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Methods of cleaning and disinfection of drinking water in livestock farms

Miglena Paneva* **and Peter Panev**

Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences, Sofia, Bulgaria
**Corresponding autor:* m.paneva7@gmail.com

Abstract

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In this article, the methods of cleaning and disinfection of drinking water in livestock farms are discussed. In order to choose the appropriate cleaning method, first an analysis is made of the water that will be used for irrigation and then the necessary processing is selected – filters, water softening, reverse osmosis, additional mineralization, disinfection by means of UV sterilizers. On the basis of the cost rate for irrigation of dairy cows, the necessary cleaning agents with the most effective capacity are indicated. By observing certain water parameters, the health and quality of life of animals in small and large farms is guaranteed.

Keywords: disinfection; drinking water; methods; livestock farms

Introduction

Disinfection or decontamination of drinking water in livestock farms is carried out with the aim of destroying disease-causing microorganisms in the polluted environment by various methods and means (FOTHERINGHAM, 1995). Precautionary disinfection is a constant measure in healthy farms to prevent the penetration and outbreak of infectious diseases, and the technology varies according to the season of the year.

For a complete cleaning and disinfection process, the surface layer must first be thoroughly cleaned by mechanical means and objects and surfaces must be washed with heat and disinfected with ultraviolet rays and chemical preparations (AGRI, 2023).

The greatest application finds moist heat. It is used as hot water (about 70°C) most often for washing milking equipment and dishes, especially with the addition of a 1-2% sodium carbonate solution, or boiling water for disinfecting water, dishes, etc (Regulation (EU), 2012), (CIR (EU), 2023).

In order to apply chemical disinfectants in livestock farms, it is necessary:

- to kill all pathogenic microorganisms;
- not to cause poisoning of humans and animals and not to damage processed objects;
- be easy to apply;
- to be cheap.

In disinfection practice, chlorinated lime, sodium hydroxide, slaked lime, formalin, lysol, etc. are most widely used. In the form of water solutions and the disinfection itself is achieved by immersion, washing and spraying with the help of special devices.

Water quality requirements

The quality of the water provided for drinking by the animals has a great influence on their health and the economic benefit of their rearing. In order for the animals to reveal their genetic potential and bring a good profit in addition to good living conditions and suitable feed, they must be provided with water of very good quality.

Whether the water is obtained from a borehole or a water supply, the first step is to perform a laboratory analysis. Based on the obtained results, the water purification technology is selected. In boreholes, water quality can change, so

the analysis should be performed periodically at least once a year. The tap water provided by water companies usually comes from a safe source, but it is chlorinated, which is not good for animal welfare.

Plumbing installation in modern farms requires that the water is not hard and the water should not contain harmful impurities and pathogenic microorganisms. The properties of the water must be regulated so as not to have a negative impact on the digestive system of the animals. In addition, there can be no disinfection by products in the water.

According to experts, the most important characteristics of drinking water for animals are:

- microbiological purity;
- no harmful chemical substances;
- appropriate water hardness;
- suitable pH of the water (preferably neutral, 6.5 – 8.5);
- temperature adapted to the requirements for the species and age of the animals.

The quality of the water provided to the animals must be regularly checked. It is recommended to carry out physico-chemical and microbiological analysis at least twice a year, see Table 1 (WPPF, 2020). Tests should be more frequent if the water is from a private water source. The water for analysis is taken from the farthest animal drinker. It is also important to monitor the condition of the water system, drinkers and teats. The entire water installation must be regularly cleaned and disinfected. To pay attention to the hermeticity of the system so that external contamination does not fall into it.

Table 1. Water quality requirements

Parameter	Permissible limits
Iron	<0.3 ppm (0.3 mg / l)
Hardness	<7 german degrees (120 mg / l)
Turbidity	<1 NTU
Manganese	<0.05 ppm (0.05 mg / l)
Tannins	<0.1 ppm (0.1 mg / l)
Permeability of UV rays	> 75%

Problems caused by poor quality water

When the water parameters do not meet the norms, in addition to the deterioration of the quality of life of the animals, the quality of the irrigation facilities also deteriorates (WPPF, 2020). The most common problems are described below:

a) High hardness – scale causes numerous damages: clogging of nozzles and pipes, promotes the formation of bacterial biofilm on the inside of pipes and accessories. With high water hardness, the effectiveness of disinfection decreases. In addition, calcium content above 75 mg per liter is associated with poorer absorption of nutrients and drugs. Too much magnesium leads to diarrhea and indigestion.

b) Water pH too high or too low. Water used on farms should have a near neutral pH of 6.5 to 8.5. Too high or too low pH is not desirable because of the negative impact on animals and the water systems themselves.

A high pH above 8.5 is directly related to the presence of large amounts of magnesium and calcium in the water, i.e. water has a high degree of hardness and prolonged consumption can lead to digestive disorders and diarrhea. The effectiveness of disinfectants (such as chlorine) is also reduced.

Low water pH is associated with faster growth of mold, yeast and microbes. In addition, such water has a corrosive effect on an installation.

c) High content of nitrates and nitrites. Water fed to birds should not contain ammonia, nitrates or nitrites. Digestion of food is difficult in the presence of nitrates in the water, which leads to slower weight gain.

Nitrites are much more harmful even at lower concentrations than nitrates. Nitrites cause disorders in the process of transporting oxygen by hemoglobin, which causes a dangerous and fatal disease.

d) High concentration of iron and manganese.

Iron is involved in many physiological processes in the body, but when it is in excess it is toxic. Research proves that water containing more than 0.6 mg Fe / l can lead to problems with the bone system, negatively affect growth and damage the walls of the capillaries of the circulatory system. High concentrations of iron in water negatively affect its taste and smell.

High levels of manganese also have a negative impact on animal health. Causes damage to capillaries, central nervous system, liver.

Insoluble particles of iron and manganese are deposited on the inner walls of a plumbing installation and form an excellent environment for bacterial biofilm.

Methods of water disinfection in livestock farms

Depending on the degree of water pollution and the physico-chemical analyzes performed, a purification and disinfection system is selected. Below will be described types of systems according to needs:

1) **By Ultraviolet (UV) sterilizer**, Figure 1 – UV disinfection is a purely physical process where no chemicals are used. It does not negatively affect the taste and chemical-physical parameters of water. Disinfection using UV lamps is an economical way to purify water, requiring minimal maintenance and a relatively small initial investment.

The way these systems work is to use gas emitters to artificially generate ultraviolet rays. Mercury vapor is placed in a quartz tube, excited by an electric charge, it emits rays with a certain spectrum, which destroy the microbes in the water. The emission range is between 240 and 280 nm. With a correctly determined flow rate, it removes 99.9% of microorganisms. To be effective, the water must be very well purified of solid particles. A mechanical filter with a filtration accuracy of no less than 20 microns must be installed before the UV system. It is important to note that if the dose of radiation is weaker compared to the flow rate and transparency of the water, the disinfection may be insufficiently effective. It is always better to choose a UV system with more power than not enough. The flow rate of the systems varies from 2 m^3/hour ÷ 12 m^3/hour.

It is not desirable to frequently disconnect the UV lamp from the electrical supply, because each interruption shortens the life of the UV emitter by 10-20 hours. Also, the power consumption for the entire device is only 41W. The UV sterilizer is a barrier through which "new" dangerous microorganisms will not penetrate, but if they have nested in other parts of the installation, they must be removed by a one-time disinfection of the installation, for example with sodium hypochlorite (NaClO, bleach). In Figure 2 shows an assembly diagram of UV lamps.

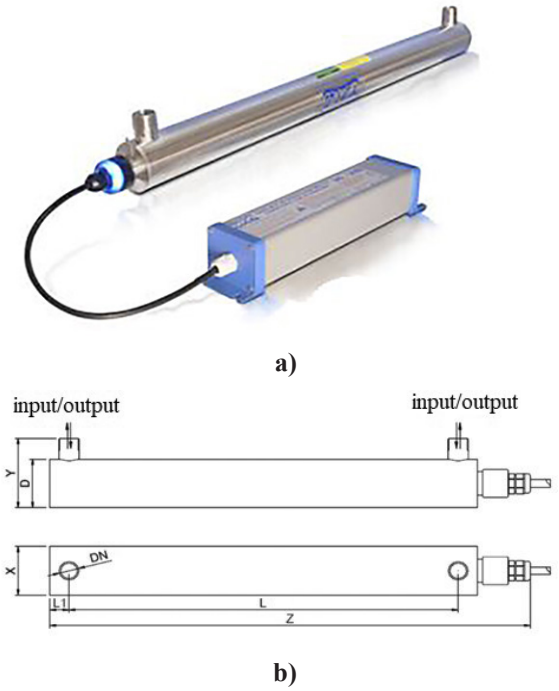

Fig. 1. a), b) UV sterilizer (Pavirani, 2023)

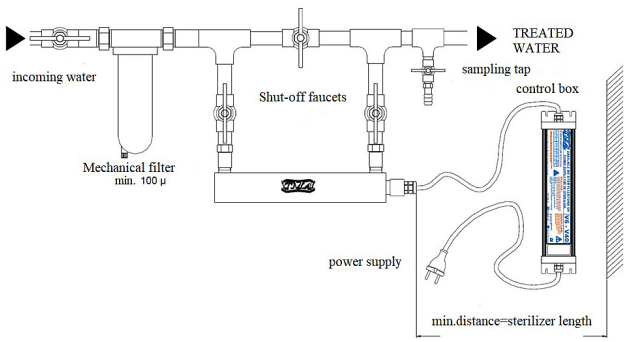

Fig. 2. Scheme for installation of UV lamps (Pavirani, 2023)

2) **Water softener** (Pavirani, 2023) – used when water hardness is above 7 German degrees (120 mg/l). High water hardness causes scale and clogging of plumbing systems and damage to appliances. The place of the water softening installation must be near a sewer and have the possibility of an electric power supply. The connection to the sewer for draining waste water during regeneration can be made at a height not greater than 70 cm above the level of the control head. There should be enough space to comfortably load a softening system with tablet salt. In the room where the softening system will be installed, the temperature must not fall below +4 °C. Before a softening installation for calcareous water, a mechanical filter for solid particles with a minimum filtration accuracy of 40 microns must be installed, fig.3. It is recommended to build an external bypass with shut-off valves so that, if necessary, the water can be supplied directly to the water supply without passing through the softener.

For greater efficiency in water disinfection, a UV system can be added to eliminate germs and viruses.

3) **Through reverse osmosis** (ROS, 2023) – Reverse osmosis is a process aimed at removing all contaminants from tap or well water. This process consists of two main parts. The first is pre-filtration, where the water passes through several filters: a filter with a permeability of 5 microns, which takes care of the removal of larger pollutants from the water, capturing all large pollutants in it – sand, rusts; a filter with granular activated carbon, designed to remove substances such as chlorine, fluorine, residues of harmful preparations, as well as all unwanted bacteria and microorganisms from the water; a second filter with activated carbon to remove chlorine, fluorine, bacteria and odors and has a lower permeability than the previous one.

Then it goes to the actual reverse osmosis, associated with a change in the chemical composition of the water. It is carried out by a membrane with reverse osmosis, taking care

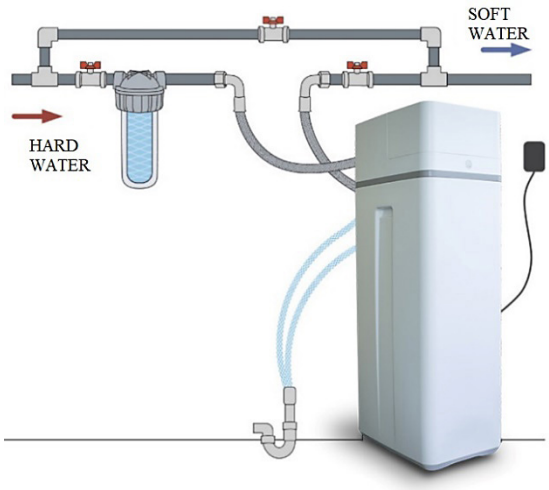

Fig. 3. Softening system (Pavirani, 2023)

not to allow any calcareous compounds, heavy metals, bacteria and microorganisms into the purified water. The most essential characteristic of a reverse osmosis membrane is its low permeability of 0.0001 micron (0.1 nm). An indication of the effectiveness of the relevant reverse osmosis membrane is that heavy metals cannot pass through it, even if they are at the molecular level. The next step in the process is again a fine activated carbon filter. Its purpose is to give purified water a soft and pleasant taste.

It is recommended to install an inlet water tank as well as a clean water tank with a float of a volume corresponding to the flow rate of the system to ensure the most efficient operation of and constant availability of clean water. It is recommended that a water softener be installed before the system, which will provide a lower TDS (the total weight of all solids (minerals, salts or metals) dissolved in a certain volume of water, which is expressed in milligrams per liter (mg/l) or parts per million (PPM)) and longer membrane life.

When the incoming water is heavily contaminated with sand, silt or rust, it is recommended to place a quartz sand column at the beginning of the system.

For complete protection from viruses, bacteria and other microorganisms, it is recommended to place a UV sterilizer after the membrane or in the clean water tank.

Cost rate and choice of treatment system

A study was made on the consumption rate of water for 1 dairy cow in a livestock farm. According to (Trifonov, 2016) the drinking needs of dairy cows for one day is within the range of 80÷100 l/day. In addition to drinking, water is used for preparing feed, washing dishes and installations, washing udders and cleaning manure, cleaning premises and disinfection, as well as for staff needs. The required amount of water for one dairy cow is 42 l/day. The total water consumption per day for 1 cow is 142 l/day. If 100 cows are raised on the farm, 14,200 l/day or 592 l/hour (0.592 m^3/hour) are needed.

In such a case, a UV sterilizer with a performance of 2 m^3/hour, an automatic, single-column softening system with 45 liters of resin and a nominal performance of 1.6 m^3/hour and a reverse osmosis system with a performance of 500 l/hour will be needed. In order to guarantee constantly clean and disinfected water, a tank vessel with a volume of 30 m^3 is recommended before and after purification. In this way, there will be disinfected water for 2 days, in case of an accident of some of the systems or a shortage of water.

Conclusion

Water is the most important component of the external environment, without which it is impossible to maintain a healthy state of the body and achieve significant productivity from farm animals and poultry. Due to poor water quality, animal diseases can lead to losses of up to 20% of production and it is therefore vital that they are controlled. When properly applied, disinfection can reduce the need for disease control through the administration of expensive vaccines and antibiotic therapy and is the easiest way for the farmer to exercise disease control without the need for external resources.

After determining the parameters of the water and the way in which it will be delivered to the animals and determining the consumption of water for washing, watering and feeding, the type of purification can be determined. The type of purification and disinfection is determined by the degree of water pollution – UV sterilizers, water softeners and reverse osmosis systems. Water analysis should be done at least twice a year.

Future scope

For the profitability of animal husbandry production, it is important to achieve the best balance between feeding and drinking costs and the output obtained, without neglecting the needs of the animals (Agrobio, 2013). In order to achieve such conditions, the farm must have an automated watering system (Paneva et al., 2021). In addition to the automatic supply of water for watering and washing the drinker of animals, it is good to program water quality indicators. After receiving the data from the physico-chemical properties of the water, they will be entered into a software program that will signal the need to add a corresponding chemical agent automatically.

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