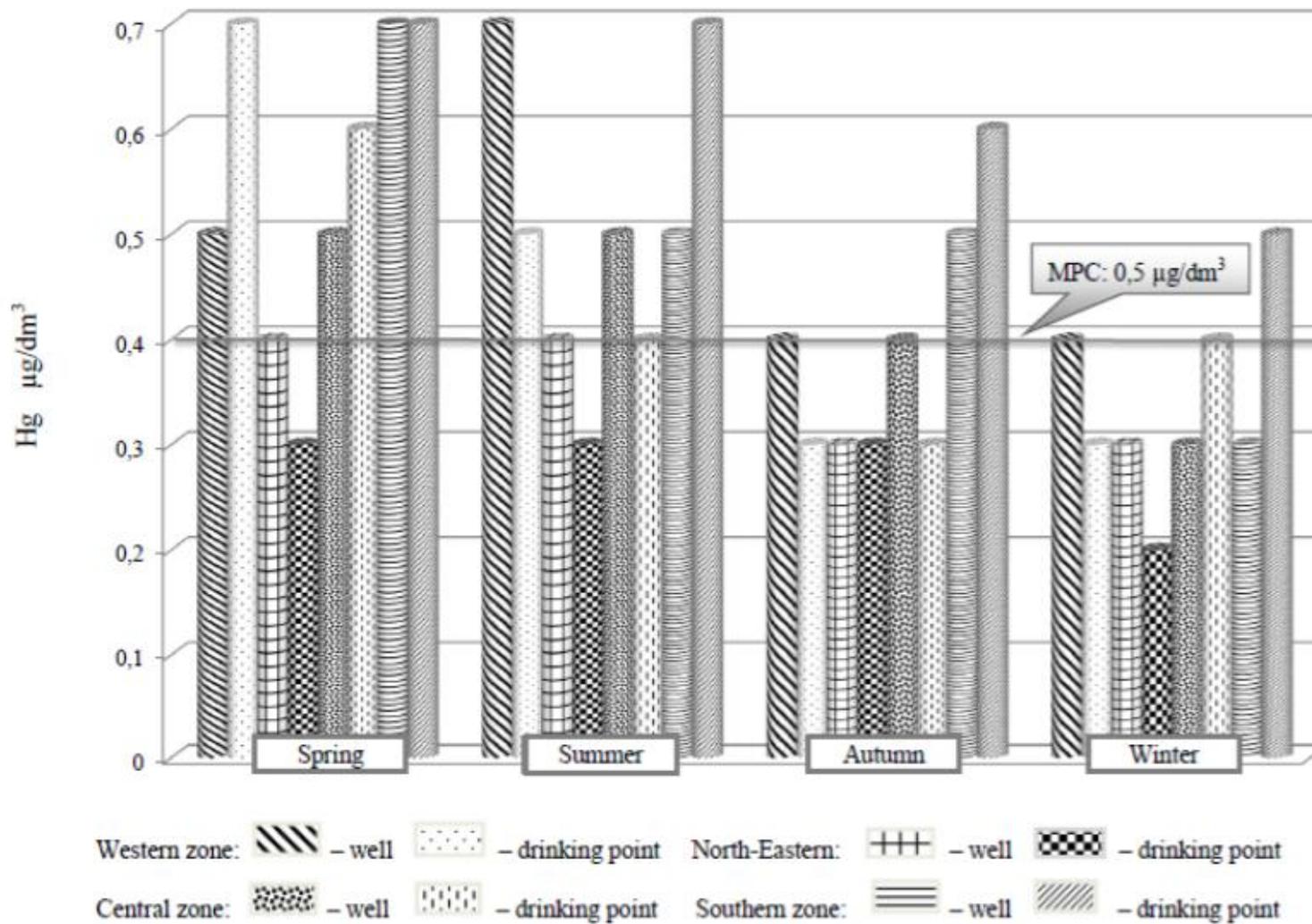


Fig. 2. The content of mercury in the drinking water for animals in biogeochemical zones of Ukraine

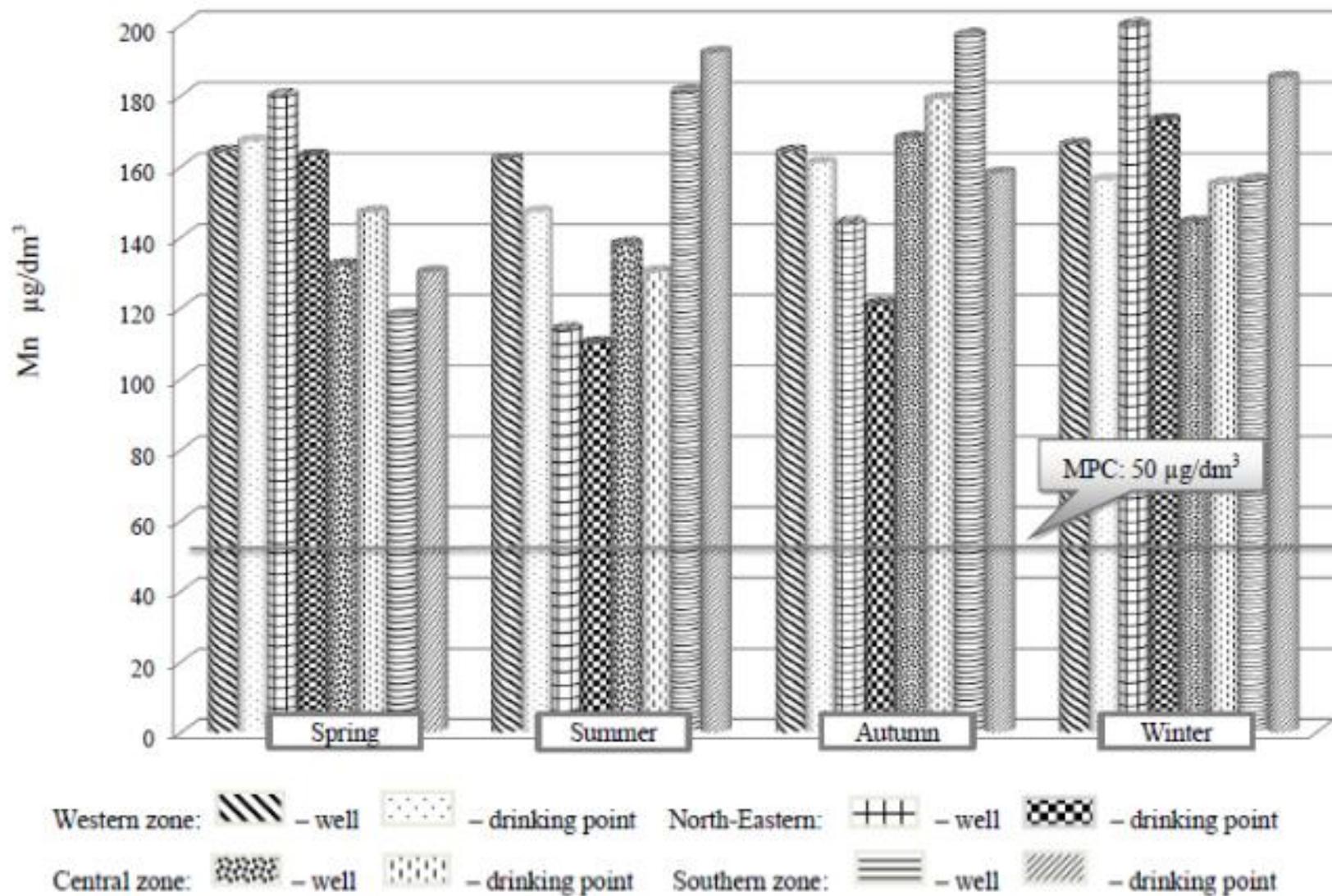


Fig. 3. The content of manganese in the of drinking water for animals in biogeochemical zones of Ukraine

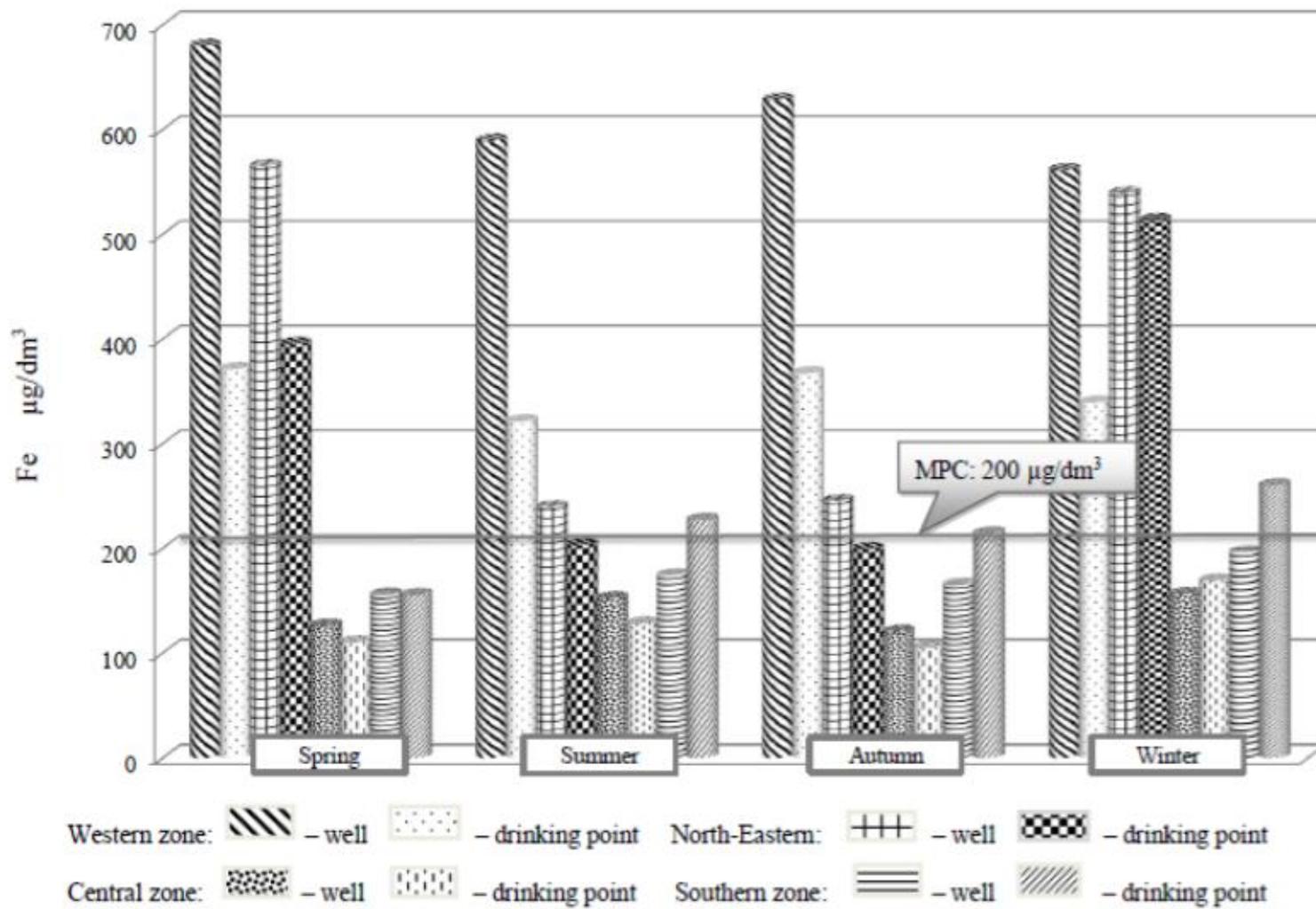


Fig. 4. The iron content of the drinking water for animals in biogeochemical zones of Ukraine

Conclusions

1. Sanitary-hygienic evaluation of water sources and quality of drinking water for animals on twenty dairy farms of eighteen farmsteads located in the North-Eastern, Western, Central and Southern biogeochemical zones of Ukraine showed that sensory, bacteriological and sanitary-chemical indicators on the most of the farms do not meet the requirements of the state hygienic standards.

2. The number of mesophilic aerobic and facultative anaerobic microorganisms in the water of all farms exceeded the permissible level by 1.1 - 1.5 times. The content of mercury, iron and manganese in water exceed the permitted values. There were found the marked seasonal fluctuations of organoleptic, bacteriological and sanitary-chemical indicators of water quality.

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ПОКАЗНИКИ БЕЗПЕКИ ВОДИ ДЛЯ НАПУВАННЯ ТВАРИН У БІОГЕОХІМІЧНИХ ЗОНАХ УКРАЇНИ

В. М. Соколюк

Вивчено санітарно-гігієнічні показники якості води із джерел водопостачання для напування тварин на двадцяти молочно-товарних фермах вісімнадцяти господарств, розташованих у північно-східній, західній, центральній та південній біогеохімічних зонах України. Встановлено, що за органолептичними, бактеріологічними та санітарно-хімічними показниками

вода для напування тварин не відповідає вимогам державних гігієнічних нормативів. Загальна кількість мезофільних, аеробних і факультативно-анаеробних мікроорганізмів у воді та вміст феруму, мангану та меркурію перевищує встановлені граничні допустимі показники.

Ключові слова: *вода для напування тварин, санітарно-гігієнічні показники, біогеохімічні зони України*

ПОКАЗАТЕЛИ БЕЗОПАСНОСТИ ВОДЫ ДЛЯ ПОЕНИЯ ЖИВОТНЫХ В БИОГЕОХИМИЧЕСКИХ ЗОНАХ УКРАИНЫ

В. М. Соколюк

Изучены санитарно-гигиенические показатели качества воды из источников водоснабжения для поения животных на двадцати молочно-товарных фермах восемнадцати хозяйств, расположенных в северо-восточной, западной, центральной и южной биогеохимических зонах Украины. Установлено, что по органолептическим, бактериологическим и санитарно-химическим показателям вода для поения животных не соответствует требованиям государственных гигиенических нормативов. Общее количество мезофильных, аэробных и факультативно-анаэробных микроорганизмов в воде и содержание ферума, марганца и ртути превышает предельно допустимые показатели.

Ключевые слова: *вода для поения животных, санитарно-гигиенические показатели, биогеохимические зоны Украины*