

Further Detail Study of Bacteria from the Drinking Water in Indonesia for the Past Five Years

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Abstract: The quality of drinking water in various regions of Indonesia was surveyed and the results of bacteriological studies during the last 5 years were summarized. The following results were obtained.

1. The quality of drinking water of Indonesia became better a slight since 1982, but the mean positive rates in the number of total colonies and coliform group counts did not become so good.
2. Among the strains detected, *Klebsiella pneumoniae*, *Enterobacter cloacae*, *Enterobacter aerogenes* and *Citrobacter freundii* were frequently detected each year. *Escherichia coli* was found in 8 water samples in 1979, 7 samples in 1980 and 5 samples in 1982. From the tap water in Jakarta, *Escherichia coli* was detected in 3 samples in 1979, and 2 samples in 1982. Among the bacteria related to the enteric bacteria, *Pseudomonas aeruginosa* and *Aeromonas hydrophila* were frequently detected.

These bacterial strains detected showed no difference among the areas and the sources of the water samples.

3. It is noteworthy that *Salmonella* E₁ group was detected in 1 samples from each of well water in 4 islands, and *Salmonella* C₁ group in 1 sample from Jakarta.

Key words: Total colonies counts, Coliform group counts, Enteric bacteria, Drinking water, Indonesia

INTRODUCTION

On consideration of factors on sanitary environment and disease constitution in the tropical zone, our attention was focussed on water. Drinking water was sampled from each region of Indonesia for the survey on its quality for 15 years from 1968 to 1984. In the present report, the results of more detail bacteriological studies of the recent 5 years from 1979 to 1983 are summarized with some discussion.

PERIOD AND AREA

Approximately 1 month period around July and August in each year was selected for study. Water was sampled in main cities of Java, Kalimantan, Sulawesi and Sumatra islands.

MATERIALS AND METHODS

Numbers of total colonies and coliform group counts were measured by using URICULT set (Daiichi Kagaku Co.) containing CLED and MacConkey medium, and the URICULT set was directly dipped in water at water sampling. After removing excess water, the container was tightly sealed and kept at 30–40°C for about 18 h. The number of colonies formed was counted, and we were used as the number of total colonies and coliform group counts respectively. At the same time, 0.5 ml sample water was inoculated to brain heart infusion broth with addition of 0.2 % agar, and it was brought back to Japan for the isolation of the enteric bacteria and related bacteria (Buchanan, R. E. and Gibbons, N. E., 1975; Kozakai, N., 1974).

RESULTS

Results on the number of total colonies and coliform group counts. The water samples were regarded as positive when the number of total colonies and coliform group counts exceeded 10^3 /ml and 10^2 /ml respectively. Table 1 summarized the results of these two counts of drinking water in Indonesia from 1979 to 1983.

The number of total colonies counts was positive in as high as 71 % in 1979, and as low as 56 % in 1983, with the mean of 63 %. The number of coliform group counts, on the other hand, was as high as 55 % in 1979 and 1980, but was as low as 37% in 1983, with the mean of 49 %. The results on the number of total colonies and those of coliform group counts showed the slight better tendency of the quality of the drinking water from 1979 to 1983.

Table 2 showed the evaluation of the data after each of region and water source for 5 years. Tap water was most abundantly supplied in the city of Jakarta, and the number of total colonies counts was positive in 46 % and number of coliform group counts was positive in 32 % of the tap water samples for 5 years. Tap water has recently been also supplied to a small part of Kalimantan and Sulawesi islands, after

completion of water filtration plant in the Banjarmasin city of Kalimantan island and Ujung Pandang city of Sulawesi island. According to our results, however, all samples from these regions were positive for total colonies and coliform group counts except for one sample. The amount of potassium permanganate consumption measured by the simultaneous chemical tests showed the faecal contamination of these samples (Fujita *et al.*, 1982; Okuwaki *et al.*, 1982). Most of other samples consisted of well water were positive for number of total colonies and coliform group counts, suggesting that a large part of total colonies counts was occupied by coliform group counts.

Isolated strains. As shown in Table 3, *Klebsiella pneumoniae*, *Enterobacter cloacae*, *Enterobacter aerogenes* and *Citrobacter freundii* belonging to the group of enteric bacteria were abundantly detected each year. These strains were detected uniformly regardless of the site and source of water sampling. *Escherichia coli* was detected in 8 samples in 1979, 7 samples in 1980 and 5 samples in 1982. It should especially be noted that 3 samples in 1979 and 2 samples in 1982 from the tap water of Jakarta were positive of *E. coli*. It is also important that *Salmonella* E₁ group was found in 1 sample each from the well water of the 4 islands, and *Salmonella* C₁ group was detected in 1 sample of well water of Jakarta.

Among the bacteria related to the enteric bacteria, *Pseudomonas aeruginosa*, *Aeromonas hydrophila* and *Acinetobacter calcoaceticus* were frequently detected. In the results of 1982, these related bacteria were not frequently detected, probably because a method to facilitate the detection of enteric bacteria was employed.

Table 1. Time course results of total colonies and coliform group counts

	Total samples	Positive samples	
		Total colonies (%)	Coliform group (%)
1979	76	54 (71)	42 (55)
1980	76	52 (68)	42 (55)
1981	78	51 (65)	39 (50)
1982	75	43 (57)	37 (49)
*1983	59	33 (56)	22 (37)

*; Only in Jakarta

Table 2. Annual distribution of total colonies and coliform group counts divided into each region and water source

	1979			1980			1981		
	No. of samples	Positive samples		No. of samples	Positive samples		No. of samples	Positive samples	
		Total colonies counts (%)	Coliform group counts (%)		Total colonies counts (%)	Coliform group counts (%)		Total colonies counts (%)	Coliform group counts (%)
J A V A	15	7 (47)	6 (40)	11	5 (45)	4 (36)	20	9 (45)	6 (30)
Well water	42	29 (69)	23 (55)	35	23 (66)	18 (51)	34	21 (62)	19 (56)
Rain water	0	0	0	0	0	0	0	0	0
KALIMANTAN	7	7 (100)	6 (86)	11	8 (73)	8 (73)	7	6 (86)	4 (57)
Well water	1	1 (100)	1 (100)	3	2 (66)	2 (66)	1	1 (100)	1 (100)
Rain water	0	0	0	0	0	0	2	1 (50)	1 (50)
SULAWASI	3	3 (100)	2 (67)	3	2 (67)	2 (67)	1	1 (100)	1 (100)
Well water	2	2 (100)	1 (50)	3	3 (100)	2 (67)	5	5 (100)	3 (60)
Rain water	0	0	0	0	0	0	0	0	0
SUMATRA	6	5 (83)	3 (50)	8	7 (88)	5 (62)	6	5 (83)	3 (50)
Well water	0	0	0	2	2 (100)	1 (50)	2	2 (100)	1 (50)
Rain water	0	0	0	0	0	0	0	0	0
Total	76	54	42	76	52	42	78	51	39

	1982			1983		
	No. of samples	Positive samples		No. of samples	Positive samples	
		Total colonies counts (%)	Coliform group counts (%)		Total colonies counts (%)	Coliform group counts (%)
J A V A	28	11 (39)	6 (21)	32	18 (56)	10 (31)
Well water	29	14 (48)	13 (45)	27	15 (56)	12 (44)
Rain water	0	0	0	0	0	0
KALIMANTAN	4	4 (100)	4 (100)	1	1 (100)	1 (100)
Well water	1	1 (100)	1 (100)	1	1 (100)	1 (100)
Rain water	0	0	0	0	0	0
SULAWASI	2	2 (100)	2 (100)	2	2 (100)	2 (100)
Well water	2	2 (100)	2 (100)	2	2 (100)	2 (100)
Rain water	0	0	0	0	0	0
SUMATRA	4	4 (100)	4 (100)	4	4 (100)	4 (100)
Well water	4	4 (100)	4 (100)	4	4 (100)	4 (100)
Rain water	0	0	0	0	0	0
Total	75	43	37	59	33	22

Table 3-1. Isolated strains from drinking waters (1979)

	JAKARTA		Total number
	Tap water	Well water	
<i>Escherichia coli</i>	•••	•••	8
<i>Klebsiella pneumoniae</i>	•	•••	4
<i>Enterobacter cloacae</i>	••	•••	7
<i>Citrobacter freundii</i>	•		1
<i>Pseudomonas aeruginosa</i>	●•	●•••	26
<i>Aeromonas hydrophila</i>	•••	•••	15
<i>Alcaligenes faecalis</i>	•••		3
<i>Acinetobacter calcoaceticus</i>	•••	•••	7

• ; 1 sample ● ; 10 samples

Table 3-2. Isolated strains from drinking waters (1980)

	JAVA		KALIMANTAN			SULAWASI			SUMATRA		Total number
	Tap water	Well water	Tap water	Well water	Rain water	Tap water	Well water	Rain water	Well water	Rain water	
<i>Escherichia coli</i>				•••	•				•••		7
<i>Klebsiella pneumoniae</i>	••	●•••					••		••	•	24
<i>Enterobacter aerogenes</i>		•		•							2
<i>Citrobacter freundii</i>		•••							••		5
<i>Edwardsiella tarda</i>				••							2
<i>Hafnia alvei</i>		•••		•					•		5
<i>Pseudomonas aeruginosa</i>		•••		•••					••		10
<i>Pseudomonas sp.</i>		•••		•••					•••		11
<i>Aeromonas hydrophila</i>		••		••	••				•••	••	13
<i>Plesiomonas shigelloides</i>		•••									3
<i>Alcaligenes faecalis</i>		•		••			••	•			6
<i>Acinetobacter calcoaceticus</i>	•••	●••					••	••	••	•	23

• ; 1 sample ● ; 10 samples

Table 3-3. Isolated strains from drinking waters (1982)

	JAVA		KALIMANTAN			SULAWASI			SUMATRA		Total number
	Tap water	Well water	Tap water	Well water	Rain water	Tap water	Well water	Rain water	Well water	Rain water	
<i>Salmonella C, group</i>		•									1
<i>Salmonella E, group</i>		•		•			•		•		4
<i>Escherichia coli</i>	••	••		•							5
<i>Klebsiella pneumoniae</i>	•	••							•		4
<i>Serratia marcescens</i>		•	•			•			••		5
<i>Enterobacter cloacae</i>	•	••••	••	••		•			•		16
<i>Enterobacter aerogenes</i>	•										1
<i>Citrobacter freundii</i>	•••	•••	•••	•	•			••		•••	21
<i>Pseudomonas aeruginosa</i>		•••			•						6
<i>Pseudomonas putida</i>		•									1
<i>Pseudomonas putrefaciens</i>		•									1
<i>Pseudomonas punctata</i>		•									1
<i>Aeromonas hydrophila</i>	•	••				•	•				5

•; 1 sample ●; 10 samples

DISCUSSION

Indonesia is a tropical country with high temperature and humidity, suitable for the growth of microorganisms. Infections by microorganisms such as typhoid fever, dysentery, cholera and various parasitic diseases still occupy high places as important diseases in Indonesia (Japan Association for Public Health, 1981). As one of the causal factors for such diseases, we have focussed our attention on the drinking water. We have surveyed the quality of water at various regions of Indonesia and reported the results (Fujita *et al.*, 1974; Fujita *et al.*, 1980; Fujita *et al.*, 1982; Okuwaki *et al.*, 1982).

In Indonesia, a tendency of accumulation of the population to large cities still persists and Jakarta is said to have population exceeding 8.5 millions, although the official population is 6 millions (Japan Association for Tropical Medicine, 1982). As the results, even in some areas in which the tap water is supplied, tap water is frequently led away illegally by using a connecting tube, so that the water pressure falls and the water does not reach each home. A motor is therefore used to secure sufficient water (Japan Association for Tropical Medicine, 1982). These leads to contamination of the tap water by organic substances and microorganisms which are in the soil or have infiltrated the soil. *Escherichia coli*, *Enterobacter cloacae*, *Enterobacter aerogenes* and *Citrobacter freundii*, belonging to the enteric bacteria originally infesting the intestinal tract of humans and

animals, were found not only in well water, but also in tap water. Detection of *Salmonella* sp. is noteworthy, even if it is from the well water. Genus *Salmonella* infests the intestinal tract of reptiles and mammals, causing asymptomatic infections. Consequently, it is quite possible that these microorganisms show an extensive spread over the soil due to the contamination by such excreta. When the wells are relatively shallow, the possibility of such contamination would no doubt be quite high. According to the report of Sunaga *et al.* (1984) who have surveyed the quality of the drinking water in various parts of the world, no residual chlorine was found in the tap water in developing countries. This would suggest that chlorine disinfection is not done at all or done only incompletely in most of the cases. In the survey on a different region, Sierra Leone, Africa, by Wright, R. C. (1982), *Salmonella* sp. were detected in about 10% of the water samples. According to Donald, J. R. (1981), 80% of the diarrhea in travellers through the tropical and subtropical zones are due to *Salmonella* sp., enterotoxigenic *E. coli*, *Leptospira* and *Yersinia*. *Salmonella* was thought to be most important among these. In view of such report, it is no wonder that *Salmonella* sp. was detected from the well water in developing countries. Devises should be made on transportation medium for *Salmonella* sp. as well as *Yersinia* for the future study of more detail examination.

The bacteria related to the enteric bacteria are Gram negative rods not fermenting glucose. These are classified into those originally infesting humans and animals and those living in water and soil. *Pseudomonas aeruginosa* is important because of pathogenicity and drug resistance. *Pseudomonas cepacia* persist even in the solution of disinfecting agent, hibitane concentrate, and is known to be capable of causing urinary tract infection. *Aeromonas hydrophila* also lives originally in fresh water, known as the causative microorganism for infection in fish. *Aeromonas hydrophila* has caused acute gastroenteritis in humans, drawing widespread attention from the viewpoint of the opportunistic infection (Okuwaki *et al.*, 1980). These microorganisms thus require caution not only from the viewpoint of direct etiology, but also with reference to secondary infection. The water surveyed by us has been used not only as the drinking water, but also as the daily life, so that the data reported presently will be usefull for the prevention of purulent diseases and urinary tract infection in Indonesia.

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過去5年間のインドネシアにおける飲料水の細菌学的研究

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熱帯地における衛生環境のなかで、我々は重要な役割りを担うものとして水に注目し、1968年より経年的にインドネシア各地で飲料水を採取し、その水質調査を続けている。そこで、これまでの成績のうち、1979年から1983年までの最近5か年間の細菌学的検索の結果をまとめ、若干の考察を加えて報告する。

1. インドネシア各地の飲料水は、1982年以降やや改善のきざしがみられるものの、一般細菌数及び大腸菌群数の平均陽性率は、それぞれ63%と49%という成績であった。ジャカルタ市内の水道水の成績は、一般細菌数で45%、大腸菌群数で32%に陽性が示された。

2. 検出された菌種は、腸内細菌では *K. pneumoniae*, *En. cloacae*, *En. aerogenes*, *C. freundii* が例年多く検出されている。し尿系汚染との関係から注目される *E. coli* は、1979年8検水、80年7検水、82年5検水から検出され、そのなかにはジャカルタ市内の水道水で、79年3検水、82年2検水より検出されている。一方、腸内細菌類縁菌では、*P. aeruginosa*, *A. hydrophila* が多く検出されている。これらの菌種は、調査した地域や検水の由来によつての差はみられていない。

3. 1982年の調査で、*Salmonella* E₁ 群がジャワ島、カリマンタン島、スラウェシ島、スマトラ島のそれぞれの井戸水1検水ずつ、また *Salmonella* C₁ 群がジャカルタ市内の井戸水1検体より検出されたことは注目され、今後輸送及び保存培地などに工夫を行い、検出率を高めると共に、*Yersinia* 属などについても検討を加えていきたい。