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MICROBIOLOGICAL QUALITY OF DRINKING RAINWATER IN THE INLAND REGION OF PAJEÚ, PERNAMBUCO, NORTHEAST BRAZIL

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SUMMARY

Despite all efforts to store and reduce its consumption, water is becoming less inexhaustible and its quality is falling faster. Considering that water is essential to animal life, it is necessary to adopt measures to ensure its sanitary conditions in order to be fit for consumption. The aim of this study was to analyze the microbiological quality of drinking rainwater used by rural communities of Tuparetama, a small town located in Northeast Brazil. The study covered seven rural communities, totaling 66 households. In each household two samples were collected, one from a tank and the other from a clay pot located inside the home, resulting in 132 samples (tank plus clay pot). Approximately 90% of samples were below the standard recommended by the current legislation, being considered unfit for human consumption. Part of this high microbiological contamination of drinking rainwater could be related to the lack of sanitary education and of an adequate sewerage sanitation system.

KEYWORDS: Rainwater; Water consumption; Diseases; Parasites; Cisterns.

INTRODUCTION

The quality of human life seems to be related to the quality of drinking water, because it is a major element able to be used for preparing food, maintaining good personal hygiene and cleaning utensils. Access to safe drinking water is essential for achieving good conditions of health, therefore drinking water cannot have any pathogens and/or toxic chemicals that could damage human organisms. Pathogens such as bacteria, viruses, protozoa and helminths are able to cause human or animal diseases through ingestion or contact with food and contaminated water samples[1].

Water can transmit diseases when a pathogen enters the human body through food, water, hands or soil contaminated with fecal material. Intestinal diseases cause an estimated 1.8 million deaths each year worldwide[18], and these diseases have been discussed in relation to limited access to safe water, inadequate treatment of water for drinking by households, and lack of proper storage practices for drinking water before consumption[6,17,18].

To avoid consumption of contaminated drinking water there are some relatively simple methods, such as chlorination or boiling that can prevent many diseases caused by contamination of food and water sources[9].

Diarrheal diseases are common in developing countries, mainly in children under three years old that live in poor regions worldwide with low sanitation and bad water quality. This factor contributes to some outbreaks of diarrhea resulting in high rates of child mortality related to the consumption of drinking water[8,12,15].

Water quality seems to be worse in semi-arid regions, especially in poor rural communities, because most of them do not have proper sanitary conditions. In the town of Tuparetama, located in Northeast Brazil, for example, only 4.1% of households have a water supply[3], despite the fact that the population consumes rainwater from dams and small reservoirs that are frequently contaminated.

Limited access of households to safe water leads to increased poverty, disease and hunger, problems that could be avoided or solved if the water supply was efficient. More evidence of water problems in semi-arid regions occurs because they have long periods of drought that plague the region and lack of an adequate use of low rainfall. Due to the scarcity of water in semi-arid regions, the idea of storing some rainwater in proper water systems at home in rural areas has been suggested. Rainwater would be useful in times of prolonged drought. The main constraints for domestic rainwater use have been related to its quality which depends on the purity of the atmosphere, and materials used to collect it in households, gutters and pipes[2].

According to resolution No. 518, March 2004[4], the Brazilian Ministry

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of Health recommends investigating the presence of bacteria such as coliforms to define the microbiological standard of water quality[4]. The coliform group includes several bacteria, such as *Escherichia*, *Enterobacter*, *Citrobacter* and *Klebsiella*, from the Enterobacteriaceae family. As *Escherichia coli* is a member of normal human flora and can be found in normal human feces, its presence in water reflects a basic test to determine fecal contaminated water or contaminated food[14]. It is recommended that other pathogenic organisms such as *Giardia* spp, *Cryptosporidium* spp and enterovirus could also be investigated.

Water related disease is a common problem in developing countries, mainly in rural communities that consume rainwater without a proper microbiological quality. This study proposes to evaluate microbiological quality of drinking rainwater in Northeast Brazil and to analyze possible causes of contamination related to water sources, water-handling practices and socioeconomic characteristics of the population.

MATERIAL AND METHODS

Tuparetama is an inland town of the State of Pernambuco, located in the northeast of Brazil, has a population of about 8,177 inhabitants, and a semi-arid tropical climate. The study, undertaken in March and June 2006, involved seven rural communities (with a total of 66 households) of Tuparetama, which was selected due to its historical problems of water supply, poor population and the precarious state of the sanitation infrastructure. Water analysis was sampled in all 66 households and collected from both tank and clay pot inside the residence, totaling 132 samples. The choice for collecting from two points in each household was necessary to determine where the main source of contamination was located, either in tank or earthen pot, and thereby establish a program to raise awareness in communities about the care of water.

A questionnaire was given to each household aimed at collecting data about the existing sanitation, water care, family hygiene habits, including questions about water treatment in tanks and jars, and evaluation of the water quality.

Samples were collected in sterile 200 mL Schott Duran glass bottles. They were washed, dried and then 0.1 mL sodium thiosulfate ($Na_2S_2O_3$) was added to 10% of each 100 mL of collected water sample. The addition of $Na_2S_2O_3$ prevents the action of residual chlorine that may exist in the sample, thereby avoiding erroneous results. After $Na_2S_2O_3$ was added, all bottles were sterilized in an autoclave at 121 °C for 21 minutes.

Microbiological analysis was performed using chromogenic fluorogenic substrate, a test that is used to identify the presence or absence of total coliforms and *Escherichia coli* in water samples[11]. It is based on identification of enzymes produced by coliforms, that can use a defined bacteria substrate able to change color and producing fluorescence under U.V. light irradiation, without confirmatory tests.

Parasite analysis was performed using Hoffman, Pons & Janer method or spontaneous sedimentation. Protozoa cysts are common contaminants of water supplies because they survive a long time in the environment, at least two months in favorable conditions of temperature and humidity[13]. Water samples of 500 mL were collected in non sterile plastic bottles and left for 24 hours while the sedimentation of protozoan cysts and helminth eggs occurred. Lugol was added to 50 mm³ water sediments and a microscope slide analysis was conducted to identify parasitic structures.

Protozoa oocysts were isolated by the Kinyoun method, based on the resistance of the parasite to maintain a red color, acquired through fuchsin, after the addition of an alcohol-acid solution at room temperature. Parasites were observed by immersion objective (100 X).

RESULTS

Bacterial analysis showed that out of the total 132 water samples collected in tanks or pots from the households of the Tuparetama communities, 87.14% presented coliform in tanks and 94.28% in pots (Table 1). Thermotolerant coliform tests were positive in 30% of samples from tanks and 41.42% of clay pots used in the house to store drinking water. The results were therefore at odds with the potability criteria established by Ordinance No. 518/2004[4] from the Brazilian Ministry of Health.

Table 1
Bacterial analysis of rainwater in rural communities in Tuparetama

	Total samples	Total coliform	Thermotholerant coliform
Tank	66	87.14%	30.00%
Pot	66	94.28%	41.42%

In order to compare the different focus of bacterial contamination at each residence, from a total of 66 households, 39 did not present any difference of contamination in tank or pot, whereas 20 residences showed a higher contamination in pots, pointing to problems with transport and management of the water supply (Table 2). Only two residences presented suitable drinking water in tank and pot, showing a correct

Table 2
Rainwater bacterial contamination in tanks and pots from rural communities in Tuparetama

	Number of residences	Number of residences in percentual data (%)
Same tank and pot contamination	39	59.09
Higher pot contamination	20	30.30
Higher tank contamination	5	7.57
Absence of tank and pot contamination	2	3.03
TOTAL	66	100.00

method of water treatment with sodium hypochlorite and cleaning of the pot weekly, according to the questionnaires. Thus, the consensus is that treatment with sodium hypochlorite at least would be effective in order to eliminate bacterial contamination inside houses.

Parasite analysis showed that at least 46 (34.8%) out of a total of 132 households presented one or more parasite (helminth or protozoan) species in rainwater samples from tanks and pots. C*ryptosporidium* spp oocysts and *Giardia* spp cysts were positive in approximately 15.9% and 10% of rainwater conserved in pots and tanks, respectively.

Helminth analysis showed the presence of *Ascaris lumbricoides* and *Hymenolepis nana* in 16.6% and 1.55% of tanks and pots, respectively. Other parasites such as *Entamoeba coli*, *Entamoeba histolytica/E. dispar*, *Endolimax nana* and *Isospora belli* were also observed (Fig. 1).

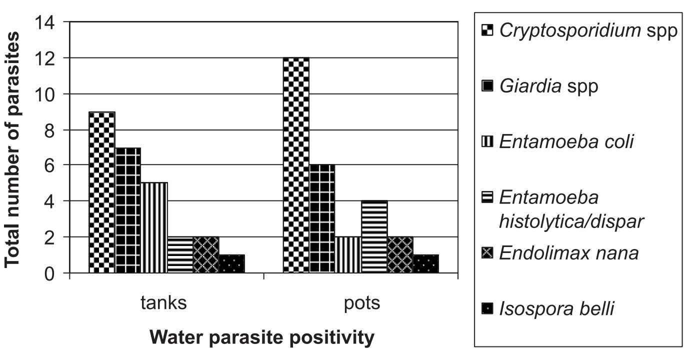

Fig. 1 - Rainwater parasite contamination in tanks and pots from rural communities in Tuparetama

It was also observed from the questionnaires that 35% of the households did not have a sewer system, and none had garbage collection. All garbage was burned in the backyard of the houses. Some people (24%) said that they treated their water tanks with chlorine, but the majority (76%) said that they do nothing to treat the water. Regarding the clay pot, 47% said that they also do nothing to treat this water. Despite this, 81% of the people said that they considered their water as having good quality, and 44% also believe that they could not fall sick because of the water.

DISCUSSION

This study demonstrated the variation of bacterial and parasite contamination of rainwater stored in tanks and pots by people living in some rural communities of Tuparetama. Higher prevalence of bacterial contamination in ready-to-drink water was observed in pots and tank of residences, particularly total coliforms in tanks and *Escherichia coli* plus total coliforms in pots. High levels of *E. coli* in water samples means that it was recently contaminated by feces. This fact is according to the answers given at interviews, showing at the same time an absence or inefficient rainwater treatment, and lack of functional disease-prevention proficiency, poor hygiene habits and local sanitary conditions.

High fecal contamination by total coliform in water samples was observed by other authors in groundwater from artesian wells, 97% for total coliform, *Pseudomonas* and feces coliform and 99.3% for feces coliform[5,7,8].

In this study there was a lower contamination by termotholerant coliform in comparison with other studies, perhaps due to the existence of other microorganisms contaminating the rainwater system, such as bacteria from vegetables and soil contamination[7].

Although some households declared that they treat their rainwater using chlorine, protozoa contamination continued to be high as observed in pots and tanks, demonstrating that a sodium hypochlorite addition seemed not to be efficient against protozoa contamination, at least in *Giardia lamblia* positive slides. According to HELLER *et al.* (2004)[10], *Cryptosporidium* spp and *Giardia* spp are resistant to chlorinated water in the amount recommended by Brazilian Health Ministry.

Since sodium hypochloride was not able to destroy protozoa parasite, we investigated the possible effect of this compound to destroy helminth parasite, thereafter an enhanced helminth contamination was sustained in rainwater conserved in tanks and pots of rural communities in Tuparetama. Our results pointed out that *Ascaris lumbricoides* eggs tested in slides after the addition of sodium hypocloride were also resistant to chlorination (SOARES ROCHA and XAVIER, unpublished data).

Approximately 90% of rainwater samples showed contamination by coliforms and 34.8% showed the presence of at a least one parasite specie such as *Cryptosporidium spp, Ascaris lumbricoides* and *Giardia spp*. Such large numbers of contaminants could be justified by a lack of education among the population of the importance to conserve their water in clean pots and avoid contaminating them with animal or human feces.

Another important fact was the lack of proper sanitation, since in the homes surveyed there was no garbage collection, piped water nor sewer system. A large number of homes did not have toilets with septic tanks. We came to the conclusion that there could be a positive correlation between lack of sanitation and the occurrence of diarrhea and some intestinal parasitosis in the population, especially among children.

This study was conducted at the end of the dry season (March) and the beginning of the winter season (June), 2006. Higher bacterial densities are observed during the rainy season than during the dry season[16], thus further studies are required to monitor seasonal variation of bacterial and parasite quality of ready-to-drink water of Tuparetama.

In conclusion, the results of this study demonstrate that bacterial and parasite contamination is a common occurrence in rainwater used by rural communities in Northeast Brazil, highlighting the necessity of preventive measures such as adequate and periodic rainwater sanitary monitoring to improve the local sanitary conditions and health education of the population. People confirmed their belief that they have good quality water, despite having no concern about its correct storage or its treatment.

RESUMO

Qualidade microbiológica da água potável no interior, Região de Pajeú, Pernambuco, nordeste do Brasil

Apesar de todos os esforços para armazenar e diminuir o seu consumo, a água está se tornando, cada vez menos, inesgotável e sua qualidade vem se reduzindo cada vez mais rápido. Sendo a água imprescindível à vida animal, é necessário que se adotem medidas para garantir sua qualidade higiênico-sanitária a fim de que seja própria para o consumo. O objetivo desse trabalho foi analisar a qualidade microbiológica da água da chuva utilizada pelas comunidades rurais da cidade de Tuparetama, localizada no nordeste do Brasil. O estudo envolveu sete comunidades rurais, totalizando 66 residências. Em cada residência foram coletadas duas amostras, uma da água armazenada na cisterna e outra da água armazenada no pote de barro localizado no interior da residência, resultando em 132 amostras (cisterna mais pote de barro). Aproximadamente, 90% das amostras estavam em desacordo com a Legislação vigente, sendo consideradas impróprias para o consumo humano. Parte dessa elevada contaminação microbiológica da água da chuva armazenada para consumo pode dever-se à falta de educação sanitária e de um sistema de esgotamento sanitário adequado.

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