

BACTERIOLOGICAL AND CHEMICAL STUDY OF THE DRINKING WATER IN INDONESIA¹

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Abstract: We carried out the examination of drinking water in Indonesia for past 13 years. The present paper reports the results of bacteriological and potassium permanganate consumed test conducted from July to August in 1980.

Bacteriological examination revealed that *Klebsiella pneumoniae* was isolated most frequently from the drinking water in Indonesia, and *Acinetobacter calcoaceticus*, *Aeromonas hydrophila*, *Pseudomonas* sp. and *Pseudomonas aeruginosa* were found next to it. *Klebsiella pneumoniae* and *Acinetobacter calcoaceticus* were found most frequently from drinking water in Java, while *Aeromonas hydrophila* was isolated most often in Kalimantan and Sumatra. From the samples of the tap water, *Acinetobacter calcoaceticus* and *Hafnia alvei* were found most frequently, while from the well water, *Klebsiella pneumoniae*, *Acinetobacter calcoaceticus* and *Aeromonas hydrophila*, and from rain water, *Acinetobacter calcoaceticus* and *Chromobacterium violaceum* were respectively found.

From the results of the potassium permanganate consumed test, 62% of the drinking water from Java were shown positive in this test, while 90% from Kalimantan, 100% from Sumatra as well as Sulawesi were proved positive respectively. The correlation between isolated bacteria and results of potassium permanganate consumed test was following; All the drinking water, in which such bacteria as *Escherichia coli*, *Edwardsiella tarda*, *Enterobacter aerogenes* were found, showed positive also in potassium permanganate consumed test, while only 33% of the drinking water contained *Hafnia alvei* was proved positive in this test.

INTRODUCTION

Indonesia lies in the tropical zone, and with high temperature and humidity, its climate is most favorable for the propagation of microorganisms. In most parts of the country, sanitary conditions are far from desirable. Diseases like typhus, cholera, dysentery, epidemic hepatitis, and various parasitosis are still high frequent under the existing circumstances.

We focus our attention to the drinking water, as it plays an important role in outbreak and transmission of these diseases. With the aid of Japan Association for

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Tropical Medicine, we started to examine the drinking water in each place of Indonesia since 1968 and have conducted the study for more than ten years.

The results were shown that the drinking water in Indonesia contained a large amount of microorganisms, and chlorinization of drinking water was never carried out in any places in Indonesia (Fujita, Ikeda and Matsumoto, 1974). For example, *Escherichia coli* was found in more than 10% of samples of the drinking water supplied by Jakarta city, in spite that the base line of the drinking water of Indonesia was prescribed more strictly by law than that of WHO (World Health Organization, 1971), and of Japan (Takeuchi, 1980).

In the present paper, we report the microbiological and some chemical study of drinking water in Indonesia based on the survey in 1980.

PERIOD, AREA, MATERIALS AND METHODS

During the period from 4 July to 2 August 1980 in Jakarta and other main cities of Java, Kalimantan, Sulawesi, and Sumatra, we collected samples from the drinking water with cleansed containers, after washing them thoroughly with it (Table 1). Each sample of 0.1 ml water was dropped into 0.2% agar added to Brain heart infusion broth to make semi solid medium with a sterilized pipet, and on our return to Japan, it was cultivated with modified Drigalski medium, SS agar, TCBS agar, NAC agar and Manitol salt agar. The isolated colonies were discriminated in the procedure of Fig. 1-1 and Fig. 1-2, and their species were determined (Buchanan,

Table 1 Drinking water classified by regions and sources

	JAVA	KALIMANTAN	SULAWASI	SUMATRA
Tap water	9	2	0	0
Well water	35	7	5	10
Rain water	2	5	1	0
Total points	46	14	6	10

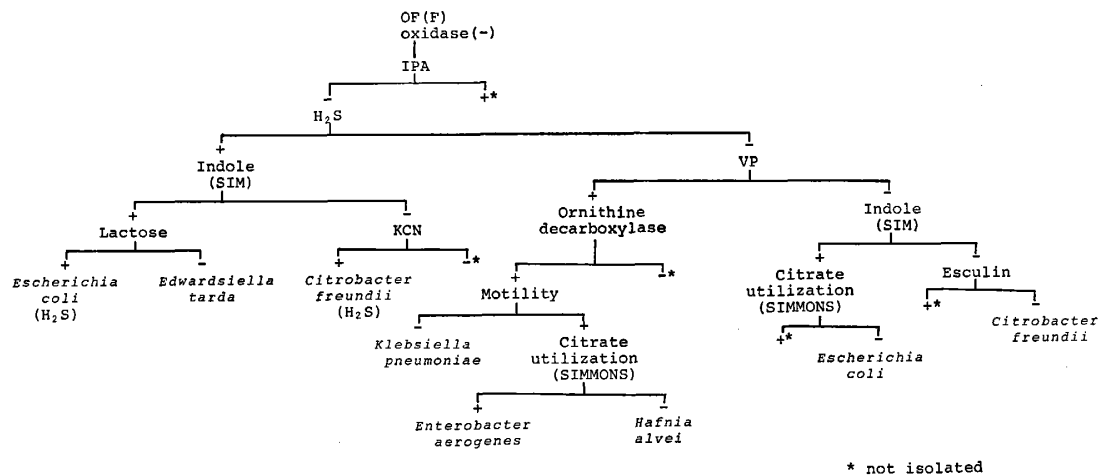


Figure 1-1 Procedure of discrimination of Gram negative rods.

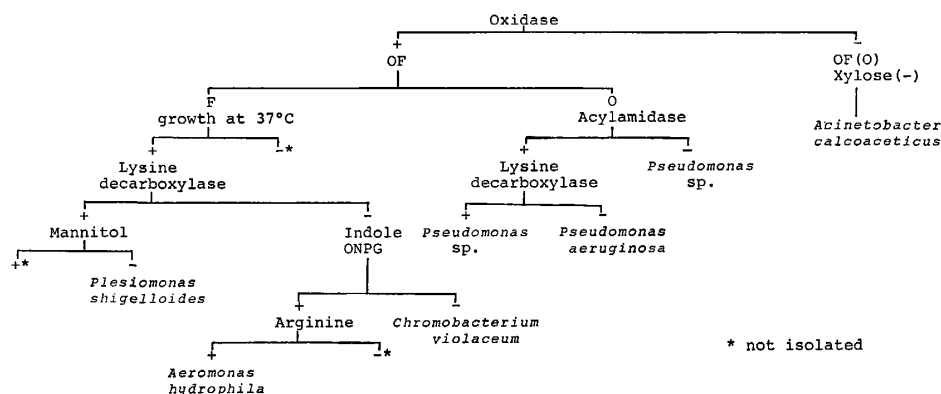


Figure 1-2 Procedure of discrimination of Gram negative rods.

R. E. and Gibbons, N. E., 1975; Kozakai, 1974).

On the same time, each of 50 ml sample water was taken to sterilized polyethylene vessels, and potassium permanganate consumed test was carried out with Shibata 8052-05 type water gauge (Shibata Chem. Co., Ltd. Tokyo, Japan).

RESULTS

Seventy six samples of the drinking water from Java, Kalimantan, Sumatra and Sulawasi of Indonesia were examined first by the potassium permanganate consumed test, which is regarded as the most important index among various kinds of chemical examinations in connection with the water pollution. Results of the test revealed that 62% of the drinking water from Java was shown positive in potassium permanganate consumed test, while 90% from Kalimantan, 100% from Sumatra as well as Sulawasi were proved positive, as shown in Table 2. When the positive rate classified by the source, 17% of tap water, 82% of well water and 100% of rain water became positive (Table 3).

Table 2 Results of potassium permanganate consumed test from drinking water classified by regions

	Total points	positive (%)
JAVA	46	62
KALIMANTAN	14	90
SULAWASI	6	100
SUMATRA	10	100

Table 3 Results of potassium permanganate consumed test from drinking water classified by sources

	Total points	positive (%)
Tap water	11	17
Well water	57	82
Rain water	8	100

Table 4 shows the results of bacteriological examinations of drinking water in Indonesia. It was *Klebsiella pneumoniae* and *Acinetobacter calcoaceticus* that were isolated most often, and *Aeromonas hydrophila*, *Pseudomonas* sp. and *Pseudomonas aeruginosa* were found next to it. Contrary to our expectation, *Escherichia coli* was found only in seven

samples. When the strains isolated were classified by regions, *Klebsiella pneumoniae* and *Acinetobacter calcoaceticus* were most frequently found in Java, *Pseudomonas aeruginosa* and *Pseudomonas sp.* followed them. In Kalimantan, *Aeromonas hydrophila* and *Pseudomonas sp.* were frequent, and *Escherichia coli* was found in four samples. In Sumatra, *Aeromonas hydrophila* was isolated most often, and *Escherichia coli* in three samples. In Sulawesi, *Acinetobacter calcoaceticus* and *Chromobacterium violaceum* and others were found.

Table 4 The number of strains isolated from drinking water classified by regions

Strains	JAVA	KALIMANTAN	SULAWASI	SUMATRA	Total No. of strains
<i>Escherichia coli</i>	0	4	0	3	7
<i>Klebsiella pneumoniae</i>	19	0	2	3	24
<i>Edwardsiella tarda</i>	0	2	0	0	2
<i>Enterobacter aerogenes</i>	1	1	0	0	2
<i>Hafnia alvei</i>	3	1	0	1	5
<i>Citrobacter freundii</i>	3	0	0	2	5
<i>Aeromonas hydrophila</i>	2	4	0	7	13
<i>Chromobacterium violaceum</i>	1	2	3	0	6
<i>Acinetobacter calcoaceticus</i>	16	0	4	3	23
<i>Plesiomonas shigelloides</i>	3	0	0	0	3
<i>Pseudomonas aeruginosa</i>	5	3	0	2	10
<i>Pseudomonas sp.</i>	4	4	0	3	11

When classified by the source of the water, the results are shown in Table 5. From the samples of the tap water, *Acinetobacter calcoaceticus* and *Hafnia alvei* were found frequently. But in case of 57 samples of the well water, various kinds of species were

Table 5 The number of strains isolated from drinking water classified by sources

	Tap water	Well water	Rain water	Total No. of strains
Total points	11	57	8	
<i>Escherichia coli</i>	0	7	0	7
<i>Klebsiella pneumoniae</i>	0	22	2	24
<i>Edwardsiella tarda</i>	0	2	0	2
<i>Enterobacter aerogenes</i>	0	0	2	2
<i>Hafnia alvei</i>	3	1	1	5
<i>Citrobacter freundii</i>	2	3	0	5
<i>Aeromonas hydrophila</i>	0	11	2	13
<i>Chromobacterium violaceum</i>	1	2	3	6
<i>Acinetobacter calcoaceticus</i>	4	15	4	23
<i>Plesiomonas shigelloides</i>	0	3	0	3
<i>Pseudomonas aeruginosa</i>	1	7	2	10
<i>Pseudomonas sp.</i>	2	8	1	11

found, but among them, *Klebsiella pneumoniae* was most frequently found (in 22 samples) and *Acinetobacter calcoaceticus* was next (in 15 samples). From the samples of the rain water, *Acinetobacter calcoaceticus*, *Chromobacterium violaceum* and others were found.

Table 6 shows the correlation between isolated bacteria and results of potassium permanganate consumed test. Among the samples in which *Hafnia alvei* or *Chromobacterium violaceum* was found, only 40% and 33% of drinking water was proved positive in the potassium permanganate consumed test. In case of *Plesiomonas shigelloides*, this correlation was next lowest value of 67%. But, 100% of drinking water which contained such bacteria as *Escherichia coli*, *Edwardsiella tarda*, *Enterobacter aerogenes*, *Aeromonas hydrophila* and so on showed positive also in potassium permanganate consumed test.

Table 6 Correlation between the results of potassium permanganate consumed test and the isolated bacteria

Strains	negative sample (%)	positive sample (%)
<i>Escherichia coli</i>	0	100
<i>Klebsiella pneumoniae</i>	4	96
<i>Edwardsiella tarda</i>	0	100
<i>Enterobacter aerogenes</i>	0	100
<i>Hafnia alvei</i>	60	40
<i>Citrobacter freundii</i>	20	80
<i>Aeromonas hydrophila</i>	0	100
<i>Chromobacterium violaceum</i>	67	33
<i>Acinetobacter calcoaceticus</i>	9	91
<i>Plesiomonas shigelloides</i>	33	67
<i>Pseudomonas aeruginosa</i>	5	95
<i>Pseudomonas sp.</i>	9	91

DISCUSSION

We have conducted the examination of drinking water in Indonesia for 13 years, and we found that the sanitary conditions have never changed during these periods, as already reported by Fujita, et al. in 1974. Furthermore, according to the last year's survey, 30 among 54 samples (56%) of drinking water in Indonesia contained more than 10^2 coli-form bacilli per ml (Fujita, Okuwaki, Ikeda, Tsukidate, Sugiyama and Iwami, 1980).

Mohammedanism, which forms a basis for the life in this country, seems to have a greatest influence to the sanitary conditions. Cities and villages are situated along large or small rivers, which also serve as traffic routes. Peoples are attached to the rivers, and use the water for drinking, washing vessels or clothes, bathing and washing away faecal matters. An Islamic way of thinking that "flowing water is always clean" brings about such a situation. People cannot even imagine that the water possibly contains pathogenic microorganisms. Therefore, cholera, dysentery, typhus or

epidemic hepatitis became prevalent every year in each locality.

We have considered that the drinking water plays a most important part of the causes of these diseases in Indonesia. Therefore, we carried out the more detailed bacteriological as well as chemical tests of the drinking water in Indonesia in the present study. In our bacteriological survey of the drinking water in Indonesia, *Escherichia coli*, which suggests the existence of fecal matters, was isolated not very often. But, bacteria such as *Klebsiella pneumoniae*, and *Aeromonas hydrophila* were found regardless of the locality. As these bacteria are normally distributed in the realm of natural and river water, we can infer that the admixture of bacteria by the bursting of the water pipe from outside water occurs in almost all parts of Indonesia.

From the results of the potassium permanganate consumed test, 100% of the drinking water in Indonesia, in which *Escherichia coli* was found, was proved positive also in this test, and over 62% of drinking water from each place of Indonesia became positive in the potassium permanganate consumed test. These results will suggest that the drinking water in Indonesia is polluted by fecal matters with relatively high probability. It is hoped that the efforts to maintain the drinking water clean will be realized in the near future in Indonesia.

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インドネシア各地の飲料水の細菌学および化学的研究¹

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われわれは、過去13年間にわたりインドネシア各地の飲料水について、その水質に関する調査を実施してきた。その成績とインドネシア各地に発生する疾病との因果関係に考察を加えると同時に、熱帯地における衛生上の問題点についても言及してきた。

今回、1980年7月から8月にかけての約1カ月間、インドネシア各地の飲料水について、細菌学的検索を行い、併せて過マンガン酸カリウム消費量を測定し、興味ある知見を得たので報告する。

インドネシア各地で採取した総計76検体の飲料水について、細菌学的検査を行ったところ、*Klebsiella pneumoniae* が最も多く検出され、次いで *Acinetobacter calcoaceticus*, *Aeromonas hydrophila*, *Pseudomonas* sp. および *Pseudomonas aeruginosa* などの細菌類が検出された。飲料水を地域別に分けた場合、ジャワ島では *Klebsiella pneumoniae* や *Acinetobacter calcoaceticus* が多く検出されたのに対して、カリマンタン島やスマトラ島での飲料水には *Aeromonas hydrophila* が最も多く検出された。また、飲料水を水源別にした場合では、水道水からは *Acinetobacter calcoaceticus* と *Hafnia alvei* が量も多く検出されたのに対して、井戸水からは *Klebsiella pneumoniae*, *Acinetobacter calcoaceticus* と *Aeromonas hydrophila* が、一方、雨水からは *Chromobacterium violaceum* がそれぞれ多く検出された。

さらに、水質検査のうちで、有機物混入の最も良い指標とされている過マンガン酸カリウム消費量を測定し、検出された細菌類との地域別および水源別についての関係を調べた。ジャワ島での飲料水は62%が過マンガン酸カリウム消費量が陽性となった。一方、カリマンタン島での飲料水は90%が、スマトラ島およびスラウェシ島での飲料水では実に100%が同反応で陽性となった。また、検出された菌種との関係をみると、*Escherichia coli*, *Enterobacter aerogenes* などが多く検出された飲料水は過マンガン酸カリウム消費量の反応が100%陽性であったが、*Hafnia alvei* が検出された飲料水は33%にしか同反応で陽性を示さなかった。

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