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Microbiologic water quality for dairy cows in rural households and farms from Transylvania

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Abstract

The aim of this paper was the microbiological quality assessment of water consumed by dairy cows in rural households and farms. We analyzed 60 water samples, comparing the results with our country's legal previsions. The total bacterial count ranged from 0 to $3.24x10^4$ cfu/mL, and the numbers of total and fecal coliforms from 0 to $1.60x10^3$ cfu/100 mL, and from 0 to $3.48x10^2$ cfu/100 mL, respectively. In 70% of samples total coliform and in 63.33% fecal coliform were found; with statistically insignificant differences between the farm- and household samples. Dairy cows consumed both in farms and in rural households of Transylvania qualitatively improper water, due to its microbial contamination.

Key words: total bacterial count, total coliform, fecal coliform, drinking water

Introduction

Water is the most important nutrient for dairy cattle but its importance has been commonly forgotten in dairy systems (Hole et al., 2006). It is required for all of life's processes - transport of nutrients and other compounds to and from cells; digestion and metabolism of nutrients; elimination of waste materials (urine, feces, respiration and excess heat from the body); maintenance of a proper fluid and ion balance in the body and provision of a fluid environment for the developing fetus (Murphy, 1992).

In conformity with the recommendations regarding the dairy cows' welfare, the animals should have permanent access to fresh drinkable water in sufficient quantity, to satisfy all metabolic processes essential for life and performance. In our country it is recognized that the water consumed by animals must be of the same quality than the water consumed by humans but in some countries special recommendations exists for the quality of the water consumed by animals. Water quality might cause poor production or nonspecific diseases and should be one aspect of the procedures used to investigate such problems (Jemison and Jones, 2002). Water quality is often overlooked, even though research clearly shows that performance decreases when certain components of water quality reach threshold levels. Poor water quality also affects consumption, which may limit food intake and animal health (Loneragan et al., 2001; Socha et al., 2003). Microbiological analysis of water for total bacteria and coliform bacteria is necessary to determine sanitary quality. The possible consequences of microbiologically contaminated water's consumption are of such severity than its control is always very important and should be never compromised.

The aim of this work was the determination of the microbiological quality of the water consumed by dairy cows in rural households and farms.

Material and methods

A total number of 60 water samples (30 from rural households and 30 from farms) were collected and analysed over December 2009 - March 2010. The sampling was made using sterile recipients, in quantity of 0.5 L. The samples were analyzed within 4 hours from collection, in the laboratory. The microbiologic water quality was appreciated based on the total bacterial count (TB) and the numbers of coliform bacteria and

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fecal coliform bacteria. The total number of bacteria was determined by inoculation on culture medium in Petri dishes and 48 hours incubation on 37 C°. For the samples derived from local sources previous decimal dilutions were made in culture tubes. After incubation the grown colonies were calculated by a mechanical optic colony counter and the total number of bacteria was calculated with the help of a formula (Popescu and Borda, 2008). In order to assess water quality, samples were analyzed for total coliforms (TC), using a multiple-tube fermentation technique based on lactose fermentation with acid and gas production, within 48 hours, in a lauryl tryptose broth. If the water sample yielded presumptively positive results, simultaneous inoculation into brilliant green lactose bile broth, for total coliform and EC broth for fecal coliform (FC) was required. Positive result for EC broth, incubated at 44.5 C° for 24 hours, was considered as positive completed test response. Parallel positive brilliant green lactose bile broth with negative EC broth cultures indicated the presence of nonfecal coliform. The number of coliform bacteria per 100 mL of water was then calculated from the distribution of positive and negative tubes in the test by referring to an appropriate table. The total bacteria number was expressed in cfu/mL and the coliform in cfu/100 mL.

The results were compared to the values set out by the Law 458/2002 modified and completed by the Law 311/2004. Data were processed using the GraphPad InStat version 3 (GraphPad Software Inc. USA) software. The descriptive statistical indicators (mean, standard deviation, median, minimum and maximum) were calculated for the microbiological parameters of the water quality from the rural households and farms. The Dunn's Multiple Comparisons Test was used to compare the data.

Results and discussion

The descriptive statistical indicators (mean, standard deviation, median, minimum and maximum) for the microbiologic parameters determined in the water samples collected from rural households (30 samples) and farms (30 samples) are shown in table 1.

The total bacterial count and the numbers of total and fecal coliforms varied widely in the water samples collected from farms and households. The mean values of total bacterial count in the samples collected from households are very close to those in the samples from farms, ranging between 0 and 3.24×10^4 cfu/mL. The total coliforms recorded also similar values in the water collected from rural households and farms. In the majority of the analysed water samples fecal coliforms were found, with a mean value of 4.6 x 10 cfu/100mL in the cows' drinking water in rural households and of 6.4 x 10 cfu/100mL in the water consumed by cows in the farms. Although the mean values were slightly higher in the water samples from farms, the difference was statistically insignificant (Dunn's Multiple Comparisons Test, $p > 0.05$). According to our country's legislation regarding the drinking water quality (Law 458/2002 and Law 311/2004) this should not contain any bacteria and coliform. For water consumed by animals in some countries there are different recommendations. For example, Looper and Waldner (2002) suggests as safe levels for cattle: 5000/L for the total bacterial count, 150/L for total coliform bacteria and 100/L for fecal coliform bacteria, while Socha et al., (2001) considers as threshold levels 10 total bacteria/L and 0 total and fecal coliforms/100mL.

Within all of the analyzed water samples in 91.67% bacteria, in 70% total coliform and in 63.33% fecal coliform were found, respectively. The comparative analysis of the water samples from farms and rural households shows that in 83.33% of the samples from farms and in 100% of the samples from the water consumed by cows in rural households bacteria were present. Moreover, total coliform bacteria were identified in 50% of the samples collected from farms and in 45% of household water samples. Fecal coliform bacteria were found in 76.67% of the household samples and in 50% of the farm samples (Figure 1).

Table 2. Descriptive statistic indicators for the microbiologic parameters of the analyzed water samples

Parameter	Farms			Rural households		
	TB cfu/mL	TC cfu/100mL	FC cfu/100mL	TB cfu/mL	TC cfu/100mL	FC cfu/100mL
n	30	30	30	30	30	30
Mean	2.91×10^3	2.28×10^2	6.4 x 10	2.81×10^3	3.08×10^2	4.6 x 10
SD	6.61×10^3	4.84×10^2	1.70×10^2	3.39×10^3	4.94×10^2	8.60 x 10
Minimum	0.00	0.00	0.00	1.00	0.00	0.00
Maximum	3.24×10^4	1.60×10^3	9.18×10^2	1.28×10^4	1.60×10^3	3.48×10^2
Median	8.57×10^2	8.50	4.50	1.44×10^3	1.09×10^2	1.7 x 10

TB = total bacteria; TC = total coliform; FC = fecal coliform

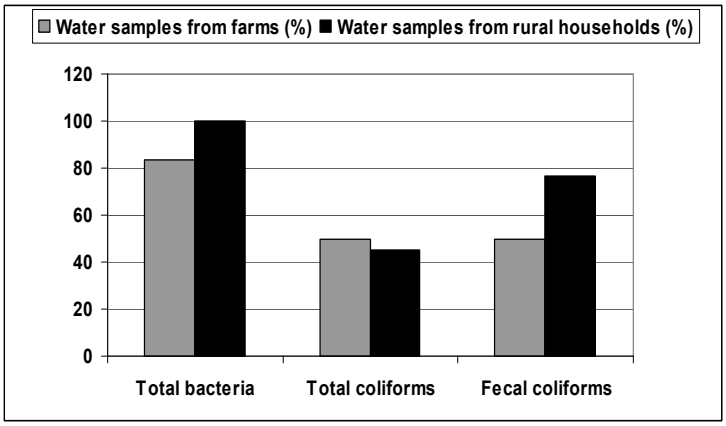

Fig 1. The proportion of water samples which contains total bacteria, total and fecal coliform bacteria

Total bacteria, total coliform and fecal coliform are all indicators of drinking water quality. The total bacterial count measures virtually all pathogenic as well as non-infectious bacteria that use organic nutrients for growth. Total bacterial counts in excess of 500/100mL may indicate water quality problems (Wagner et al., 2001). Water sources with total bacterial counts in excess of 1 x 10^6/100mL should be avoided for all classes of livestock. Most water supplies will continuously have counts below 200/100mL. Bacteria polluted water may increase susceptibility or contribute to a variety of calf and cow disease problems (Ensley, 2000). Drinking bowls, cups and troughs should be kept relatively clean. A raised base around tanks helps to keep manure contamination problems to a minimum. Cleaning tanks and water bowls to prevent build-up of old feed and other debris is important.

The total coliform group is a large collection of different kinds of bacteria. Fecal coliform bacteria are a sub-group of total coliform bacteria that mostly exist in feces. If total coliform is present, the sample will also be tested for either fecal coliform. Total coliform bacteria are commonly found in the environment (e.g., soil or vegetation) and are generally harmless. If only total coliform bacteria are detected in drinking water, the source is probably environmental and fecal contamination is not likely. However, if environmental contamination can enter the system, there may also be a way for pathogens to enter. Therefore, it is important to find the source and resolve the problem. Fecal coliform bacteria appear in great quantities in the intestines and feces of people and animals. The presence of fecal coliform in a drinking water sample often indicates recent fecal contamination, meaning that there is a greater risk that pathogens are present than if only total coliform bacteria is detected. There is evidence that livestock can tolerate relatively high bacterial loads in drinking water (Jemison and Jones, 2002) although there are actually very little data available.

Our results show intense microbial contamination of the water consumed by dairy cows, being in accordance with other studies (LeJeune et al., 2001; Popescu et al., 2005, 2010; Wagner et al., 2001). A large US study of livestock drinking water (LeJeune et al., 2001) investigated 473 water troughs in 98 dairy farms. The authors concluded that troughs are a major source of exposure of cattle to enteric bacteria, including a number of food-borne pathogens, and the degree of bacterial contamination appeared to be associated with potentially controllable factors. The results of the study indicated that drinking water offered to cattle is often of poor microbiological quality with total coliform and *E. coli* counts of around 105 and 104cfu/L, respectively. Interestingly, metal troughs had significantly lower coliform and *E. coli* counts compared to other construction materials respectively concrete, plastic and other materials. The group also found that bacterial contamination was higher in troughs that were closest to the feed-trough. Proximity of the water troughs to the feed-trough may have permitted a greater amount of food to enter the water trough, thus increasing the level of contamination, as well as providing a nutrient-rich substrate for bacterial growth at the bottom of the water trough. LeJeune et al. (2001) also noted the association between the water quality and the ecological parameters measured, suggesting that many of the same factors that influence the survival and proliferation of bacteria in natural aquatic ecosystems have parallels in water trough environments. Bacterial contaminants in troughs may arise from multiple sources (e.g. cud or fecal material and extraneous matter including dust or feed). In some instances, depending on the source, water may be heavily contaminated before it enters the trough. Overland and sub-surface flow of feces into waterways is also likely to play a part in bacterial dissemination as *E. coli* can survive in bovine feces for several weeks (Wang *et al.*, 1996). Sediments within a trough may have much higher levels of microbial contamination.

The presence of the coliform, especially of fecal coliform, in the majority of the water samples analyzed indicates also a high risk of waterborne diseases.

Conclusions

The water consumed by dairy cows both in farms and in rural households in Transylvania is qualitatively improper due to its microbial contamination. Intake of low quality water will affect cows' health and milk yield.

Acknowledgments

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