UDC: 631.6.03:636
DOI: 10.56407/bs.agrarian/2.2024.42

Ukrainian Black Sea Region Agrarian Science
Vol. 28, No. 2

The influence of water quality in the Western biogeochemical zone of Ukraine on the organisms of farm animals

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Abstract. The research of water indicators in the farms of the Western biogeochemical zone of Ukraine is important and relevant in terms of ensuring water quality for cattle. The aim of the study was to investigate the chemical regime of groundwater used for animal watering in the farms of Lviv and Rivne regions. Methods that were used in the study included: drinking samples; atomic absorption spectrophotometry; turbidimetry; and removal of microbiological and organic biofilm and bacteria. During the study of drinking water supply for cows, it was found that water turbidity was increased in all seasons, especially in summer, but the organoleptic properties of water, such as smell, colour, taste and aftertaste, met the standards. It was found that the alkalinity index exceeded the standard threshold limit value in spring. The amount of calcium ions increased in autumn and winter and generally ranged from 115 ± 25.2 to 156 ± 12.7 mg/dm^3. It was also found that the levels of manganese were increased by two times and iron by three times above normal. Nitrate levels in the water samples were close to exceeding the permissible limit and ranged from 15.2 ± 8.91 to 26.3 ± 14.68 mg/dm^3, while mercury was also within the sub-threshold range and reached 0.1 ± 0.1 to 0.3 ± 0.11 μg/dm^3. It is worth noting that the use of hydrogen peroxide and activated silver solution not only improved the health and productivity of cows but also ensured an increase in the quality of milk produced. The results of the study can be used in practice by ecologists, agricultural workers, and state and local governments to develop and implement programmes and projects to manage the quality of water supply on farms

Keywords: source; watering trough; cows; heavy metals; turbidity; cavitation

INTRODUCTION

Regular researches on methods for assessing water quality are important for maintaining a favourable environmental state of the territory of dairy farms in the Western regions. The study topic requires thorough examination since one of the main problems of farms is the issue of providing quality drinking water from centralised water supply sources. This problem exists because the water supply systems are located in areas where there is significant industrial and agricultural activity, which can lead to contamination of still waters and sources with chemicals and pesticides. The consumption of contaminated water by animals can lead to gastrointestinal diseases and hepatitis.

According to the study on water quality indicators and their impact on the productivity of livestock, presented in S. Movchan *et al.* (2021), the necessity of implementing comprehensive measures to improve water quality on the farm was identified. According to the

Article's History:
Received: 07.02.2024
Revised: 11.04.2024
Accepted: 11.06.2024

Suggested Citation:
Bondar, A. (2024). The influence of water quality in the Western biogeochemical zone of Ukraine on the organisms of farm animals. *Ukrainian Black Sea Region Agrarian Science*, 28(2), 42-52. doi: 10.56407/bs.agrarian/2.2024.42.

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researchers, a possible way to solve the problem of water quality and increased energy costs for the water supply of livestock farms may be the implementation of a water filtration and purification system on farms.

During the study on the health risks associated with consuming drinking water with elevated nitrate (NO_3-) levels, research by M. Danchyshyn (2023) provided new data on the age-related characteristics of metabolic processes during the consumption of nitrate-contaminated drinking water. In particular, these results on the impact of water with excessive nitrate content on blood parameters are of practical significant for farmers in Lviv and Rivne regions, which use local water sources to meet their needs and animals.

O. Berehova & O. Liapina (2020) examined the impact of present impurities on the development and productivity of poultry. It was found that heavy metals in the water used for drinking by animals accumulated in vital organs and slowed down the development of young animals, ultimately leading to a decrease in the quality of meat products.

The study by N. Hetman *et al*. (2022) focuses on the use of cavitation-treated water in the agro-industrial complex and the benefits of measures to introduce the latest technologies for its structuring. Significant benefits of using structured water in animal husbandry and poultry farming, such as reduced animal mortality, cultivation without the use of synthetic vitamins and antibiotics, increased productivity, improved product quality, reduced disease, and reduced need for antibiotics, have been documented.

The analysis of nitrate contamination in water conducted by H. Krupko *et al*. (2023) provided important conclusions for implementing measures to preserve drinking water quality and reduce risks to public health. The measures outlined in the study, such as the optimal use of fertilisers and pesticides in compliance with the time intervals for their application, annual well cleaning and disinfection, can be implemented on farms in the Western regions of Ukraine.

The scientific research by O. Dereza & S. Dereza (2020) examined water purification processes and methods such as sedimentation, coagulation, and filtration. The study presents a possible solution to the problem of water purification from suspended particles and microorganisms. The authors noted that additional water treatment, such as ultrafiltration or irradiation with ultraviolet light, could be a solution to this problem.

The authors S. Kelina & O. Nevinsky (2021) emphasise the urgency of the problem of increasing phosphate content in Ukrainian water bodies, which leads to eutrophication and complicates water treatment. They refer to the data that only when the phosphorus concentration in water bodies is reduced below 0.5 mg/dm^3 eutrophication is limited, and at a concentration below 0.05 mg/dm^3 it almost completely stops. Therefore, the authors highlight the importance of quantitatively determining orthophosphates in natural objects.

It is worth noting that insufficient attention has been given to studying methods for improving wat er quality for cattle and plants as a tool for improving their health and productivity from a technical, economic and environmental perspective. The purpose of the study was to investigate methods and approaches to improve the quality of drinking water in conditions of chemical and bacterial pollution. The research objectives included investigating the effect of the cleaning method on the overall productivity and health of cows; assessing the effectiveness of the method of using a solution of hydrogen peroxide and activated silver on water quality in the drinking water supply system in farms in the Western biogeochemical zone of Ukraine.

MATERIALS AND METHODS

The study was carried out using research methods for assessing water quality established by legislative acts: DSTU 4077:2001 (2002), State Sanitary Rules and Regulations 2.2.4-171-10 (2010) and DSTU 7525:2014 (2014). Water samples for animal drinking in the farms were collected from the drilled water well and watering troughs seasonally according to the guidelines of the methodology for sanitary and hygienic water quality assessment. The study was conducted in compliance with ethical standards:

1. Ensuring dignified standards of dairy cow welfare, including proper nutrition, access to clean water, free access to open spaces, and medical care.
2. Minimising resource use (water, land, energy) and reducing waste associated with milk production.
3. Providing accurate and reliable information to consumers about the conditions of dairy cow farming, milk production, and its potential impact on health.

In the study, the method of drinking samples (n = 3) was used to assess the concentration of substances in the liquid. The method of atomic absorption spectrophotometry was used for determining the content of heavy metals in water; the turbidimetry method for measuring water turbidity; the method of removing microbiological and organic biofilm and bacteria for cleaning and disinfecting the water supply system; and the M.H. Kurlov formula for analysing the major ions and salt composition of water (Khilchevskyi *et al.*, 2012).

The research was conducted during 2022-2023 in five farms located in the Western biogeochemical zone of Ukraine in Lviv and Rivne regions, namely: privately held company (PHC) Agrofirma Luhove; agricultural service cooperative (ASC) Pokrova; Lesya Ukrainka agricultural producer cooperative (APC); agricultural limited liability company (ALLC) Idna; Peasant (farm) household (PFH) Kalynivske. Water from the groundwater of the Volyn-Podilsky artesian basin was used as a source of water supply in the farms of the Western biogeochemical zone of Ukraine (Table 1).

Table 1. *Indicators of aquifers whose water is used for animal watering*

Name of the enterprise	Water abstraction depth, m	Aquifers
PHC Agrofirma Luhove, Luhove village, Brody district, Lviv region	70	Maastricht fissured marls of Upper Cretaceous deposits
ASC Pokrova, Zabolottsi village, Brody district, Lviv region	60	Maastricht fissured marls of Upper Cretaceous deposits
Lesya Ukrainka APC, Ploska village, Dubno district, Rivne region	85	Chloride-sodium waters of Myrhorod type in volcano-sedimentary rocks of the Vendian and Paleozoic
ALLC Idna, Ostrozhets village, Dubno district, Rivne region	70	Chloride-sodium waters of Myrhorod type in volcano-sedimentary rocks of the Vendian and Paleozoic
PFH Kalynivske, Kalynivka village, Sarny district, Rivne region	110	Radon mineral waters of Vendian and Paleozoic volcano-sedimentary rocks

Source: *compiled by the author*

The depth of artesian drilled water wells on agricultural and farm enterprises ranged from 60 to 110 m. According to the water abstraction technical documentation, the water supply systems of the studied farms had been in operation for 30-40 years. The research was conducted on experimental farms housing 155 milking cows, 15 dry cows and 126 calves and heifers. The water was measured at the following points: from the sources, water storage tanks, calf watering troughs, chutes for dry and milking cows, as well as heifers.

The study of qualitative and quantitative indicators of impurities in drinking water from the water supply sources of agricultural and farm experimental enterprises was conducted at the State Scientific Research Institute of Laboratory Diagnostics and Veterinary Sanitary Expertise in Kyiv. Equipment used for detecting heavy metals in sample specimens included: an atomic absorption spectrophotometer AA-7000 (manufactured in Japan) with a hollow cathode lamp and a titanium burner, operating on an acetylene-air mixture principle; a water quality scanner consisting of a device for measuring adenosine triphosphate (ATP) content, and a turbidimeter the Orion AQ4500 (manufactured in the USA), which utilised a photometric operating principle with the light source aligned on the same axis as the sample.

RESULTS

The water towers, water conduits (pipelines) and water supply systems through which water was transported from artesian aquiferous drilled water wells to the places of consumption were made of steel electric-welded pipes belonging to Group B (a material that is resistant to chemical attack). During operation, the water supply equipment was corroded, which reduced the quality of the drinking water. The water supply network in the buildings of the peasant (farm) household Kalynivske was installed with galvanised steel pipes (using the hot-dip galvanisation method), which negatively affected the qualitative characteristics of the drinking water used for animal watering.

Artesian drilled water wells were located on the territory of farms at a distance of 25-60 m from the buildings where animals were kept, paddocks, hay storage pits, silage, pulp and household wastewater reservoirs. The area where the water abstraction wells are located is unfenced and littered, and could be freely accessed by unauthorised persons, pets, and vehicles. The area where the water abstraction wells are located is unfenced and littered, and could be freely accessed by unauthorised persons, pets, and vehicles. Thus, it can be stated that the territory of the farms where drinking water was supplied did not meet the requirements of sanitary standards, which could lead to a decrease in the quality and hygienic characteristics of water intended for animal consumption. The organization of water supply in the research facilities was designed to ensure high-quality water at an economically feasible cost. Dairy farms were supplied with water from centralised water supply sources. The results of the study of water quality and the state of underground water sources in farms of the Western biogeochemical zone of Ukraine are presented in Table 2.

Table 2. *Sanitary and chemical indicators of safety and quality of drinking water for animals from drilled water wells in the Western biogeochemical zone of Ukraine, M ± m, n = 3*

No.	Indicators title	Measurement units	TLV	Spring	Summer	Autumn	Winter
	I. Organoleptic characteristics						
1	Smell: at t = 20°C, t = 60°C	Points	≤2	4/2	1/2	1/2	2/4
2	Colour	Degrees	≤20	18 ± 1.1	5 ± 1.1	8 ± 2	16 ± 3
3	Turbidity	NTU	≤1	1.4 ± 0.5	1.6 ± 0.45	1.5 ± 0.1	1.5 ± 0.16
4	Taste and aftertaste	Points	≤2	1.5 ± 0.24	1.1	1.3 ± 0.1	1.3 ± 0.1
	II. Indicators of epidemic safety of drinking water						
5	Coliform index	-	<3	<2	<2	<2	<2
6	MAFAM	CFU/cm^3	He>100	112.8 ± 4.15	116.2 ± 7.54	137.5 ± 7.1	128.4 ± 6.01
	III. Physico-chemical parameters A) inorganic indicators						
7	pH value	pH	6.5 - 8.5	5 ± 0.05	5.1 ± 0.05	5 ± 0.04	5.1 ± 0.02
8	Alkalinity	mEq/dm^3	≤6.5	7 ± 1.8	6.2 ± 1.2	5.5 ± 1.2	5.2 ± 0.36
9	Total hardness	mEq/dm^3	≤7	5.1 ± 1.96	5.2 ± 2.1	5.7 ± 2.55	6.3 ± 0.84
10	Calcium ions Ca^{2+}	Mg/dm^3	≤130	115 ± 25.2	129 ± 25.1	141 ± 36.4	156м12.7
11	Magnesium ions Mg^{2+}	Mg/dm^3	≤80	8 ±м3.1	9 ± 2.8	9 ± 5.6	9 ± 0.5
12	Chloride	Mg/dm^3	≤250	42 ± 7.7	44 ± 7	49 ± 9	48 ± 10
13	Sulphate	Mg/dm^3	≤250	77 ± 20.7	72 ± 17	64 ± 15.6	60 ± 18.4
14	General minerals	Mg/dm^3	≤1,200	867 ± 207.1	808 ± 144.2	738 ± 150.3	722 ± 70.2
15	Dry residue	Mg/dm^3	≤1,000	593 ± 150.6	547 ± 108.2	536 ± 112.1	487 ± 17.3
16	Permanent oxidation	MgO/dm^3	≤5	2.4 ± 0.3	2 ± 0.4	2.5 ± 0.85	3.7 ± 0.42
17	Divalent copper cations Cu^{2+}	μg/dm^3	≤1,000	17.2 ± 0.4	20 ± 2.07	12.2 ± 1.07	22.0 ± 1.2
18	Divalent zinc cations Zn^{2+}	μg/dm^3	≤1,000	14 ± 3.4	12.7 ± 2.77	15.3 ± 2.15	27.0 ± 5.5
19	Iron Fe	μg/dm^3	≤200	678 ±м83.5	587 ± 92	626 ± 143.5	559 ± 159.6
20	Divalent manganese cations Mn^{2+}	μg/dm^3	≤50	163 ± 7.6	160 ± 5.5	162 ± 18.7	164 ± 26.8
	B) organic components						
21	Divalent cadmium cations Cd^{2+}	μg/dm^3	≤1	0.03 ± 0.014	0.02 ± 0.003	0.02 ± 0.008	0.02 ± 0.006
22	Lead acetate Pb^{2+}	μg/dm^3	≤10	0.2 ± 0.11	0.4 ± 0.2	0.2 ± 0.9	0.3 ± 0.05
	Sanitary and toxicological parameters A) inorganic indicators						
23	Ammonium nitrogen	mgN/dm^3	≤0.5	0.06 ± 0.011	0.06 ± 0.02	0.06 ± 0.011	0.03 ± 0.001
24	Nitrates	mgN/dm^3	≤50	26 ± 18	15.2 ± 8.91	25 ± 18	26.3 ± 14.68
25	Nitrites	mgN/dm^3	≤0.5	0.03 ± 0.001	0.03 ± 0.001	0.03 ± 0.002	0.02 ± 0.001
26	Potassium and sodium ions $K^+ + Na^+$	Mg/dm^3	≤200	20 ± 0.93	11 ± 2.95	19.6 ± 3.07	19.4 ± 4.87
27	Bicarbonate ions HCO_3^-	Mg/dm^3	-	251 ± 21.2	226 ± 25.4	248 ± 18	274 ± 10.8
28	Arsenic acetate As^{2+}	μg/dm^3	≤10	1.6 ± 0.29	1.5 ± 0.36	1.2 ± 0.17	1.5 ± 0.22
29	Divalent mercury cations Hg^{2+}	μg/dm^3	≤0.5	0.3 ± 0.04	0.3 ± 0.11	0.2 ± 0.06	0.1 ± 0.1
	B) integral indicator						
30	Divalent cations of carbon monoxide (cobalt) Co^{2+}	μg/dm^3	≤100	8 ± 1.8	8.5 ± 10.1	4 ± 0.57	7.6 ± 0.7

Notes: *TLV – threshold limit value; NTU – nephelometric turbidity units; CFU – colony-forming unit; MAFAM – aerobic and facultative anaerobic microorganisms*
Source: *compiled by the author*

It should be noted that in case of non-compliance with the standard organoleptic indicators, water is deprived of the ability to support the secretory function of the digestive system (Sokolyuk *et al.*, 2019). When there is a disturbance in the secretion of enzymes in saliva (amylase, maltase), gastric (pepsin, lipase), pancreatic, intestinal juices (trypsin, lipase, amylase, lactase, maltase), and bile in animals, there is a physiological reaction of complete refusal or reduced consumption of poor-quality water. It is worth noting the compliance of the organoleptic properties of water (smell, colour, taste and aftertaste) comply with the TLV standards in the spring, summer, autumn and winter. However, the indicator of water turbidity exceeded the established TLV standard (the NTU indicator ranged from 1.4 ± 0.5 to 1.6 ± 0.45) and was observed at an elevated level in all studied seasons. The exceeding of the water turbidity index indicated the presence of suspended particles of organic origin and bacterial contamination. Deviations from the requirements of the current DSTU 7525:2014 (2014) were recorded in the epidemiological safety indicators of all drinking water samples. There was a noted variation in the indicators of the quantity of MAFAM throughout all periods of the study, ranging from 112.8 ± 4.15 to 137.5 ± 7.1 CFU/cm^3. The quantitative indicator of faecal contamination of water (Coliform index) remained below the established normative TLV.

The investigation of the pH value showed that in all examined farms in the Western biogeochemical zone of Ukraine, the hydrogen reaction was weakly acidic, ranging from 5 ± 0.05 to 5.1 ± 0.05 pH. The alkalinity index exceeded the norm in the spring season, reaching 7 ± 1.8 mEq/dm^3, while in summer, autumn and winter the alkalinity of water was within the standard values. To reduce alkalinity, remove salts, heavy metals, pesticides, bacteria, and other contaminants from water, reverse osmosis filtration systems should be used. In the studied households, the water contained minor amounts of calcium salts, and based on the hardness index, the water was classified as soft. The total water hardness did not exceed the norm and ranged from 5.1 ± 1.96 to 6.3 ± 0.84 mEq/dm^3. It should be noted that if the concentration of chlorides in water exceeds 1%, it will have a salty taste, leading to dehydration of tissues and disruption of electrolyte balance in animals' bodies. Regarding the effects of sulphates on animals, concentrations above 1 g/dm^3 can lead to diarrhoea.

The study of the water's salt composition showed that hydrocarbonate ions, chloride and sulphate anions, and magnesium ions had stable levels within the acceptable range. It was found that the calcium ion level in summer was 129 ± 25.1 mg/dm^3, while in autumn and winter, it increased to levels ranging from 141 ± 36.4 to 156 ± 12.7 mg/dm^3, which exceeded permissible concentrations. However, potassium and sodium cation levels gradually decreased throughout the entire study period, from 20 ± 0.93 mg/dm^3 in spring to 19.4 ± 4.87 mg/dm^3 in winter. The water samples showed low concentrations of magnesium ions, making the soft water less suitable for animal consumption due to insufficient mineral salts. In case of insufficient salt content in drinking water, mineral salts should be additionally included in the animal diet. Water salinity at the level of 300 to 500 mg/dm^3 was considered optimal. Throughout the year, the total salinity decreased from 867 ± 207.1 mg/dm^3 in spring to 722 ± 70.2 mg/dm^3 in winter, indicating an unstable hydrochemical regime of the aquifer. The degree of mineralisation of the water of the studied farms was characterised as fresh with an increased level of mineralisation. The water class and group were determined by the Kurlov formula. Accordingly, the water in the studied farms belonged to the hydrocarbonate class, the calcium group of the first type. The dry residue was within the regulated values. Nitrate levels in the water samples were close to exceeding the TLV level (from 15.2 ± 8.91 to 26.3 ± 14.68 mg/dm^3), while the content of ammonium nitrogen and nitrite did not exceed the permissible limits of the standard. The concentration of lead, cadmium, arsenic, copper, zinc, and carbon monoxide in water samples was insignificant. The mercury content in the water was on the verge of exceeding the permissible standard in terms of TLV and reached 0.3 ± 0.04 μg/dm^3 in spring and 0.3 ± 0.11 μg/dm^3 in summer.

In the artesian basin, water is characterized by high concentrations of iron and manganese, which enter the water as a result of leaching from rocks. The manganese content in the water exceeded permissible concentrations throughout the year, reaching its highest levels during the spring-winter period, specifically 163 ± 7.6 and 164 ± 26.8 μg/dm^3 respectively. Water samples also showed a high iron content, which ranged from 559 ± 159.6 μg/dm^3 in winter to 678 ± 83.5 μg/dm^3 in spring. Therefore, in the studied water samples, the manganese content exceeded permissible limits by two times, while the concentration of iron exceeded the established TLV values by three times. To reduce the content of manganese and iron, it is necessary to correct the water parameters before it is supplied to the distribution network of the buildings where the animals are kept. The recommended filtering material for reducing the content of iron, manganese, calcium and magnesium salts, as well as ammonium and hydrogen sulphide in artesian water is the synthetic zeolite Crystal Right CR 200, a white crystalline powder made from sodium aluminosilicate salt. According to a study by H. Van den Berg *et al.* (2023), wastewater treatment plants were identified as a likely source of infection during outbreaks of pneumonia in the Netherlands caused by the bacterium *Legionella pneumophila*. To increase milk yields and improve cow health, it is recommended to use methods to remove microbiological and organic biofilms (cleaning) and bacteria from the water supply system (disinfection) (Aftanaziv *et al.*, 2018).

The water quality was assessed using a scanner consisting of a device for measuring the content of ATP, which is produced by living organisms and measured in relative light units (RLU). This method was employed to determine the quality of various water samples collected from five farms in Lviv and Rivne regions (Table 3).

***Table 3.** Water quality indicators from farms and households in Lviv and Rivne regions*

Values of relative light units	Characteristics	Incoming water (n = 14)	Buffer capacity (n = 8)	Drainage gutters and lines (n = 124)
<70	Water is allowed for human consumption	11	2	13
70-300	Water is allowed for animal consumption	2	1	24
300-500	Recommended water quality testing		2	6
500-1,000	Measures to improve water quality are needed			20
>1,000	Immediate water testing is required		2	52

***Source:** compiled by the author*

Thus, in the first place, with an RLU indicator >1,000 in 54% of cases, immediate water testing is required. In the second place (RLU 70-300), in 27% of cases, the water was deemed safe for animal consumption. In the third place (RLU <70), in 26% of cases, the water was considered safe for human consumption. For an RLU value of 500-1,000, in 20% of cases, measures to improve water quality were needed. Additionally, with an RLU of 300-500, in 8% of cases, water quality testing was recommended. A possible solution to the problem of water turbidity and bacteriological contamination could be the use of hydrogen peroxide and activated silver solution. Based on the quality indicator, the water from the source was suitable for human consumption (9 RLU), but in the storage tank, the RLU indicator exceeded 300, and at an RLU value of 1,000, measures to improve water quality were necessary. The quality indicators of water sampled from five points are presented in Figure 1.

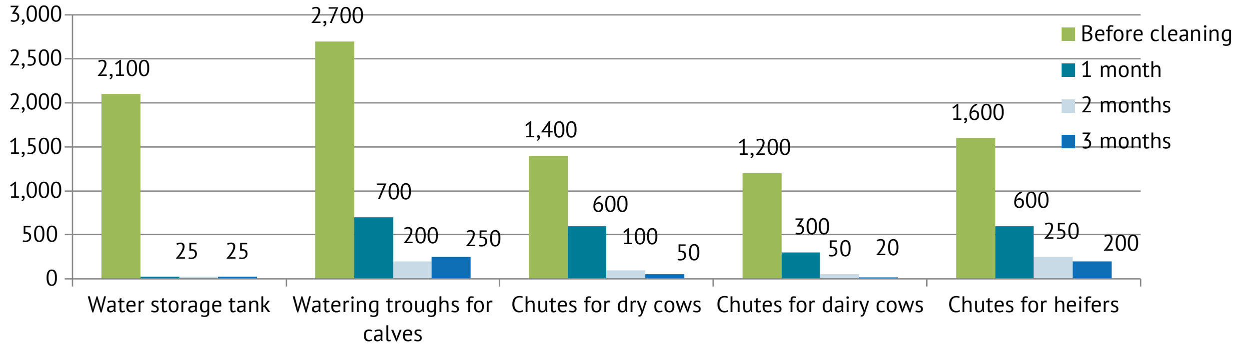

***Figure 1.** Water quality indicators*

***Source:** compiled by the author*

The water storage tank was emptied and cleaned, followed by the addition of 40-90 mg/m^3 of hydrogen peroxide and silver solution to treat the water system until the RLU dropped below 300 at all sample collection points. The water quality in the reservoir immediately reached the level acceptable for human consumption (<70 RLU). Water quality indicators in other points improved over time to levels acceptable for animal drinking (below 300 RLU). Within a month, the quality also improved in the troughs for dry, milking cows and heifers. After this initial improvement, the solution was introduced only once a week until good water quality indicators were consistently achieved. Consequently, all samples showed 300 RLU, which was considered a positive result since the animals often contaminated the troughs with feed residues and mucous secretions. Table 4 compares the effects on milk yield and protein without using the solution (2022) and with using the solution (2023).

***Table 4.** Efficiency of hydrogen peroxide and activated silver solution for the period 2022-2023*

Indicators	2022 (the solution was not used)	2023 (the solution was used)
Average number of cows, heads	155	178
Number of young animals per 10 milking cows, heads	7.7	5.3
Average daily milk yield per cow per day, kg	28.2	29.6
Protein content, %	2.33	2.49

Table 4, Continued

Indicators	2022 (the solution was not used)	2023 (the solution was used)
Urea, mg/dL	29	25
Fat content, %	5.2	5.24
Average dry period, days	64	52
Calf mortality rate from 3 to 63 days, %	7.4	4

Source: *compiled by the author*

Therefore, during 2022-2023, the average daily milk yield per cow increased by 1.4 kg. There was a noted increase in protein content by 0.9%, and due to better protein absorption, the urea level decreased by 4 mg/dL. Additionally, it became possible to increase the herd size while maintaining a lower number of young stocks per 10 milking cows and reducing the dry period by 12 days. It was recorded that the calf mortality rate before weaning from 3 to 63 days decreased from 7.4 to 4%, indicating the undeniable effectiveness of using hydrogen peroxide and activated silver solution to improve the quality indicators of water. Thus, it can be stated that the removal of biofilm from the centralised water supply system ensured positive results such as the complete absence of *Escherichia coli* bacteria (strains *E. Coli*), reduced oxidative demand, reduced formation of dangerous disinfection by-products, increased filter cycle, and mucus removal.

DISCUSSION

According to the obtained research results, it was found that the quality of drinking water in the investigated farms of the Western biogeochemical zone of Ukraine required corrective measures. In the scientific study by W. Feng *et al.* (2020) on the example of nitrate pollution of groundwater in a mining area, it was noted that the concentration of nitrate ions exceeded national standards by 5.48 times. A comparison of research results showed that the researchers recorded a significant exceedance of the normative values of nitrates in the water, while in the present study, it was indicated that the concentration of nitrates in the water samples was close to exceeding the TLV level and ranged from 15.2 to 26.3 mg/dm^3, with the TLV standard being ≤50.

The study by G. Yu *et al.* (2020) focused on examining the impact of nitrate concentration in drinking water in rural areas on the health of the population. The researchers found that high nitrate concentrations in rural areas could result from the interaction of fertilizers and geological factors. The impact of nitrates on minors and adults exceeded the permissible level. This study primarily focused on investigating the quality and safety of drinking water in agricultural farms through a comprehensive analysis of organoleptic and chemical indicators.

The study by P. Li *et al.* (2021) focused on analysing the impact of groundwater pollution on human health and ecological systems in various countries. The researchers found that anthropogenic pollution, caused by the discharge of chemical wastes and uncontrolled wastewater dumping, had a serious impact on the ecosystem and the health of local populations in China, Turkey, and Ethiopia. In the conducted study, atomic absorption spectrophotometry was used to determine the content of heavy metals in the water, while the researchers' study relied on chromatographic methods to analyse organic pollutants in groundwater.

The researchers R. Ennajeh *et al.* (2018) conducted an analysis of water samples from surface and groundwater wells to detect nitrates using a UV spectrophotometer Shimatzu 2401PC. They studied the population's impact on the quality of drinking water and found that an 81.8% exceedance of permissible nitrate levels in water could be attributed to uncontrolled fertilizer use and improper wastewater disposal. The focus of this study was on analysing the physicochemical parameters of drinking water, such as turbidity, pH, alkalinity, mineralisation, ion concentrations, and various pollutants.

N. Kalvani *et al.* (2021) conducted a study to evaluate the effectiveness of different modules for removing iron and manganese at a water treatment plant. The researchers found that the use of Module No. 1 with open aeration and chlorine as an oxidizer was the most effective method for removing iron and manganese at the water treatment plant. The study focused on identifying optimal technologies and purification parameters for treating groundwater to ensure reliable and safe access to drinking water for the population. The research aimed to assess the quality of drinking water and determine compliance with chemical composition standards and safety norms to ensure proper animal health.

In the study by I.V. Roch *et al.* (2023), it was found that the chemical pollution of river water is caused by elevated levels of phosphorus, ammonia, nitrogen, sodium, iron, calcium, and magnesium. This research focuses on analysing the quality of drinking water and its impact on the organisms of agricultural animals, while the scientists' research is oriented towards studying the impact of agricultural and industrial activities on the river ecosystem, as well as developing and implementing strategies for conserving and restoring the quality of water resources in its basin.

The study by H. Kutay (2024) demonstrated that poor water quality containing harmful substances or microorganisms could cause illnesses and weaken the immune system of animals. The researcher employed a method for monitoring water quality and controlling its consumption, which involved using modern analytical instruments such as spectrophotometry, chromatography, and nuclear magnetic resonance spectroscopy. This study utilised a method to analyse the physicochemical parameters of water based on standard techniques for determining the concentration of various components, including turbidimetry for measuring turbidity, photometry for determining substance concentrations, and bacteriological analyses to assess microbiological contamination.

According to the findings of G. Jain & J. Singh (2023), the productivity of dairy cows was shown to depend on the quality of drinking water, as elevated levels of iron in water could lead to digestion issues and reduced appetite. The researchers' methods relied on chemical analysis of water, considering parameters such as pH level, mineral salt content, heavy metal content, and other chemical components. The study explored potential methods to improve conditions to increase milk yields and enhance cow health, such as removing microbiological and organic biofilms and bacteria from the water supply system. The researchers' paper, as well as the results of the study, highlight the importance of maintaining water quality for animal health and productivity.

The study by P. Erdei-Tombor *et al*. (2024) was conducted to explore the impact of biofilms on the quality and safety of drinking water, as well as to determine effective materials and disinfection methods aimed at controlling biofilm formation in water distribution networks. The presented research focused on evaluating the organoleptic properties of water and detecting turbidity. Therefore, in the researchers' study, as well as in the scientific article carried out, the use of filtration and disinfection systems was recommended for purifying water from bacteria and contaminants.

To investigate the impact of intermittent water supply on the microbiological and physicochemical characteristics of drinking water, researchers C.C. Preciado *et al*. (2021) conducted an experimental run of a chlorinated pipe system. The findings of their study indicated that minimising the time of interruptions in the water supply could help prevent an increase in the concentration of disinfection by-products and improve the safety of the water supply for consumers. The researchers' study aims to understand the impact of intermittent water supply on drinking water quality and biofilm in water distribution systems, while this study focused on the chemical composition and bacterial contamination of water in an artesian basin and the development of methods to reduce the content of dangerous bacteria in it.

In the study by D.C. Onuoha & O.G. Ogbo (2022), research was conducted on the application of nanotechnologies for water purification and treatment to improve water supply quality. According to their findings, this technology not only effectively cleans water from various contaminants but also reduces energy consumption and resource usage. The study identified issues with water quality, including exceeding standards for turbidity, epidemic safety, manganese, and iron content in water. The researchers focused on using nanomaterials such as carbon nanotubes, membranes made from carbon nanotubes, and aluminium oxide fibres for nanofiltration. G. Mitropoulou *et al*. (2023) explored the potential of removing biofilm from non-cellular supernatants of five strains of *Lacticaseibacillus rhamnosus* to address water turbidity issues and bacterial contamination, proposing the use of hydrogen peroxide solution and activated silver.

L. Gallina *et al*. (2022) conducted a review of recent methods for extracting solid substances from water for industrial applications. The researchers demonstrated the potential of ultrasound and hydrodynamic cavitation methods. These methods not only increased extraction speed but also reduced the use of harmful organic solvents. The study also examined similar research focused on studying plant growth parameters such as height, root length, leaf count, physiological indicators of plants (such as photosynthetic activity), as well as nutrient content and trace elements in plants after irrigation with water treated using cavitation technology.

Therefore, the section included a literature review and comparison of research results concerning aspects such as water quality and its impact on animal health, methods for water quality analysis and monitoring, the effectiveness of measures to improve water supply quality, and methods for water purification from contaminants.

CONCLUSIONS

A general study of water indicators on farms in the Western biogeochemical zone of Ukraine indicated several problematic aspects. The organoleptic properties of water, such as smell, colour, taste and aftertaste, were in line with the TLV, but water turbidity was elevated in all seasons of the year, with a particularly high level in summer – 1.6 ± 0.45 NTU. This indicated the presence of suspended organic impurities and bacterial contamination. The study of the epidemic safety of drinking water showed deviations from the requirements of the State Standard. The pH of the water was weakly acidic with normal values, but the alkalinity exceeded the standard in the spring and reached 7 ± 1.8 mEq/dm^3.

Despite the low water salinity, the calcium ion content exceeded the permissible limits and reached the highest level of the season in winter (156 ± 12.7 mg/dm^3). In addition, the concentration of nitrates and mercury increased to levels that were close to exceeding the standards. A particular problem was the increase in manganese (163 ± 7.6 μg/dm^3 in spring and winter) and iron in water (164 ± 26.8 μg/dm^3 in summer and winter), which exceeded the permissible limits by two and three times, correspondingly. To ensure water quality and safety, additional measures are required, such as the use of reverse osmosis filter systems and monitoring of manganese and iron in water.

Thus, the results of the study showed that the use of a solution of hydrogen peroxide and activated silver effectively reduced bacteriological contamination of water in the water supply system for cows. This led to an improvement in water quality, a reduction in RLU to acceptable levels for animals, and an improvement in animal health and productivity. The study showed an increase in milk yield by 1.4 kg, a 0.9% increase in protein content, a 4 mg/dL decrease in urea levels, and a reduction in calf mortality from 7.4 to 4%.

Further research into the method of using a hydrogen peroxide solution with the addition of activated silver to maintain the purity of the water supply system may include studying the effect of different concentrations of hydrogen peroxide solution and different amounts of activated silver on the efficiency of water purification from bacteria and other contaminants, assessing the stability of such a system to different operating conditions, and comparing this method with other traditional methods of water purification.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

None.

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Вплив якості води західної біогеохімічної зони України на організм сільськогосподарських тварин

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Анотація. Дослідження водних показників у господарствах західної біогеохімічної зони України є важливим і актуальним з погляду забезпечення якості води для утримання великої рогатої худоби. Метою роботи було дослідження хімічного режиму підземних вод, які використовуються для напування тварин в господарствах Львівської та Рівненської областей. В ході дослідження застосовувались методи: напувальних проб; атомно-адсорбційної спектрофотометрії; турбідіметрії; видалення мікробіологічної та органічної біоплівки та бактерій. Під час проведення дослідження питного водопостачання для корів виявлено, що мутність води була підвищеною у всі сезони, особливо влітку, однак органолептичні властивості води, такі як запах, кольоровість, смак і присмак, відповідали нормам. Встановлено, що показник лужності перевищував норму гранично-допустимої концентрації весною. Кількість іонів кальцію підвищувалась восени і взимку, і загалом складала від 115 ± 25,2 до 156 ± 12,7 мг/дм^3. Також було виявлене понаднормове збільшення рівня марганцю в два рази та заліза в три рази. Показник нітратів у пробах води був близьким до перевищення допустимої норми і його значення встановилось на рівні від 15,2 ± 8,91 до 26,3 ± 14,68 мг/дм^3, тоді як ртуть також перебувала в межах підпорогового перевищення і досягла від 0,1 ± 0,1 до 0,3 ± 0,11 мкг/дм^3. Варто відзначити, що використання розчину перекису водню та активованого срібла сприяло не лише покращенню стану здоров’я та продуктивності корів, але й забезпечило підвищення якості виробленого молока. Результати дослідження можуть бути використані на практиці екологами, працівниками сільського господарства, державними та місцевими органами управління з метою розробки та впровадження програм та проектів з управління якістю водопостачання в фермерських господарствах

Ключові слова: джерело; напувалка; корови; важкі метали; мутність; кавітація