Study on Tap Water Acceptance and Exposure Analysis of Fecal Bacteria for Local Residents and Travelers in Hue, Vietnam

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1. Background and Objectives

In Hue City, Vietnam, the water supply system has been rapidly developing since the recent decade; but there is no information about the water usage of citizens and the current sanitary situation. Hue City has become a tourist destination because of the world heritage sites in it. In 2013, 720,000 foreign travelers visited the area. Therefore, in this study, tap water acceptance of citizens and environmental pathway vectors surrounding citizens and tourists such as raw vegetables, drinking water, ice, dishes and glasses, etc, contaminated by fecal bacteria were investigated. Based on the data, main exposure pathways of fecal bacterium and the amount of exposure for citizens and tourists were calculated by stochastic analysis using Monte Carlo Simulation.

2. Survey and Experiment methods

Questionnaire survey about the usage of tap water was conducted in the houses and street stalls. The concentration of *E.coli* in raw vegetables, drinking water, dishes and glasses etc. of houses and food services was measured from September to October in 2014. The food services were classified into street stalls, small restaurants, and big restaurants because sanitary situations depend on the scale of restaurant. **Table 1** presents the calculation of the amount of exposure; the target bacteria being *E.coli*. The distribution was set by the results of concentration of *E.coli* and questionnaire survey; the amount of exposure per meal and per day was then calculated using Monte Carlo Simulation.

Table 1 Categorization of eating places

	Street stall	Small restaurant	Big restaurant
Pic.			
Style	No store	Store	Store
Eating place	All outside	Outside & inside	All inside

3. Results and Discussion

E. coli was not detected in 14 out of the 17 samples of tap water. In the three samples where it was detected, the concentration range was 1 or 2 CFU/100 mL. Ninety percent (90%) of local citizen subjects (n=80) drink tap water after boiling or filtering; tap water is also used to wash vegetables. However, *E. coli* of 1.8×10^3 CFU/g-wet in 50th percentile was detected in raw vegetables of houses and *E. coli* of 2.1×10^2 CFU/g-wet in 50th percentile was detected in raw vegetables of big restaurants (**Fig. 1**). The amount of *E. coli* exposure per meal mainly depends on raw vegetables. Local citizens intake *E. coli* in a rate of 9.7×10^4 CFU/time in 50th percentile from raw vegetables of houses, and Japanese tourists intake *E. coli* in a rate of 2.3×10^3 CFU/time in 50th percentile from raw vegetables of big restaurants(**Fig. 2**). These results implied it would be significant to improve the sanitary management of raw vegetables in house and restaurants to reduce the exposure of residents and tourists in Hue City, Vietnam to *E. coli*.

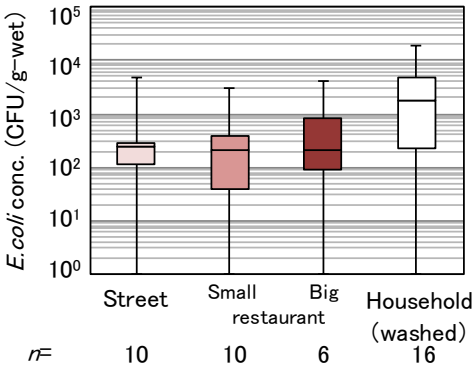

Fig. 1 *E.coli* conc. of raw vegetable

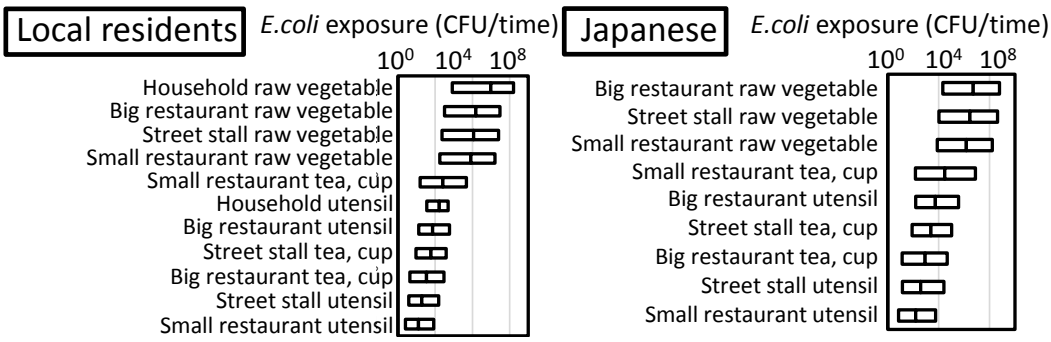

Fig. 2 *E.coli* exposure(Left: Local residents, Right: Japanese tourist)