RESEARCH BRIEF, AUGUST 2019

ARE PRESENCE/ ABSENCE MICROBIAL TESTS APPROPRIATE FOR MONITORING LARGE URBAN WATER SUPPLIES IN AFRICA?

Monitoring for Safe Water (MfSW) is an action research program that promotes drinking water safety through improved monitoring. The Aquaya Institute (Aquaya) launched MfSW with a grant from the Bill & Melinda Gates Foundation. Partners have included the African Water Association (AfWA), the International Water Association (IWA), and the World Health Organization (WHO).

INTRODUCTION

Water quality testing is critical for safeguarding public health. However, achieving adequate levels of water quality testing is a challenge in resource-limited settings [1]. One strategy for addressing this challenge is to improve the efficiency of monitoring activities. Presence/absence (P/A) microbial tests are a simpler, promising alternative to traditional quantitative methods, especially for chlorinated water systems that generally have non-detectable levels of fecal contamination. To determine if the P/A method is appropriate for monitoring urban, chlorinated piped water systems, Aquaya researchers published a comparative analysis of quantitative and P/A microbial water testing methods:

MacLeod, C., Peletz, R., Kere, F., M'Baye, A., Onyango, M., Aw, S., El Hadj Issabre, M., Tung, R., Khush, R. (2019). Are Presence/Absence Microbial Tests Appropriate for Monitoring Large Urban Water Supplies in Sub-Saharan Africa? Water. 11,491; doi:10.3390/w11030491.

METHODS

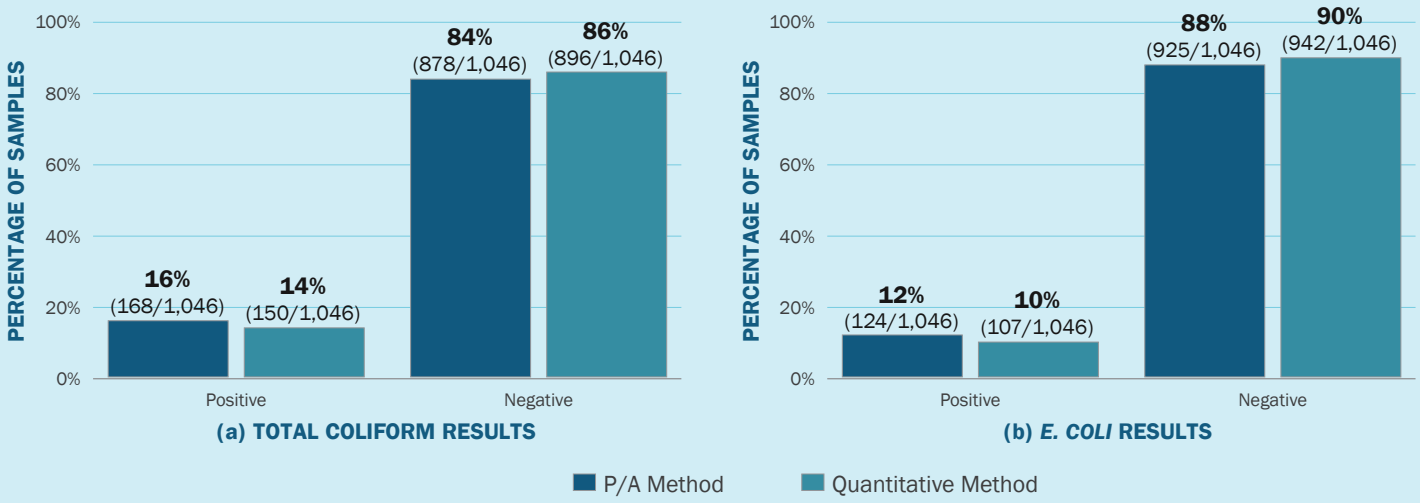
The Aquaya Institute collaborated with five urban water suppliers in sub-Saharan Africa operating chlorinated piped distribution systems with low levels of microbial contamination. These suppliers included L'Office National de l'Eau et de l'Assainissement (ONEA) in Burkina Faso; Société de Distribution d'Eau de le Côte d'Ivoire (SODECI) in Côte d'Ivoire; Nairobi City Water and Sewerage Company (NCWSC) in Kenya; Société Malienne de Gestion de l'Eau Potable (SOMAGEP) in Mali; and Sénégalaise des Eaux (SDE) in Senegal. Between June 2015 and August 2016, these partners analyzed a total of 1,048 water samples from their distribution systems for total coliforms and *E. coli* using both their established standard quantitative methods (e.g., most probable number or membrane filtration) and the Colitag™ method in P/A format (Table 1).

TABLE 1:
Quantitative methods for microbial water testing employed by the five African water suppliers that participated in this study. The total number of tests includes analysis of positive and negative control samples.

Water supplier	Number of Connections	Method	QAQC Samples	Total Number of Tests
ONEA	361,475 [2]	MF	16	214
SODECI	473,347 [3]	MF	51	198
NCWSC	582,502 [4]	MPN	50	205
SOMAGEP	210,730 [5]	MF	33	220
SDE	666,547 [6]	MF	20	211[1]
TOTAL			**170**	**1,048[1]**

QAQC = Quality Assurance and Quality Control (i.e., positive or negative controls)
[1]For Total Coliforms, the total number of tests= 1,046; the total number for site 5=209
MF = Membrane Filtration
MPN = Multiple Probable Number

FIGURE 1:
(a) Percentage of positive and negative samples for total coliforms according to P/A and quantitative diagnostic methods; (b) Percentage of positive and negative samples for *E. Coli* according to P/A and quantitative diagnostic methods.



RESULTS

The researchers found that the two diagnostic methods produced similar results for total coliforms and *E. coli*. Combined results from these tests demonstrated high agreement rates between the quantitative and P/A methods: 98% (1,024/1,046) for total coliforms and 98% (1,025/1,048) for *E. coli* (Table 2). There was no significant difference between testing methods (P/A vs. quantitative) when comparing fractions of positive samples for total coliforms (16% vs. 14%, p = 0.29) or *E. coli* (12% vs. 10%, p = 0.23) (Figure 1). However, when disaggregating samples by institution, there was a significant difference between the two methods in *E. coli* detection at one study site (18% vs. 11%, p = 0.03). Among those samples, the majority came from piped water supplies, which likely contained chlorine-injured organisms. These data suggest that the P/A method may be more accurate at detecting *E. coli* contamination for certain water sample types than the quantitative method, particularly when injured organisms are present [7]. It is also worth noting that the study found low levels of contamination overall: 96% (674/700) of samples from distribution network tested negative for total coliforms, and 99% (694/700) tested negative for *E. coli*.

TABLE 2:
2 x 2 contingency tables for (a) total coliform, and (b) *E. coli.*

P/A Method	Quantitative Method +	Quantitative Method -	Total
+	148	20	168
-	2	876	878
Total	150	896	1,046

(a) TOTAL COLIFORMS

P/A Method	Quantitative Method +	Quantitative Method -	Total
+	103	20	123
-	3	922	925
Total	106	942	1,048

(b) *E. COLI*

CONCLUSION

The P/A test offers advantages as a simpler and similarly sensitive alternative for detecting microbial contamination in urban chlorinated piped water systems in Africa. As most water quality monitoring institutions in sub-Saharan Africa do not achieve testing levels specified in standards or guidelines [1], the simpler P/A test may provide an opportunity to improve sampling rates. However, the application of P/A methods by African water suppliers will likely be driven by cost considerations. While equipment costs for the P/A test are generally lower than quantitative methods, the cost of procuring consumables is currently higher; therefore, suppliers will likely favor the use of quantitative methods over P/A tests, especially where agencies have already invested in equipment for quantitative methods. Nevertheless, validated P/A tests may still prove cost-effective in settings with chlorinated piped water systems that are not supported by established laboratories. Additionally, the application of P/A methods will also likely depend on regulatory acceptance of the P/A method by national regulatory agencies.

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