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CATTLE DRINKING WATER QUALITY - WELFARE INDICATOR

Marjanović[1], S., A. Tofant[2]

SUMMARY

The paper describes the importance of hygienic quality of drinking water and its influence on health, productivity and welfare of cattle. Quality of water from four different sources was determined in a laboratory by testing the organoleptic, physico-chemical and bacteriologic parameters. Samples that were not in compliance with the requirements of the Croatian standards for drinking water were disinfected, in vitro, with chlorine and hydrogen peroxide based disinfectants. In a field study such disinfected water was offered to cattle. The study results, obtained by monitoring the drinking behaviour of cattle, have shown no preferences of non-disinfected over disinfected water with possible changed taste or odour.

Key words: *water, disinfection, watering, cattle*

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INTRODUCTION

Water is one of the fundamental prerequisites for life and its subsistence. Today, about 71% of the Earth's surface is covered with water and living organisms contain 60-70% of water. Of that 97% is salty seawater, 2.4 % glaciers and only 0.6% drinkable water. World Health Organisation is now in charge of water-related issues and its preservation.

In the veterinary field of activities water has an important place and significance, both as regards its quantity and quality (Anonymous, 2006). For the needs of livestock production, drinking water is of utmost importance. It is a very important factor of the animal welfare, a complex concept, which includes behaviour, physiological need, physical health, productivity, reproduction and feelings of animals. The welfare standards which take account of 5 basic needs are: freedom from thirst, hunger and malnutrition, freedom from discomfort, freedom from pain, injury and disease, freedom to express normal patterns of behaviour and freedom from fear and stress. The term «water as a welfare indicator» does not refer only to the need for water as basis for life, but also to its acceptable hygienic quality.

By providing sufficient quantities of water of acceptable hygienic quality, two of these animal freedoms will be met, freedom from thirst and freedom from diseases.

According to the regulations now in force in our country, the drinking water for animals should be of identical quality as water for men, and therefore, it is evaluated according to the Rules on health safety of drinking water (Anonymous, 2004). In a large number of developed countries this rule has been changed because of unavailability of sufficient quantities of drinking water, and different criteria have been established, according to which water for watering of different species and categories of animals is evaluated as «hygienically acceptable water».

Both the quantity and quality of water are very important for cattle because of their great needs for water. For example, the average daily requirement of fresh water for a cow in lactation period amounts to 50 l, but it can be as high as 100 l in case of some more productive breeds. Yearling cattle need daily 20-30 l of water on average, and calves to 1 month of age 8-10 l. These figures are quite impressive. In case of greater cattle farms, it is a very demanding task to water all animals and provide sufficient quantities of potable and safe water. Watering of animals represents a serious problem to cattle owners who need to secure sufficient quantities of drinking water for their animals. Water from wells is often used for smaller herds, even in cases when water from waterworks is available. One of often mentioned reasons for use of water from wells is «different taste» of conditioned and disinfected water.

The aim of this study was to determine the hygienic quality of drinking water given to cattle by analysing the organoleptic, physico-chemical and bacteriological parameters of water from three different sources and water-supply system. Water samples of unacceptable hygienic quality were disinfected and then, in a field study, such water was offered to cattle in order to find out if and how the improved, changed quality of water influences its acceptability and possible change in behaviour of cattle during watering.

MATERIALS AND METHODS

Water samples

Samples of water were collected from four sources:

Sample 1. Open water source – well about 6 m deep

Sample 2. Closed water source – water pumped from about 18 m deep water layer

Sample 3. Open water source – well about 19 m deep

Sample 4. Water sample from a water-supply system, control sample

Methods

Hygienic quality of water was assessed by determination of organoleptic, physico-chemical and bacteriological parameters in compliance with standard methods of titration and photometry (Anonymous, 1975) on HACH DREL/4000 spectrophotometer and HACH conductometer, and with bacteriological methods of inoculation in culture media. Residual hydrogen peroxide was determined by immersion of test tapes.

Disinfectants

In the study were used two commercially available disinfectants with active chlorine as active ingredient and chloramine T and Na-dichloroisocyanurate and a commercial preparation with 50% of hydrogen peroxide (Block, 1991). A series of final concentrations were tested *in vitro* in the laboratory. The following optimum concentrations were selected for use in field trial: for disinfection of sample 1 - chloramine T, 234 mg/l, for disinfection of sample 3 - Na-dichloroisocyanurate, 2 mg/l, and for disinfection of sample 2 – hydrogen peroxide, 40 mg/l, as recommended by the manufacturer.

Animals

Fifteen animals of Simenthal breed were monitored for their behaviour during watering, in order to see how they accepted the offered drinking water, in consideration of performed disinfection, as well as possible side effects.

Table 1. Organoleptic and physico-chemical parameters determined in drinking water from the investigated wells

Parameter	Sample				MSP
	1	2	3	4	
Colour, mg/l PtCo	0	343	2	0	20
Turbidity, NTU	0	18	0	0	4
Electric conductivity, µS/cm	1128	521	808	721	2500
pH	6,53	7,16	7,28	6,89	6,5-9,5
$KMnO_4$ consuming capacity, mgO_2/L	4,1	2,73	1,76	1,12	3,0
Ammonium, mg/L NH_4^+	0,131	1,158	0,026	0,099	0,5
Nitrite, mg/L NO_2^-	0,196	0,84	0,145	0,019	0,1
Nitrate, mg/l NO_3^-	6	15	7	5	50
Chloride, mg/L Cl^-	44,0	11,0	75,0	26,0	250
Hardness, ° dH	35,3	17,4	21	21,6	

RESULTS

Results of investigation of organoleptic, physical and chemical parameters in drinking water for cattle taken from three wells are presented in Table 1. Analysed parameters revealed non-compliance with health safety standards with respect to maximum permissible levels (MPL). The table also presents the values of the same parameters of conditioned water from the water-supply system. Table 2 presents the values of bacteriological parameters, aerobic mesophilic bacteria and the most probable total counts and the presence of faecal coliform bacteria. The same bacteriological parameters recorded after disinfection are given in Table 3. Reduced bacteria count suggests efficiency of the applied procedure. Similarly, the concentrations of free residual chlorine in samples 1 and 2 and of residual hydrogen peroxide in sample 3 show that correct doses of disinfectants were used in practice.

Table 2. Bacteriologic parameters determined in the drinking water from the investigated wells

Parameter	Uzorak				MPL.
	1	2	3	4	
Heterotrophic plate count, CFU/ml 37 °C	600	8	3	3	20
Heterotrophic plate count, CFU/ml 22 °C	360	0	360	0	100
Total coliform, MPN/100ml	>240	>240	38	0	0
Faecal coliform, positive/negative	+	+	+	-	-

DISCUSSION AND CONCLUSION

Watering is also an important factor in cattle breeding as are the mode of housing and correct nutrition. Inadequate, reduced quality of water, with respect to organoleptic, physico-chemical or microbiological characteristics, has a significant impact on the animal health, productivity and welfare. Problems related with quality of drinking water for cattle, in the sense of unfavourable effect on health and productivity, derive from qualitative composition of water, however, they can be the consequence of disinfection of water due to developed harmful by-products.

Animals are very sensitive and demanding when odour and taste of water are concerned. Odour is of high sanitary importance, since it is often the first obvious sign of contamination. Taste has similar significance and is also an indicator of contamination. Water in nature is tasteless, with the exception of seawater, and its strange taste derives from natural substances (algae, earth and bacteria) and from organic and inorganic impurities (phenols, chlorine). Suspended and dissolved substances feign the colour of water. Its true colour is obtained by filtration of suspended particles. The colour itself is of no hygienic significance; it only affects the appearance of water. The drinking water is considered safe for use if its turbidity does not exceed 4 NTU. Ideal level of turbidity would be below 0.1 NTU, since any higher value can lead to coating of suspended particles and thus to protection of microorganisms against the action of a disinfecting agent. Therefore, water with a high level of turbidity is often unfit for use in spite of great quantities of chlorine added to it. For this reason, water with turbidity of 18 NTU (Sample 2) was disinfected

Table 3. Bacteriologic parameters determined in the drinking water 24 hours after disinfection

Parameter	Uzorak		
	1	2	3
Disinfectant	Chloramine T	Hydrogen peroxide	Na-dichloroisocyanurate
Heterotrophic plate count, cfu/ml 37°C	15	0	2
Heterotrophic plate count, CFU/ml 22 °	10	0	0
Total coliform, MPN/ 100ml	>240	0	0
Residual disinfectant, mg/L	0,4	40	0,5

with hydrogen peroxide. Another big problem, besides turbidity, is the presence of algae, which is manifested by increased chlorophyll level in water. Green algae can cause problems with taste and odour. On the other hand, blue-green algae produce health unsafe toxins.

Rules on health safety of drinking water (Anonimous, 2004) specify chemical parameters of standard constituents of water, but also of other ingredients present in water as contaminants and health questionable compounds. Increased levels of natural (iron, manganese, sulphur, calcium, magnesium, nitrates, sodium, hydrocarbonates and phosphorus) or artificial chemical compounds in drinking water (waste substances, petrol, oils and pesticides) can cause various problems starting from health disorders in animals and men to aesthetic changes.

Contamination is the presence of organic substance in water and as a risk to health is considered the organic waste substance which is a potential carrier of pathogenic microorganisms and parasites or which contains toxic, cancerogenic or otherwise noxious substances. Of great sanitary importance is the determination of nitrogen in the form of ammonia, nitrates and nitrites, since these compounds occur as a result of decomposition of organic substance containing nitrogen, or of bacteria activity or are induced by chemical processes. Special attention should be paid to water in regions with intensive agricultural production where artificial and natural fertilisers are widely used. From the standpoint of health, nitrates and nitrites present the greatest risk. Nitrites can cause methemoglobinuria, as well as nitrates that reduce to nitrites in the alimentary system. Nitrates are also potential cancer-causing agents. One of the parameters for determining the amount of oxidative organic substance is the utilisation of potassium permanganate $KMnO_4$. Sample 1 was non-compliant according to this parameter. As regards nitrogen fractions, the highest level of contamination was found in sample 2, and the chosen disinfectant H_2O_2 caused additional oxidation of a portion of these ions. Chlorides are present in waters in the form of metallic salts. They originate from the earth, as they are freely soluble or are contaminants in the household water or wastewater being a composite part of urine. Total water hardness represents the quantity of dissolved salts of calcium and magnesium. Water hardness is of no major significance for health and its maximum permissible levels are not indicated in the respective Rules. Hardness is more important for the equipment status since, when excessive, it can cause impairment of equipment because of scale formation. Hardness of water in the analysed samples ranged from very hard, sample 1, to hard in samples 2, 3 and 4 (Tofant and Vučemilo, 2002).

Microbiological composition of drinking water is responsible for the most common and easily visible water-related health problems. Risk to health present both the microorganisms and their toxins that often remain in water after the disappearance of microorganisms. Water-borne infections are contagious diseases that are transmitted and spread by water in a limited area and within a relatively short period of time. Bacteria, viruses and parasites can be transmitted by water. Determination of total bacteria count per millilitre is the commonest sanitary indicator. Provisional determination of total coliform count and faecal coliform count is employed for identification of most frequent causal agents of infections, especially of the alimentary system. In addition to negative effect of microbial contamination on health, it also affects productivity, usually through reduced weight gain.

Since the microbiological analysis of water taken from three wells showed unacceptable hygienic quality of water, as obvious from data presented in Table 2, disinfection was carried out in order to destroy and reduce the population of pathogenic microbes below the maximum permissible level. This is the most important aim of disinfection. Organoleptic properties of water – colour, odour and taste – can often be improved by disinfection. In addition to microbicidal action, the reactions of disinfecting agents

with other substances contained in water should be taken into account, because of possible formation of by-products, compounds with consequential impact on health and productivity of animals. An example is dissolved organic carbon that in contact with chlorine forms trihalomethanes, which are cancerogenic at high doses (Tofant and Vučemilo, 2006; Tofant, 2007; Brižić et al., 2007).

The aim of the practical part of the study was to find out whether the disinfection of drinking water, and possibly changed taste or odour, influences the acceptability of three, differently disinfected water samples. The idea of such investigation arose from the statement of the cattle owner that his animals refuse to drink disinfected water. Each water sample was disinfected 24 hours prior to administration to animals. Cans containing 15 l of water each were offered to cows in order to see if they will drink disinfected water or not. The animals were offered 3 disinfected samples of water and a non-disinfected sample of water from the same source. Monitoring of the animal behaviour in the course of watering showed no preferences of any animal to any of water samples. Intake of water from all cans was identical. The animals tasted and drank disinfected and non-disinfected water without showing affinity to any of the offered samples. While drinking water, the animals will certainly not observe the differences in microbiological parameters, but the changed taste of water will not remain unnoticed. This was not the case in this study and a possible explanation is correct dosage of the used disinfectants. A major problem of water disinfection is incorrect dosage. Cattle owners do not act according to instructions in which very low doses are recommended, but instead they independently increase the dose levels, considering such low doses as insufficient. High doses result in changed taste of water, which the animals refuse to drink.

Based on the study results it can be concluded that hydrogen peroxide showed the optimum effect on bacteriological and organoleptic parameters, and was followed by Na-dichloroisocyanurate and chloramine T. Acceptability of drinking water, with respect to organoleptic parameters, odour and taste, was not influenced by any of disinfectants used.

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ZUSAMMENFASSUNG

WASSERQUALITÄT ZUM TRÄNKEN VON RINDVIEH - FAKTOR DES WOHLERGEHENS

In wird Arbeit ist beschrieben, wie wichtig die Richtigkeit des Wassers zum Tränken von Rindvieh für ihre Gesundheit, Produktivität und Wohlergehen ist. Im Labor wurde die Wasserqualität aus vier Quellenbereichen bestimmt, u.zw. durch das Prüfen von organoleptischen, physisch-chemischen und bakteriologischen Parametern. Muster, die nicht den Bedingungen laut Dienstvorschrift für gesundheitliche Richtigkeit des Trinkwassers entsprachen, wurden desinfiziert, in vitro, im Labor mit Desinfizienzien auf Chlor- und Wasserstoffperoxydbasis. Auch wurde in Praxis im Experiment das Trinkwasser zum Tränken von Rindvieh desinfiziert. Resultate, die durch die Beobachtung des Verhaltens während des Tränkens bekommen sind, weisen darauf hin, dass die Desinfektion und die eventuell geänderten Beigeschmack und Geruch keinen Einfluss auf die Wahl von Wassermustern hatten.

Schlüsselwörter: *Wasser, Desinfektion, Tränken, Rindvieh*

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