

Condições ambientais e características de potabilidade da água de bicas de uso público da cidade de Taubaté- SP

ENVIRONMENTAL CONDITIONS AND CHARACTERISTICS OF POTABILITY OF SPRINGLET WATER OF PUBLIC USE OF TAUBATÉ CITY

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ABSTRACT

Subterranean waters are bodies of water which may emerge to the surface by means of water wellsprings and springlets, they are commonly utilised by man for several activities. The objective of this study was to evaluate the standard of water potability of 12 springlets of public use and human consumption in the city of Taubaté-SP. The parameters used for evaluation were: bacteriological-total coliforms reckoning and *Escherichia coli*; physical-chemical- cloudiness and nitrate concentration; parasitological-presence of *Cryptosporidium spp* and *Giardia spp*. The water samples were collected according to the established methodology by *Standard Methods for the Examination of Water and Wastewater* (APHA, 1998), in three different stages in the year of 2005. The analyses results in consonance with the Decree number 518/2004, of Health Ministry, revealed that, from 36 samples of analyzed water were considered drinkable: 67% as for the bacteriological standard, 92% as for the physical-chemical standard; and 100% as for the parasitological standard. Considering the whole analyzed parameters in three collections, it was concluded that 58% of springlet water samples studied were considered drinkable. We point out that, during the study it was not identified any type of water quality monitoring in the studied springlets, what may put the population health at risk.

KEY-WORDS

Drinkable water. Water contamination control. Contamination.

INTRODUCTION

The human consumption water emerges from fountains (springs), which are superficial or subterranean water bodies. Subterranean waters are water bodies that can emerge in the surface by means of water wellsprings and springlets. The springlets present tubes (pipes), from what water falls. Potentially, the springlets water is considered, in its natural state, of good sanitary quality, since the process of filtration and depuration of subsoil promote its purification during its percolation (OLIVEIRA; LOUREIRO, 2000).

Jacinto (2001) observes that waters can be polluted or contaminated by living pathogenic agents, in consequence of anthropic activities or of natural processes. Grabow (1996) refers that the lack of information about diseases transmitted by water creates a false sense of security, mainly in agricultural areas and in countries in development.

The potability evaluation of water consumed by human population is fundamental because it is an important means of disease transmission caused by bacteria, as diarrhea, cholera, typhoid fever, or by virus, as hepatitis, poliomyelitis, gastroenteritis. Bacteria are responsible by several cases of diarrhea diseases which can lead to fatal results; however, virus can provoke autolimited diarrheas (D'AGUILA et al., 2000; FUNASA, 2002). Yet, protozoans, like *Giardia duodenalis* and *Cryptosporidium spp*, cause giardiasis and criptosporidiasis, respectively, reaching, in major proportion, children until 5 years old (FRANCO, 1996; OSHIRO et al., 2000; THOMPSON, 2000; SCHNACK et al., 2003; ARAÚJO, 2004).

There are also diseases of hydric origin, which are caused by chemical substances, as nitrate that causes the methemoglobinemy; fluor, that causes fluorosis; and the osseous decalcification, among others

(FERNÍCOLA; AZEVEDO, 1981; FERNÍCOLA, 1989; FIGUEIREDO, 1990; BOUCHARD et al., 1992; WHO, 1998.; CASTILHO et al., 2004).

Since water is considered a vehicle of disease transmission, this study chose to evaluate the influence of some environmental and seasonal conditions and the characteristics of water potability of public use in the city of Taubaté-SP, concerning bacteriological, physical-chemical and parasitological parameters.

MATERIAL AND METHODS

The study was performed with water samples of 12 springlets of public use from Taubaté-SP. The samples were collected in three steps: the first collection during the months of March and April; the second collection between June and August; and the third one during the months of October and November; totalizing 36 samples for the bacteriological and physical-chemical analysis.

In each collection, a standardized protocol was fulfilled, with the following data: day, time, season of the year, rain situation in 24 hours, pluviometrical index, climate conditions, environmental temperature and the hygienical-sanitary conditions of the studied area.

It was collected 8 samples of springlets water to the parasitological analysis and they accused the presence of *E. coli*, following the three steps of the collection previously mentioned.

The bacteriological analysis was performed according to the Technology of Defined Substrate whose methodology is described in Standard Methods for the Examination of Water and Wastewater (APHA, 1998).

As per the quantification of total coliforms and termotolerant coliforms (*Escherichia coli*) it was used the Collert method – Cromogenical Defined Substrate, with confirmative results as for the presence of total coliforms by the development of yellowish coloration and by the observation of fluorescence for *Escherichia coli*.

The analysis for determining the concentration of cloudiness and nitrate was accomplished according to the techniques described in Analytical Rules of Lutz Institute – IAL (1985) and the Standard Methods for the Examination of Water and Wastewater (APHA, 1998).

The results obtained in the microbiological and physical-chemical tests were compared according to the patterns established by the Decree number 518/2004, of Health Ministry, aiming at regulating appropriate and inappropriate water for the human to consumption.

The parasitological tests for *Cryptosporidium spp* and *Giardia spp* were carried out by means of spontaneous sedimentation and concentration in filtering membrane (GOMES et al., 2002). Then, blades were prepared for the test that uses the Immunofluorecence technique (Merifluor kits – Meridian Diagnostics, Cincinnati, Ohio). The exceeding sediment was examined in regular microscopy, amplified in 100 and 400 times, in order to verify presence or absence of the agents as per the specifications of the kit supplier (LEITE; ARAÚJO; KANAMURA, 2003).

RESULTS

The evaluated springlets are in different places, and some factors have evidenced precarious sanitary conditions, as presence of animals, lack of cleanness, recyclable material, domestic garbage, organic material in decomposition, rubbish, weeds, stagnant water, limb formation, streamlets with open air sewage close to the springlets, and also vestige that the local is used for personal hygienic.

Concerning the presence of *E. coli* in the samples of the researched springlets water, it was verified that the best conditions of potability occurred in the samples of water collected in the dryness period, and the contrary, in the collections carried out in the rainy period. So, the following frames show that, during the period of collection of the water samples, in 2005, the water sometimes appeared drinkable, sometimes undrinkable, concerning the bacteriological pattern, changing in accordance the climatical variations and the anthropical alterations.

Frame 1 - Climatical conditions referring to the collection days of the 1st springlets water sample

Springlet	Collection Day	Collection Time	Season of the Year	Rain in the 24 hours before the collection	Pluviometrical Index	Climate	Environmental Temperature
1 2 3	09/03/05	7h45min 8h10min 8h40min	Summer	Yes	0.0mm	Sunny	25,2° C
4 5 6	16/03/05	6h55min 7h20min 7h40min	Summer	Yes	7,2mm	Rainy	23,8° C
7 8 9	06/04/05	7h30min 7h45min 8h05min	Autumn	No	21,8mm	Cloudy	26,0° C
10 11 12	11/04/05	8h 9h40min 10h	Autumn	No	0.0mm	Sunny	22,8° C

Frame 2 - Climatical conditions referring to the collection days to the collection days of the 2nd springlets water sample

Springlet	Collection Day	Collection Time	Season of the Year	Rain in the 24 hours before the collection	Pluviometrical Index	Climate	Environmental Temperature
1 2 3 4 5 6	27/06/05	7h25min 7h35min 8h38min 7h30min 8h10min 8h51min	Winter	No	0.0mm	Fog	13,4° C
7 8 9 10 11 12	16/08/05	7h 6h55min 7h58min 7h40min 7h50min 8h55min	Winter	No	0.0mm	Sunny	19,6° C

Frame 3 - Climatical conditions referring to the collection days to the collection days of the 3rd springlets water sample

Springlet	Collection Day	Collection Time	Season of the Year	Rain in the 24 hours before the collection	Pluviometrical Index	Climate	Environmental Temperature
1	24/10/05	8h18min	Spring	Yes	0.0mm	Sunny	22,4° C
2		8h28min					
3		8h38min					
4		7h23min					
5		8h10min					
6		8h51min					
7	07/11/05	7h35min	Spring	No	3,2mm	Cloudy	22,0° C
8		7h54min					
9		8h05min					
10		8h20min					
11		8h45min					
12		8h56min					

Table 1 - Correlation between the potability classification of the springlets water samples of public use, obtained in each collection as per bacteriological, physical-chemical and parasitological patterns and the final classification

Springlets water samples	Bacteriological pattern				Physical-chemical pattern				Parasitological pattern				Final Classification
	Collections			Classification	Collections			Classification	Collections			Classification	
	1 ^a	2 ^a	3 ^a		1 ^a	2 ^a	3 ^a		1 ^a	2 ^a	3		
1	P	P	P	P	P	P	P	P	-	-	-	-	P
2	P	P	NP	NP	P	P	P	P	-	-	P	P	NP
3	P	P	P	P	P	P	P	P	-	-	-	-	P
4	P	P	P	P	P	P	P	P	P	-	P	P	P
5	NP	P	NP	NP	P	P	P	P	-	-	-	-	NP
6	P	P	P	P	NP	NP	NP	NP	P	P	-	P	NP
7	NP	NP	P	NP	P	P	P	P	-	-	-	-	NP
8	P	P	P	P	P	P	P	P	-	-	-	-	P
9	P	P	P	P	P	P	P	P	-	-	-	-	P
10	P	P	P	P	P	P	P	P	P	P	P	P	P
11	NP	NP	NP	NP	P	P	P	P	-	-	-	-	NP
12	P	P	P	P	P	P	P	P	-	-	-	-	P

P = drinkable NP = undrinkable

Figure 1 shows that the percentage obtained in the bacteriological analysis of the 36 springlets water samples was of 67% of potability.

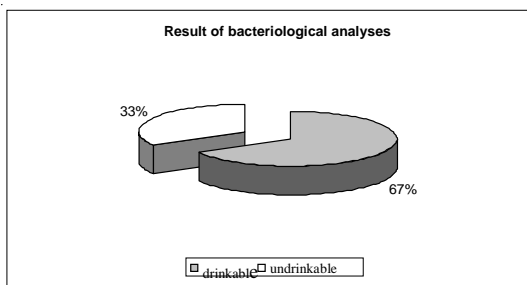


Figure 1 - Graphical representation of the percentage of springlets water samples considered drinkable and undrinkable, according to the bacteriological patterns during the 3 steps of the collection

Figure 2 exhibits that the results of the physical-chemical analysis evidenced potability in 92% of the samples.

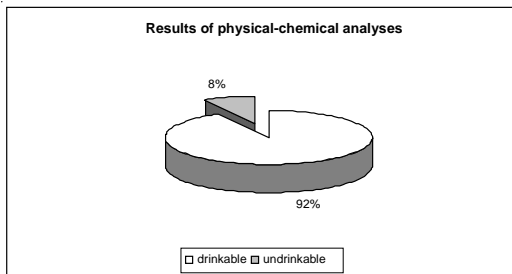


Figure 2 - Graphical representation of the percentage of springlets water samples considered drinkable and undrinkable, according to the physical-chemical patterns during the 3 steps of the collection

Regarding the parasitological tests carried out to find oocytes of *Cryptosporidium* and cysts of *Giardia*, the results obtained were negative in 100% of the samples analyzed in this study. Thus, the samples were considered drinkable in all steps of the collections, since there was not any parasitical element.

Figure 3 points out that, during 2005, 58% of the samples analyzed were considered drinkable, in the 3 steps of the collection, in all parameters of analysis.

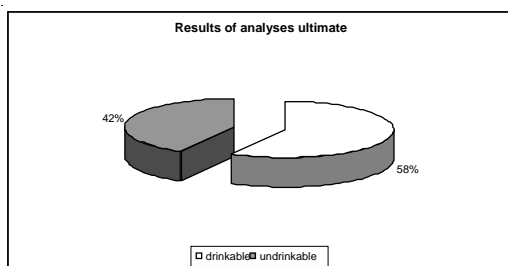


Figure 3 - Graphical representation of the percentage of springlets water samples considered drinkable and undrinkable, according to the bacteriological, physical-chemical and parasitological parameters

The statistic evaluation was accomplished with the results obtained from the averages of the variants of temperature, pluviometrical index, total coliforms, *E. coli*, cloudiness and nitrate, which were analyzed and compared between the water samples of the 12 springlets by means of the variation analysis (ANOVA, one criterion) and of Tukey test, using the BioEstar 3.0 program (ZAR, 1999).

The results of the springlets water samples indicated that there was not significant statistic difference of the more probable number NMP/100mL of total coliforms ($p>0,05$) and *E. coli* ($p>0,05$); of the cloudiness averages ($p>0,05$); of the temperature averages ($p>0,05$); of the pluviometrical index ($p>0,05$); and of the *Cryptosporidium* and *Giardia* averages ($p>0,05$), among the springlets analyzed in this work. Regarding nitrate, the only springlets whose results presented statistical significance was the springlet number 6 ($p<0,05$).

Therefore, there was no significant correlation for total coliforms, *E. coli*, cloudiness, temperature, pluviometrical index, *Cryptosporidium* and *Giardia*.

DISCUSSION

Most population has the need, the habit, and even a cultural tendency of consuming springlets water, because it considers this water pure. Contradicting that popular culture, we can evidence that, even the water is apparently crystalline, it does not mean that it is appropriate for human consumption. This research has shown - Figure 1 - that the bacteriological analysis of the 36 samples of springlets water of public use revealed that 67% of the samples were considered drinkable. Similar result was found by Batista (1996), when he verified that between 27,8% and 66,7% of the samples of springlets water analyzed in the city of Piracicaba-SP presented thermotolerant coliforms, therefore out of the pattern of potability for the human consumption. Also Gomes et al., (2002), who studied the water quality of seven natural wellsprings of public use, in the cities of Sorocaba and Votorantim-SP, verified the presence of thermotolerant coliforms in 85,7% of the analyzed samples.

The percentage found in this study (33%) of the bacteriological analysis considered undrinkable is seen with deep concern, since some authors have related the lack of information about the risks of catching diseases of hydric propagation. This fact was confirmed by Jacintho (2001), when he observed that, in 100% of the visited propriedades, which are supplied by water

mines, in Franca-SP, the people were not informed about these risks. This study has shown that the springlets water samples of public use presented better potability conditions in the period of dryness, indicating that the low pluviometrical index may have influenced the analysis satisfactory, but it is important to highlight that there was water samples in disagreement with the legislation, as in dryness period as in rain period. This result was similar to the one found by Batista (1996), Amaral et al., (2003) and Nogueira et al., (2003), who testified that the interference of the climate on the quality of the water, in hot and wet periods, what favors the increase of contamination percentages. The inverse occurs in cold and wet periods.

This research has also pointed out that the average temperature was considered regular for the region, and that the pluviometrical index was low, what may have contributed to a better quality of water. Batista (1996) also correlated the temperature and the occurrence of rain to the presence of microorganisms in the water, verifying that the climatical conditions did not interfere significantly in the number of total coliforms.

Figure 2 shows that in the physical-chemical analysis almost all results were in accordance with the legislation, what emphasizes that the percentage of 8% (considered unsatisfactory) may have been influenced by the springlet localization, close to the chemical industries of the city. According to Melo et al., (2000), the trend of this percentage is to increase, and this fact is worrying, whereas the springlet is easily accessed by the people. Besides, nitrate compromises the function of the respiratory system, mainly in children between zero and six months old. Thus providences have to be taken to avoid the water consumption by the population (FERNÍCOLA, 1989; BOUCHARD et al., 1992; WHO, 1998; MELO et al., 2000; JACINTHO, 2001; CVS, 2005).

Silva and Araújo (2003), however, pointed out different results, when evaluated the physical-chemical quality of the subterranean fountain of the urban areas of Feira de Santana-BA, referring that the cloudiness index had been disapproved in 23,4% of the water samples; therefore in disagreement with the legislation recommendation.

Although only 8% of the springlets water samples were in disagreement with the legislation, in the physical-chemical analysis, due to the high concentration of nitrate, that result was considered statistically significant. Varnier and Hirata (2002) relate that the

presence of high concentrations of nitrate occurs with more frequency in subterranean waters, and also that the concentration of nitrate is accumulative and irreversible, according to (MELO et al., 2000).

The domestic sewage and the industrial effluents are the main source of nitrogen in water. In agricultural areas, the pluvial water drainage in the fertilized soil also contributes to the presence of diverse forms of nitrogen. Nitrogen can be found in water in organic nitrogen form, and ammoniacal, nitrite and nitrate forms as well. When nitrate and nitrite are found in water samples, it means that the contamination source is far (CETESB, 2005).

Concerning the parasitological analysis, the study pointed out that 100% of the samples were considered drinkable. This result is very important, since it was not found in literature any research of oocytes of *Cryptosporidium* and cysts of *Giardia* in springlets water, in the same area. Therefore, this result may guide future researches. Divergent result was found by Gomes et al., (2002), when studied the quality of water of seven natural springlets of public use, in the cities of Sorocaba and Votorantim-SP, and found oocytes of *Cryptosporidium*.

Figure 3 shows that 58% of the analyzed samples were considered drinkable, in the three steps of collection, in all analysis parameters. This result worried because Cardoso (2000) informs that 4,4% of the population of Taubaté do not count on treated water. Thus one of the traditional or cultural ways of obtaining water is collecting it in public use springlets, as for consumption as for domestic use.

CONCLUSION

Concerning the bacteriological, physical-chemical and parasitological indicators, this work has pointed out that, as per the results of the bacteriological analysis, the water of eight springlets (67%) were considered drinkable, and, in accordance with the physical-chemical analysis, the water of 11 springlets (92%) were considered drinkable. However, the parasitological analysis showed that all the water samples were drinkable.

Taking into consideration all the parameters analyzes in the three stages of collection, it was concluded that 58% of the samples studied were considered drinkable. During the study, it was not identified any kind of quality monitoring of the studied springlets water, what may put in risk the health of the population of that area.

RESUMO

Águas subterrâneas são corpos d'água que podem aflorar na superfície por meio de fontes ou bicas d'água, comumente utilizadas pelo homem para as mais diversas atividades. O objetivo deste estudo foi avaliar o padrão de potabilidade da água de 12 bicas de uso público da cidade de Taubaté-SP, para consumo humano. Os parâmetros utilizados para avaliação foram: bacteriológico - contagem de coliformes totais e *Escherichia coli*; físico-químico - concentração de turbidez e nitrato; parasitológico - presença de *Cryptosporidium* spp e *Giardia* spp. As amostras de água foram coletadas de acordo com a metodologia estabelecida por *Standard Methods for the Examination of Water and Wastewater* (APHA, 1998), em três etapas diferentes, no ano 2005. Os resultados das análises, em conformidade com a Portaria no 518/2004, do Ministério da Saúde, revelaram que, das 36 amostras de água analisadas, foram consideradas potáveis: 67%, quanto ao padrão bacteriológico; 92%, quanto ao padrão físico-químico; e 100%, quanto ao padrão parasitológico. Considerando-se todos os parâmetros analisados nas três coletas, conclui-se que 58% das amostras de água das bicas de uso público estudadas foram consideradas potáveis. Salienciamos que, durante o estudo, não se identificou nenhum tipo de monitoramento da qualidade da água das bicas estudadas, o que pode colocar em risco a saúde da população.

PALAVRAS-CHAVE

Potabilidade da água. Controle de contaminação da água. Contaminação.

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