QUALITY OF REFILLED DRINKING WATER IN SURABAYA CITY

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ABSTRACT

Since municipal drinking water is frequently in unsafe condition and the price of mineralized water is getting more expensive, development of refilled drinking water is welcomed among middle to lower income society of Surabaya city. Therefore the objective of this study was to study whether quality of refilled drinking water in Surabaya city meet standard criteria of drinking water quality according to Decree of Health Minister of Republic of Indonesia (Kepmenkes) No. 907/Menkes/SK/VII/2002. This study was designed as a field observational study conducted cross-sectional among refilled drinking water stands (depots) in Surabaya city with descriptive analysis. Data gathering was carried out in the month of July 2004. Sample size was determined purposively by taking 1 refilled drinking water sample from the stand (depot) of each district in Surabaya city. Therefore the sample size was 31 samples of refilled drinking water. Samples were analyzed at Laboratory of Balai Teknik Kesehatan Lingkungan (BTKL) Surabaya for physical quality i.e. turbidity, chemical quality i.e. acidity (pH) and total dissolved solids (TDS), and bacteriological quality i.e. total Coliform bacteria. The results showed that all 31 samples of refilled drinking water met standard criteria of The Kepmenkes for turbidity and total dissolved solids (TDS) parameters. However, 1 (3,23 %) out of 31 samples did not meet standard criteria of The Kepmenkes for acidity level (pH) parameter; and 7 (22,58 %) out of those samples did not meet standard criteria of The Kepmenkes for total Coliform bacteria parameter. It is concluded that refilled drinking water in Surabaya has not met standard criteria of drinking water as stated in The Kepmenkes since 22,58 % of samples are contaminated by Coliform bacteria. It is recommended to consumers to boil refilled drinking water before consumed. Surabaya's Department of Health has to pay more attention and to increase activity in refilled drinking water monitoring to prevent public from suffering water borne diseases. It is suggested to consumers, to be safe, to boil this water before drinking to avoid health problem.

Keywords: *Refilled drinking water, quality, Kepmenkes.*

INTRODUCTION

Drinking water can be drinked directly without boiling (Ditjen PPM dan PLP, 1989). Drinking water must meet standard criteria of drinking water i.e. physical, chemical, bacteriological and radioactive quality as stated in Decree of Health Minister of Republic of Indonesia (Kepmenkes R.I.) No. 907/Menkes/SK/VII/2002 on conditions and monitoring of drinking water quality. Mineralized and refilled drinking water are included as drinking water (Alaerts and Santika, 2002).

Recently, development of refilled drinking water is welcomed by middle to lower income society of Surabaya city and used as an alternative drinking water supply since municipal water supply in unsafe condition. Refilled drinking water business grows well in Surabaya city due to the price of trade marked mineralized water is getting more expensive. Actually, treatment process of refilled drinking water uses the same technology as treatment process of mineralized drinking water. However, the price of refilled drinking water is cheaper compared to trade marked mineralized water due to there is no cost for packaging and distribution.

Problem raised at this moment is that quality of refilled drinking water is below standard since it does not have any National Standard Certificate and Trademark Register Number. Refilled drinking water vendors do not pay enough attention on sanitation and do not care on license from related authorized institution such as Ministry of Industry and Trade for their legal stands operation. Generally, the vendors have only a letter of recommendation from Local Department of Health at the beginning stands are opened and operated without production and trading licenses.

Suprihatin (2003) stated that 60 % out of 120 drinking water samples of refilled drinking water stands in big cities of Indonesia (Jakarta, Tangerang, Bekasi, Bogor, Cikampek, Medan, Denpasar, Yogyakarta, Semarang and Surabaya) analyzed showed that at least one parameter did not meet standard criteria of The Kepmenkes. Furthermore, 34 % out of those samples

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did not meet bacteriological standard quality according to The Kepmenkes as well. Moreover, Coliform bacteria contaminated 16 % out of those analyzed samples. Therefore, the problem formulation of this study was how are physical quality i.e. turbidity, chemical quality i.e. degree of acidity (pH) and total dissolved solids (TDS), and bacteriological quality i.e. total Coliform bacteria of refilled drinking water in Surabaya city meet standard quality of drinking water according to Kepmenkes RI No. 907/Menkes/SK/VII/2002?

The objective of this study was (1) to explore source of raw water and treatment process of refilled drinking water; (2) to measure physical quality i.e. turbidity, chemical quality namely degree of acidity (pH) and total dissolved solids (TDS), and bacteriological quality i.e. total Coliform bacteria of refilled drinking water in Surabaya city; and (3) to compare those parameters to the standard criteria of drinking water as stated in Decree of Health Minister of Republic of Indonesia (Kepmenkes R.I.) No. 907/Menkes/SK/VII/ 2002.

METHODS

This study was designed as an observational descriptive study and carried out cross sectionally. Study population was all refilled drinking water stands in Surabaya city. Sample size was determined purposively as much as number of district in Surabaya city i.e. 31 refilled drinking water stands. Therefore each district was taken one sample of refilled drinking water from stand outlet that closest to each district office.Source of raw water was studied from refilled drinking water vendor using by a questionnaire. While water treatment process was studied using by questionnaire and observation form.

Refilled drinking water samples were taken from stand outlet aseptically and analyzed at laboratory of Balai Teknik Kesehatan Lingkungan (BTKL) Surabaya for determining physical quality i.e. turbidity, chemical quality i.e. acidity (pH) and total dissolved solids (TDS), and bacteriological quality i.e. total Coliform bacteria. Turbidity of refilled drinking waters was measured by spectrophotometer method using by spectrophotometer HACH DR2010 type. Acidity (pH) was measured by electrical method using by pH-Electrode SenTix-20. Total dissolved solids (TDS) were measured by direct method of electrical conductivity using by HACH Model 44600 Conductivity/TDS-meter. While total Coliform bacteria was measured by multiple tubes fermentation method. Data from laboratory assays were analyzed descriptively and compared to standard criteria as stated in The Kepmenkes R.I. No. 907/Menkes/SK/VII/2002 on conditions and monitoring of drinking water quality.

RESULTS AND DISCUSSION

Source of raw water and water treatment process

Drinking water industry in Indonesia has developed since 1970 that is called mineralized drinking water packed in plastic glass 240 ml, small plastic or glass bottle 600 ml, big bottle 1500 ml, and plastic gallon 19000 ml (Ananto, 2002). Together with increasing needs of instant drinking water and increasing price of mineralized water, and happening of economic crisis in Indonesia started in 1999 had encouraged public innovation to develop refilled drinking water stands which spread through any places of suburb and urban area in Indonesia. In the same time, problem raised on quality assurance and standard quality of the product, monitoring mechanism of refilled drinking water stands and using of mineralized gallons by public for buying refilled drinking water (Greenberg et al., 1992; Suprihatin, 2003).

It is estimated that number of refilled drinking water stands in Indonesia have developed vastly from 55 stands in 1999 became around 2000 stands in 2000. According to Surabaya City Department of Health, in the end of 2003 number of refilled drinking water stands in Surabaya was 78 stands. Most of those do not have any business permit or production permit from Local Department of Industry and Trade. Therefore, there is no any accurate data of number of refilled drinking water stands. Whereas Surabaya Department of Health had initiative to monitor quality of refilled drinking water by giving recommendation letter at the first time the stand opened and operated.

There is variation of production periods among refilled drinking water stands in Surabaya. Some of them are newcomer just one month ago open their stands and some of them have already opened for around 48 months (4 years), with average operation period is 22 months. Room space of the stands is also different, some have 12 m^2 (58.06 %) and some have 9 m^2 (41,94 %). All the stands in all districts of Surabaya city use raw water from spring water, 28 (90,32 %) of them use spring water from Prigen, Pasuruan county, and the rest use spring water from Pacet, Mojokerto county, East Java province. Spring water is assumed free from physical or chemical contamination. However, Province Health Department stated that no spring water is free from bacteriological contamination (Ananto, 2002), then disinfections process during water treatment should pay enough attention (Ditjen PPM dan PLP, 1993; WHO dan Depkes RI, 2003).

Treatment process of raw water becomes refilled drinking water of the stands in Surabaya city is as follows (see Figure 1) :

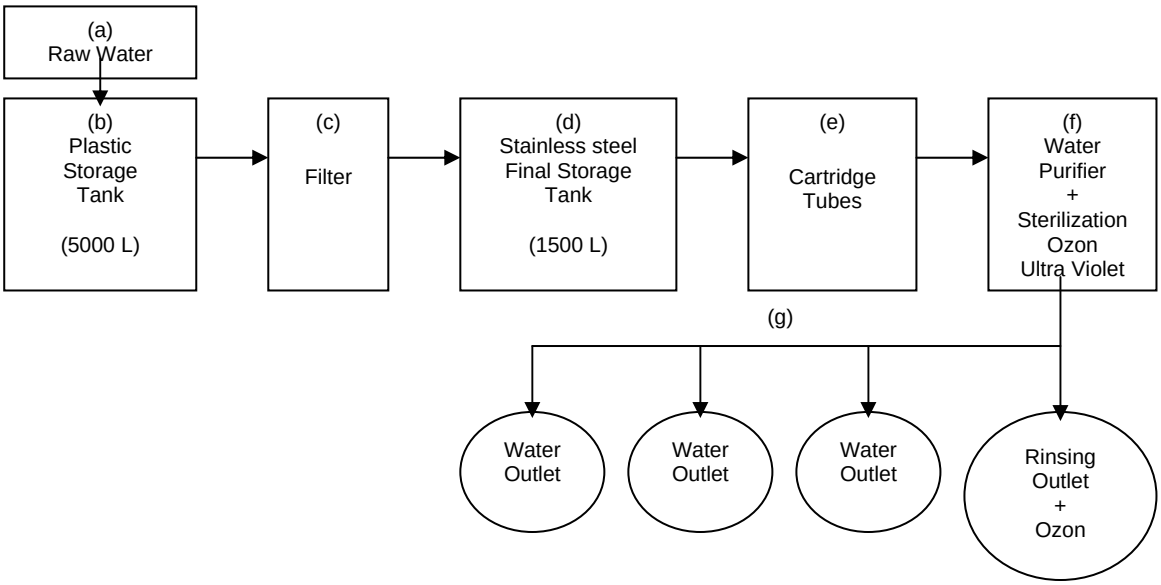

Figure 1. Scheme of refilled drinking water treatment process. (Source : Ananto K (2002) Peranan ASPADA Dalam Pembinaan Depot Air Minum. Pertemuan Pengelola Program Makanan dan Minuman Industri Rumah Kabupaten/Kota Se Jawa Tmur di Dinas Kesehatan Propinsi Jawa Timur.)

a. Raw water is spring water taken from upland of Prigen, County of Pasuruan or Pacet, County of Majokerto - East Java province. These raw waters are brought using by tank tuck with capacity of 5000 liters to refilled drinking water stand in Surabaya and directly put in plastic storage tank with capacity of 5000 liters without any laboratory assay of raw water quality. In normal standard procedure, quality of raw water has to be analyzed at recommended standardized laboratory for its physical, chemical and bacteriological quality. Raw water is an important factor in refilled drinking water supply since raw water has determinant factors in water treatment process of refilled drinking water production. In order to provide qualified refilled drinking water, the raw water used should fulfill standard quality of raw water for drinking water. Its quality has to be checked at recommended laboratory. Tank trucks and its tools used to carry and to distribute raw water to refilled drinking water stands around Surabaya should have good standardized sanitation such as use stainless still or plastic to prevent rust, always in sanitary condition, tightly closed with seal protection, unleak tank and its tools to prevent cross-connection bacteria contamination into raw water (WHO dan Depkes RI, 2003).
b. Plastic storage tank (5000 liters) is used as reservoir before raw water is processed into drinking water. Raw water in plastic storage tank is then drained to stainless steel final storage tank with capacity of 1500 liters through water filters. Plastic storage tank at refilled drinking water stands must meet sanitation standard such as made from non-metal materials, non-rust materials, always in clean condition, and always tightly closed to prevent from insects or other outside contaminants. Detention time of raw water in storage tank is not longer than 3 days due to changing of taste and keeps the water in fresh condition (Ditjen PPM dan PLP, 1993; WHO dan Depkes RI, 2003). The storage tank will be refilled soon when the water is empty (Ananto, 2002).

c. Function of the water filter is to screen small particles that may lie in this water. Before refilled drinking water is ready to provide, it must be processed first. The treatment process of raw water includes filtration, absorption and sterilization. Process of filtration uses silicate sands for macromedia filtration.
d. After filtration, the water in stainless steel final storage tank will be free from particulate pollutants and almost free from bacteriological contamination (Ananto, 2002). The water filters are usually changed annually or can be shorter if the water filters have already been dirty (WHO dan Depkes RI, 2003).
e. Next step is the water kept in stainless steel final storage tank is then drained through three cartridge tubes to improve the water taste, color and smell. Cartridge filters are used for micromedia filtration. Cartridge filters used in micromedia filtration are variation in size 0.1, 0.3, or 0.5 micron. In order to make free odor drinking water, the water treatment process uses multilayer carbon filters from the largest to the smallest size carbon filter that has more effective adsorption ability to organic matters, odor, taste and toxic materials that may exist in raw water. This carbon filters must frequently be carbonated/activated and changed with the new one annually or when the adsorption ability is getting worse (Ditjen PPM dan PLP, 1993). The more worse raw water quality is the more frequent filter carbonated/activated or change activity.
f. Before draining through water outlet, the water has to be flowed through ultra violet light radiation for disinfections purposes to kill residual bacteria that may be still persist or exist after previous treatments. After filtration and adsorption process, the water must be sterilized using by ultra-violet lights of 30 Watt ultra-violet light lamps that have 2000 – 3000 Å of wave length with flow rate of 20 gallons (75.6 liters) per minute. Based on principles of ultra-violet light sterilization, the water that is sterilized must clear, colorless, and free from turbidity, ferrous contamination, organic colloids or planktons (Alaerts and Santika, 2002). Flow rate of the water should not more than 20 gallons/minute (Degrémont, 1979; Cheremishinoff, 1993). After filtration, adsorption and sterilization process is completed, the refilled drinking water is ready to flow through water outlet into consumer's gallon.
g. After getting ultra violet radiation, the water is flowed through water outlet as refilled drinking water and ready to be put in consumer's gallons or bottles and then consumed. Usually, the water outlets are two to four holes. One of them is contained ozone that function as gallon or bottle rinsing before refilled drinking water is filled in it using by injection technique for sterilization purposes. Rinse of water treatment installation is also an important thing that must get enough attention. The owners of refilled drinking water stand rinse their installation in different period of time. Some of them rinse their installation before operation everyday, some of them rinse three times a day, and some of them rinse once a week. Rinsing of the installation must be done everyday before it is operated that leads to the best results. Furthermore, the owner should pay enough attention on changing of cartridges and keeps its good performance then it will not influence next water treatment processes (Ditjen PPM dan PLP, 1993; Ananto, 2002; WHO dan Depkes RI, 2003).

Turbidity of Refilled Drinking Water

Analysis of refilled drinking water samples taken from 31 stands in Surabaya showed that levels of turbidity were below maximum allowable concentration of The Kepmenkes R.I. for turbidity parameter i.e. 5 FTU as shown in Table 1.

Table 1. Turbidity of Drinking Water Samples from 31 Refilled Drinking Water Stands in Surabaya City on July 2004.

Number of Samples of Refilled Drinking Water (n=31)	Turbidity (FTU)	Maximum Allowable Concentration (Kepmenkes 907/2002)
16 (51.61 %)	0	5 FTU
13 (41.93 %)	1	
1 (3.23 %)	2	
1 (3.23 %)	3	

Above data show that 16 out of 31 (51.61 %) refilled drinking water samples have turbidity of 0 FTU; 13 out of 31 (41.39 %) refilled drinking water samples have turbidity of 1 FTU; 1 out of 31 (3.23 %) refilled drinking water samples has turbidity of 2 FTU; and 1 out of 31 (3.23 %) refilled drinking water samples has turbidity of 3 FTU. Therefore, refilled drinking water is clear enough and meet standard criterion of The Kepmenkes for turbidity.

Acidity (pH) and Total Dissolved Solids (TDS)

Laboratory assays showed that acidity (pH) of 31 samples of refilled drinking waters in Surabaya were in range of 6.05 (the lowest) to 7.60 (the highest). Most of the samples (30 out of 31 refilled drinking water samples or 96.77 %) meet standard criterion of The Kepmenkes for acidity i.e. 6.50 – 8.50. Only 1 (3,23 %) sample with value of 6.05 did not meet (below) the standard. It is probably caused by anaerobic decomposition of suspended organic materials in raw water contamination during unsanitary taking of this spring water from upland of Prigen, Pasuruan county of East Java. Another possibility of water contamination is come from refilled drinking water installation itself. Results of acidity (pH) assays of refilled drinking water samples from 31 stands in Surabaya city taken on July 2004 are shown in Table 2.

Table 2. Acidity (pH) and Total Dissolved Solids (TDS) of 31 Drinking Water Samples of Refilled Drinking Water Stands in Surabaya City on July 2004.

Chemical Parameters	Number of Samples (n) Refilled Drinking Water In Surabaya City	Maximum Allowable Concentration (Kepmenkes 907/2002)
Acidity (pH)		6.5 – 8.5
- Meet Reference Value	30 (96.77 %)	
- Below Reference Value (<6,5)	1 (3.23 %)	
Total Dissolved Solids (TDS)		< 1000 mg/l
- All Meet Reference Value	31 (100 %)	

Total dissolved solid (TDS) assays of 31 refilled drinking water samples showed that all values are in normal range i.e. 62.50 – 150.40 mg/l, beneath maximum allowable concentration value of drinking water of The Kepmenkes for TDS parameter i.e. 1000 mg/l. It means that all refilled drinking water are not much containing of dissolved inorganic salts. Results of TDS are shown in Table 2 as well.

Total Coliform Bacteria

Bacteriological assays of total Coliform bacteria showed that 7 out of 31 (22.58 %) refilled drinking water samples have value above reference value of 0 /100 ml water sample i.e. range of 8.80 total Coliform bacteria/100 ml - > 240 total Coliform bacteria/100 ml water sample. It means 22.58 % of refilled drinking water samples are contaminated by Coliform bacteria. The Kepmenkes R.I. No. 907/Menkes/SK/VII/ 2002 stated that drinking water must free from bacterial contamination. Resume refilled drinking water samples from 31 stands in Surabaya city for Total Coliform bacteria assays is shown in Table 3.

Table 3. Result of Total Coliform Bacteria Assays of Drinking Water Samples From 31 Refilled Drinking Water Stands in Surabaya City on July 2004.

Bacteriological Parameter	Number of Samples (n) Refilled Drinking Water In Surabaya City	Maximum Allowable Concentration (Kepmenkes 907/2002)
Total Coliform Bacteria		0 / 100 ml sample
- Meet Reference Value	24 (77,42 %)	
- Above Reference Value	7 (22,58 %)	

This result is consistently inline with study of Suprihatin (2003) that stated that 60 % out of 120 drinking water samples of refilled drinking water stands in big cities of Indonesia (Jakarta, Tangerang, Bekasi, Bogor, Cikampek, Medan, Denpasar, Yogyakarta, Semarang and Surabaya) analyzed showed 34 % out of those samples was unfulfilled bacteriological quality according to Decree of Health Minister of Republic of Indonesia (Kepmenkes RI) No. 907/Menkes/SK/VII/2002. Moreover, the study concluded that 16 % out of sample analyzed was contaminated by Coliform bacteria.

All of 7 (22.58 %) refilled drinking water samples that do not meet bacteriological standard have below treshold limit values of turbidity, acidity (pH) and total dissolved solids. Those 7 refilled drinking water stands are using raw spring water taken from Prigen upland in county of Pasuruan that may be contaminated by stool or using unsanitary procedure. This Coliform bacteria or its spore contamination could be (1) from source of raw water; (2) from tank truck during transportation; (3) during filling raw water in storage tank of refilled drinking water stand; (4) unsanitary water treatment process; or (5) combination of these factors.

Refilled drinking water industry is now become an alternative business of small scale of entrepreneur, and contributes to city drinking water supply with reasonable price. However, its development will give negative impact to public health if there is not effective monitoring from local department of health. It is suggested the owners of refilled drinking water stand to keep the drinking water in safe condition using by appropriate technology, and good installation maintenance. It is recommended to check the water quality at recommended laboratory regularly at least once a month in order to prevent public health problems.

CONCLUSIONS

All (100%) refilled drinking water samples meet drinking water's maximum allowable concentration of turbidity i.e. less than 5 FTU; and drinking water's chemical quality of total dissolved solids (TDS) i.e. below 1000 mg/l. Whereas 1 (3.23 %) sample does not meet drinking water's chemical quality standard of acidity (pH) i.e. below 6.5; and 7 (22.58 %) samples do not meet bacteriological quality standard of Kepmenkes R.I. No. 907/Menkes/SK/VII/ 2002 for total Coliform bacteria. Therefore, 7 (22.58 %) samples of refilled drinking water are not suitable to be consumed due to bacterial contamination.

It is suggested to the owners of refilled drinking water stand in Surabaya to check quality of raw water; to change water filter immediately when the filter is already dirty; to rinse cartridge tubes regularly; and to check the product of refilled drinking water quality at recommended laboratory monthly. It is recommended to consumers to boil refilled drinking water before consumed. Local department of health have to pay more attention and to increase activity in refilled drinking water monitoring to prevent public suffering from drinking water based diseases. It is suggested to consumers, to be safe, to boil this water before drinking to avoid health problem.

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