【研究ノート】

Evaluation on the Drinking Water Quality Concerning Bacteria and Inorganic Nitrogen Using Ten Spring Water Samples

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Abstract

Water supply self-sufficiency rate in nationwide of Japan is almost 100% . However, spring water is also used as drinking water. In this thesis, we examined bacterial contamination and inorganic nitrogen using ten spring water samples to evaluate their hygienic safety. Those samples were collected from Nov. 26, 2016 to Jan. 27, 2017. EC blue test and desoxycholate agar test were carried out for coliforms and fluorescent EC blue test was used for *E. coli*. Other general bacteria were detected by standard agar test. Inorganic nitrogen (e.g. NH_4-N, NO_2-N, NO_3-N) were evaluated by using each ion selective pack test and digital pack test meter. As a result, the coliforms were detected in the range of 260 to 1 CFU/mL in five samples by desoxycholate agar tests. The results of EC blue tests in the same samples were also positive. *E. coli* was positive reaction in two of the five samples. Therefore, these spring water samples were judged inappropriate for drinking. In the rest five samples, there were no *E. coli* and no coliform. The numbers of general bacteria were detected 2100 to 0 CFU/mL. Three samples, which showed the values of 2100, 400 and 110 CFU/mL respectively, were out of the drinking water quality standard (100 CFU/mL). The concentrations of NH_4-N and NO_2-N in each sample were not detected. NO_3-N concentrations were the range of 40.8 to 0.27 mg/L in ten samples. Two samples (i.e. 40.8 and 21.1 mg/L) exceeded the standard quality value (NO_3-N; <10 mg/L) of drinking water. In conclusion, five of the 10 spring water samples did not meet the quality standard criteria of drinking water by bacteriological examination and evaluation of inorganic nitrogen. We determined those five samples were not suitable for drinking. These methods, tried in this study, were very useful for quickly detecting the hygiene problems of spring water samples.

Keywords：Spring water, Drinking water quality, *E. coli*, Coliform, Inorganic nitrogen.

1. Introduction

Water supply self-sufficiency rate in nationwide of Japan is 97.8% according to the data in 2014. Although tap water in Japan hardly recognizes bacterial contamination, a certain percentage of the people, especially elderly, have a habit of drinking spring water on a daily basis, because they hate the chlorine sterilization odor in tap water. However, the quality of the spring water is not hygienically

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guaranteed and they are not paying much attention to sanitary risks unfortunately.

In the previous study, we investigated the concentration of 15 trace elements (B, Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Mo, Cd, Sb, Pb, and U) using spring water from six locations of the urban area for five years [1]. We concluded that those samples were not harmful to the human body. Because the water quality changes greatly over time, as is well known, we decided to start a new validation. In this study, we examined bacterial contamination and inorganic nitrogen to evaluate the hygienic safety. We believe that these survey items properly reflected the deterioration of water quality.

2. Materials and Methods

Ten spring water samples were taken from Noroshimizu, Miakogawa, Rakannoi, Ohmachi, Funabashidaijingu, Takifudoson, Kemigawajinja, Katushikajinja, Katushikahachiman and Matudojinjya. Six locations such as Noroshimizu, Miakogawa, Rakannoi, Ohmachi, Funabashidaijingu, and Takifudoson were the same places in the past investigation, and they were collected newly from Nov. 26, 2016 to Jan. 27, 2017.

We examined the amount of bacteria to evaluate the safety of those samples. EC blue and desoxycholate agar test were carried out to detect coliforms. Fluorescent EC blue test was also used for E. coli. Other general bacteria were detected by standard agar test. Inorganic nitrogen, e.g. NH_4-N, NO_2-N, and NO_3-N, were evaluated by each ion selective pack test and digital pack test meter (KYORITSU CHEMICAL Corp, Japan, Figure 1).

Figure 1: Digital pack test meter was used for the evaluation of inorganic nitrogen.

3. Results and Discussion

The results were shown in Table 1. The coliforms were detected in the range from 260 to 1 CFU/mL in five samples such as Noroshimizu, Rakannoi, Ohmachi, Funabashidaijingu and Katushikajinja using desoxycholate agar tests. These positive data were indicated by light green columns in Table 1. These five samples were also positive in EC blue tests. Two of five samples such as Noroshimizu and Ohmachi presented positive reactions for *E.coli*, which were showed by yellow columns in Table 1. Fluorescent EC blue test showed positive in Ohmachi's sample (Figure 2.). The samples of Noroshimizu and Ohmachi were judged inappropriate as drinking water. In the remaining three samples, nor *E.coli* was

detected. About general bacteria, three samples such as Ohmachi, Katushikajinja, and Katushikahachiman showed relatively high numbers in Table 1, i.e. 110, 2100, and 400 CFU/mL, which were showed by purple columns, respectively. These samples were out of the criteria (<100 CFU/mL) suitable for drinking. The concentrations of NH_4-N and NO_2-N in each sample were not detected in all samples. NO_3-N concentrations presented the values from 40.8 to 0.27mg/L in ten samples (Table 1.). The reaction of NO_3-N pack test from Ohmachi was showed in Figure 3. Two samples such as Ohmachi and Takifudoson showed 40.8 and 21.1 mg/L respectively (indicated by blue columns in Table 1), which were evaluated as inappropriate. These figures of NO_3-N should be less than 10mg/L. The sample taken from Ohmachi showed unsatisfactory results in all evaluation tests such as NO_3-N concentration, *E.coli* and general bacteria.

To summarize above results, five of ten samples taken from Noroshimizu, Ohmachi, Takifudoson, Katushikajinja, and Katushikahachiman did not meet the quality standard criteria for drinking by bacteriological examination and evaluation of inorganic nitrogen. We concluded those five samples were not suitable for drinking.

Furthermore, these simplified and quickly detecting methods we tried in this study (i.e. EC blue test for coliform, fluorescent EC blue test for *E. coli*, and ion selective pack test for chemical contaminants) may be effective to supply the drinking water to ensure primary health in developing countries and/or undeveloped countries.

Table 1: The results of ten spring water samples

	E. coli *	Coliform *	Coliform **	General bacteria **	NO_3-N ***
Noroshimizu	+	+	10	46	0.27
Miakogawa	−	−	0	1	2.40
Rakannoi	−	+	1	8	6.00
Ohmachi	+	+	8	110	40.8
Funabashidaijingu	−	+	1	78	3.90
Takifudoson	−	−	0	0	21.1
Kemigawajinja	−	−	0	1	9.36
Katushikajinja	−	+	260	2100	7.24
Katushikahachiman	−	−	0	400	0.40
Matudojinja	−	−	0	1	0.51

* : *E. coli* and Coliform were examined by fluorescent EC blue and EC blue method, respectively.
** : Coliform and general bacteria were examined by desoxycholate agar and standard agar test, respectively. (CFU/mL).
*** : NO_3-N concentrations were measured by pack test.

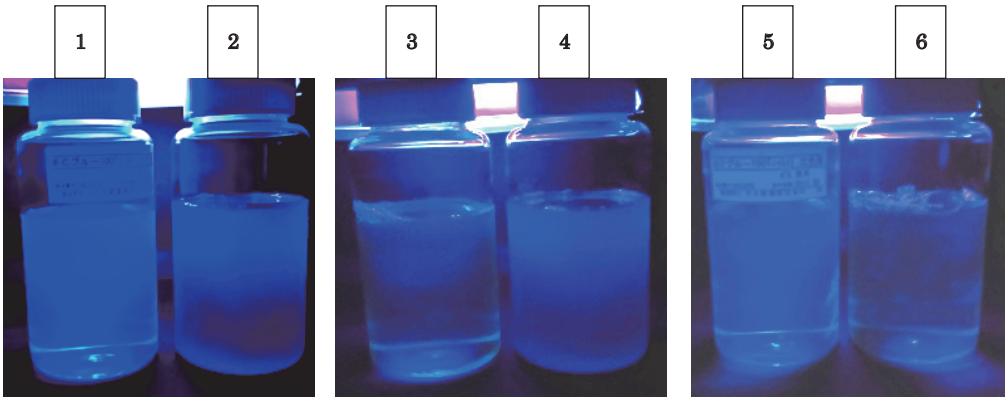

Figure 2: Fluorescent EC blue test; References (1 and 5) and samples taken from Ohmachi (2 and 4) showed positive as compared with controls (3 and 6).

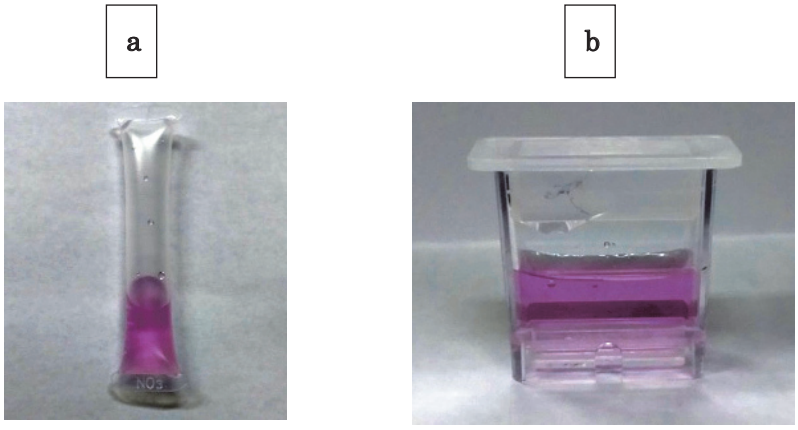

Figure 3: NO_3-N was detected by pack test (a) and in cube for pack test meter (b) in case of Ohmachi sample.

4. Conclusion

We examined bacteriological detection and evaluated inorganic nitrogen using spring water samples. These methods, tried in this study, were very useful for quickly detecting the hygiene problems of spring water samples.

References

[1] Yumi, Manaka ; Masayuki, Goto ; Takehiko, Kaneko et al. Analysis and Successive Observation of 15 Trace Elements in Spring Water at Six Locations. 3rd International Conference on Environmental Pollution and Remediation Program Booklet. 2013, p.13.

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