# Microbial Risks Assessment of Bakso and Restaurant Food Consumption due to the Escherichia Coli Contaminated Water Sources in Abepura City, Papua Indonesia 2013

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## ABSTRACT

*Microorganisms in drinking water sources may colonize in gastrointestinal (GI) tracts and this phenomenon may pose a potential health risk especially to immune compromised population. The survival characteristics of both generic E. Coli and Escherichia coli O157:H7 in varied drinking water sources were investigated to assess the potential for human exposure. This study aimed to assess microbial risks posed by human exposure due to the generic Escherichia coli (MPN/100 ml or cfu 100 g) (n=20) and Escherichia coli O157 (n=20) contaminated water drinking consumption from various sources in Abepura Regency, Papua Province. Samples from Bakso sellers and restaurants source were analyzed for those two kinds Escherichia coli contamination. Risk analysis is a necessary component to assist in selecting priority hazards and identifying hazardous scenarios. Research revealed levels of generic E. coli in water (from Bakso Seller ranged from 1.5 to 35 ± 6 cfu/100 mL, whereas in the restaurant were ranged from 0 to 12 ± 2 cfu/ml. The WHO permissible limit is 0 cfu/100 mL per water sample in ideal conditions. The highest generic E coli count recorded was 35 log cfu/ml and 12 cfu/ml in Bakso and restaurant, respectively. E coli O157:H7 were found in the same point stations (from Bakso seller mean: 1.0 cfu/g and restaurant 0.0 cfu/g). Samples that exceeded disease risks set by the WHO were collected before the implementation of strict regulation from local health centre that regularly test the restaurant food and street sellers then set fine and punishment to those sellers who break the regulation. Disease risk from consumption of Bakso and food from restaurant in Abepura was found to be within acceptable levels. No relationship was found between E. coli concentrations in Bakso' water and water used in restaurants. Conclusion; Quantitative results revealed the presence of pathogenic organisms and water quality risk due to the unsanitary water sources and environmental sanitation. Continued water quality monitoring, the application of household based disinfectants, and healthy domestic hygiene practices are highly recommended.*

***Keywords:*** *Drinking water, generic E coli, Escherichia coli O157, Microbial risks.*

# 1. INTRODUCTION

The occurrence of food-borne illnesses are major international health problems and a neccesary case due to the reduction of economic growth. This evidence not only significantly influence people's health and wellbeing, but also it consequences posed by families, communities, the food industry and the economy of a nation in global [1, 2].

High cases of contaminated drinking water that is used in daily food consumption is a major source of pathogenic organisms; the microbial pollution of a water supply presents a threat to human healthy [3, 4]. Pathogens are might be transmitted to water from the feces of warm blooded animals and some reptiles. The bacterium Escherichia Coli (E. coli) is a key fecal indicator organism for the presence of other pathogenic organisms in drinking water [5, 6]. Generic Escherichia coli and E. Coli O157 are two kind of E. Coli that uncommon but serious cause of gastroenteritis and number of infected people develop the haemolytic uraemic syndrome (HUS), which may cause of acute renal failure in children in the Americas and Europe [7]. Microbiological organisms including bacteria, protozoa, and viruses are among the oldest health threats to drinking water quality and the agents currently responsible for most waterborne diseases. Unfortunately, specific disease-producing organisms present in water are not easily identified. Many infections of E coli O157 could be prevented by the more effective application of evidence-based methods, which is especially important because once an infection has been established, no therapeutic interventions are available

to lessen the risk of the development of the haemolytic uraemic syndrome [8].

Some study have done to investigate the distribution of generic E coli and E coli O157 : H7 and varied routes of transmission from its natural sources and hosts to drinking water that used for food that locally people consumed [7]. For this reason, an "indicator organism," one that indicates that pathogenic organisms may be present, is used. A group of closely related bacteria, the total coliform group, has been selected as an indicator of harmful organisms in drinking water. The transmission of waterborne diseases is still a matter of major concern, despite world-wide efforts and modern technologies utilised for the production of safe water. Contamination can have an enormous impact in several areas, often resulting in damaged products, product recalls, illness and even death. Rapid and reliable routine monitoring of the microbiological quality of water therefore will remain of fundamental importance in the control of waterborne diseases, and ideally the occurrence and levels of all human pathogens should be monitored [9]. Presently, indicator organisms have been described only for bacteria, and in the case of other pathogens such as viruses and protozoan parasites, reliable indicators are not available, expensive and time-consuming procedures are required for the direct detection of these pathogens [10]. E. coli O157:H7 is an emerging food and waterborne pathogen. The development of acceptable guidelines for exposure to this organism based on quantitative microbial risk assessment requires a dose response curve.

Study in Scotland described the survival characteristics of Escherichia coli O157:H7 in private drinking water

wells were investigated to assess the potential for human exposure. A non-toxigenic, chromosomally *lux*-marked strain of *E. coli* O157:H7 was inoculated into well water from four different sites in the North East of Scotland. Result explained that wells with higher water quality as assessed using the European Union Drinking Water Directive standards will also allow survival of *E. coli* O157:H7 for much longer periods.[11] The presence of pathogens such as E. coli O157 may suggest possible health consequences indicator parameters and pathogens do not predict the effect of microbial contamination of drinking water on a population.[12]

## 2. MATERIAL AND METHOD

### 2.1 Escherichia coli Analysis

The generic E coli and E coli O157:H7 in drinking water from Bakso sellers and restaurants were investigated to assess the potential for human exposure in Abepura city, Papua Province. Total bacterial and coliform counts were determined, and the presence of Escherichia coli as an important water quality indicator was tested. Microbial organisms were measured as colony forming units (CFU) using a plate counting method.[13] The level of conformity of the water processors with the guidelines of Indonesian quality regulatory agency was also determined. Five risk pathways for drinking water were identified through a survey of 20 Bakso sellers and restaurants along the city of Abepura as well as the sources of the water used namely household storage, communal taps, communal wells and water sachets. Samples from each source were analyzed for generic Escherichia coli and E coli O157 contamination. The results of distribution of both generic and E. coli O157 were used for the QMRA and disease burden.

### 2.2 Quantitative Microbial Risk Assessment

QMRA is applied here for the quantification of water consumption health risk, because it directly calculates infection probabilities based on pathogens concentrations found in water both used in Bakso and in Restaurants. A comparison between water used in Bakso sellers and water used in restaurants is used as a comparison method for the results of the QMRA. A QMRA procedure consists of four successive steps (Haas *et al.*, 1999): a. Hazard identification, b. Exposure assessment, c. Dose-response relations, and d. Risk characterization.

### 2.3 Dose Response

Dose-response assessment, or hazard characterization, elaborates the relationship between the level of microbial exposure in this case generic e. coli and E. coli O157:H7 and the likelihood of infection, making it possible to estimate the risk of human infection following exposure to pathogens via either foodborne or environmental pathways. Because of ethical considerations, these data are usually unavailable for highly infectious pathogens, such as E. coli O157:H7. [14]

Infection risk has been calculated for a number of pathogens, based on the measurement of pathogen concentrations in water and dose-response relations

from literature. The uncertainty in the calculation results due to uncertainties in pathogen measurements and literature values is quantified using beta-poisson simulation. Where the for generic E coli (pathogenic strain) by Haas [15], (value for $\alpha = 0.1778$ and $\beta = 1.78 \times 10^{-6}$, whereas for E. Coli O157 H7, value for $\alpha = 0.050$ and $\beta = 1.001$ [16]. In this model the probability of surviving and reaching the host site ("r" in the exponential model) is beta distributed, and thus the model contains the two parameters $\alpha$ and $\beta$ of the beta distribution. The most used approximation The for the Beta-Poisson model is formulated as follow:

$$P_{inf} = 1 - (1 + \frac{D^{-\alpha}}{\beta}) \quad \ldots\ldots\ldots(1)$$

where P was the probability that an exposed individual will become infected, D represented the dose, and $\alpha$ and $\beta$ were parameters that describe the distribution of host susceptibility. It was assumed that each organism acted independently; one cell was capable of causing a finite probability of disease. The outcome of the dose response was the probability of disease resulting from various ingested doses.

## 3. RESULTS AND DISCUSSION

Results from this study revealed that of 20 point samples, they have varied levels of generic E coli and E. Coly O157: H7 contamination that recorded from both water used in Bakso and water used in restaurants. Total plate counts in the Bakso water samples ranged from 1.5 to $35 \pm 6$ cfu/100 mL, whereas in the restaurant were ranged from 0 to $12 \pm 2$ cfu/ml. The WHO permissible limit is 0 cfu/100 mL per water sample in ideal conditions. The highest generic E coli count recorded was 35 log cfu/ml and 12 cfu/ml in Bakso and restaurant, respectively. E coli O157:H7 were found in the same point stations (from Bakso seller mean: 1.0 cfu/g and restaurant 0.0 cfu/g). It was found that the presence of *E. coli* was not associated with the presence of human enteric viruses in drinking water sources either from well water, water tap and lake water. The existence of E. Coli in Bakso might be due to the contaminated water that is used in processes of the food and potentially also led by the less sanitary water source handling as well as the less sanitary of the water containers. The probably infection due to the E. Coli in Bakso were range from 0.052 to 0.029 and probably infection due to the food consumption in restaurant were ranged from 0.0085 to 0.036, respectively.

Some relevant studies comparable to this research such as; study from northern Pakistan implied that total plate counts recorded in the drinking water samples ranged from 18 to $96 \pm 7$ cfu/100 mL. Sample numbers 04 and 05 had higher plate counts of E. coli with $84 \pm 3$ cfu and $96 \pm 4$ cfu, respectively. Similarly, in samples from SN02 and 03 large counts of E. coli were recorded: $18 \pm 2.02$ and $62 \pm 2.43$, respectively [17]. Another research in aquaculture farming in Armenia revealed the total coliform bacteria were recorded in 86% of analyzed water samples. In 60% of analyzed samples taken from wells of "SIS" farm number of total coliform bacteria exceeded

300 cfu/100 ml [18]. Then, in the Netherlands, a health based target for microbially safe drinking water is set at less than one infection per 10,000 persons/year. For the assessment of the microbial safety of drinking water, Dutch drinking water suppliers must conduct a Quantitative Microbial Risk Assessment (QMRA) at least every three years for the so-called index pathogens enterovirus, Giardia, Campylobacter and Cryptosporidium [19].

In addition, study in Melbourne, Australia detected revealed that Levels of indicator E. coli were highly variable and the presence of E. coli was not associated with the presence of human enteric viruses in greywater. It was also noted that little correlation between reported gastrointestinal illness in households and pathogenic detection in greywater [20]. Hence, study in Accra Ghana found that the major part of the burden of disease originated from E. coli O157:H7 (78%) and the least important contributor was Cryptosporidium (0.01%). Other pathogens contributed 16% (Campylobacter), 5% (Rotavirus) and 0.3%.[21]

Likewise, results from study of sachet-packaged drinking water in Western Nigeria implied varying levels of microbial contamination were recorded in samples from the different sampling locations. The total bacteria count ranged between 2.86 and 3.45 log colony-forming units (cfu)/ml. The highest coliform count recorded was 1.62 log cfu/ml. Faecal coliform E. coli was detected in one sample from Oke-Iho and one sample from Okaka, representing 2.2% of total samples. [22]

There are clear limitations to this risk assessment. For E.coli O157:H7, the estimates are based on presumed proportions of generic E.coli that are pathogenic. This may significantly over-estimate the risk. If the proportion of E.coli considered likely to be O157:H7 was reduced by an order of magnitude, so would the final risk estimates. However, using 8% is still considered reasonable as although this may not represent directly E.coli O157:H7, it would provide a reasonable estimate of the overall health burden obtained from bacterial pathogens.

WHO have suggested that a reason able reference level of risk from pathogens in water is $10^{-6}$ risk of infection. For E.coli O157:H7, there appears to be relatively little risk from water leaving the treatment works

## 4. CONCLUSION

Quantified microbial risk assessment appears to be feasible for developing countries, although these still rely on indicator organism data and several assumptions must be made. The final estimates for the varied water sources used in food for Bakso and food in Restaurant in Abepura are subject to significant uncertainty these still appear realistic and would aid investment planning and decision-making for promoting safer water supply. Further data are required to refine these estimates or at least to try and assess the degree to which this current risk assessment deviates from estimates based on pathogen data. Hence, the quantitative microbial risk assessment developed here can help to gain a quantitative insight into the risk of *E.coli* O157:H7 infection resulted water used in food that daily consumed by people in Abepura City or anywhere else. Further

analysis of various scenario are required to have more specific performance of assessment and the potential infections due the microbial contamination.

## ACKNOWLEDGMENTS

## REFERENCE

1. WHO., *Resolution WHA53.15 on food safety adopted by the fifty-third World Health assembly. Geneva.* 2000.

2. Almanza, B.A. and M.S. Nesmith, *Food safety certification regulations in the United States. J Environ Health 2004;66:10e4.* 2004.

3. Duke, W.F., et al., *The use and performance of Biosand filters in the Artibonite Valley of Haiti: A field study of 107 households. Rural and Remote Health 2006; 6(3): 570. (Online) 2006. Available: www.rrh.org.au (Accessed 16 August 2013). .* 2006.

4. Ashbolt, N.J., *Microbial contamination of drinking water and diseases outcomes in developing region. Toxicology; 198(1-3): 229-238.* 2004.

5. Edberg, S.C., et al., *Escherichia coli : the best biological drinking water indicator for public health protection. Journal of Applied Microbiological Symtoms 2000b;88:106-116.* 2006.

6. Whelan, J.J. and K. Willis, *Problems with provision: barriers to drinking water quality and public health in rural Tasmania. Rural and Remote Health; 7:627. (Online) 2007. Available: www. rrh.org.au (Accessed 17 August 2013).* 2006.

7. Pennington, H., *Escherichia coli O157.* The Lancet. **376**(9750): p. 1428-1435.

8. Rosenberg, F.A., *The microbiology of bottled water.* Clinical Microbiology Newsletter, 2003. **25**(6): p. 41-44.

9. Clesceri, L.S., A. Greenberg, and A. Eaton, *Standard Methods for the Examination of water and Wastewater, 20th ed. American Public Health Association, Washington.* 1998.

10. Mellado, V., M.A. Ya´n˜ez, and V. Catala´n, *Evaluation of the MicroFoss system for the analysis of Escherichia coli in water Labaqua, Pol. Ind. Las Atalayas, C/Del Dracma 16-18, 03114 Alicante, Spain.* 2005.

11. Sbodio, A., et al., *Modified Moore swab optimization and validation in capturing E. coli O157:H7 and Salmonella enterica in large volume field samples of irrigation water.* Food Research International, 2013. **51**(2): p. 654-662.

12. Schets, F.M., et al., *Escherichia coli O157:H7 in drinking water from private water supplies in the Netherlands.* Water Research, 2005. **39**(18): p. 4485-4493.

13. Association., A.P.H., *Standard methods for the examination of water and wastewater , 18th edn. Washington, DC: American Water Works Association and Pollution Control Federation.* 1992.

14. Buchanan, R.L., J.L. Smith, and W. Long, *Microbial risk assessment: Dose-response relations and risk characterization. International Journal of Food Microbiology, 58(3), 159-172.* 2000.

15. Haas, C.N., Rose, J.B., Gerba, C.P., *Quantitative microbial risk assessment. Wiley, New York.* 1999.

16. Teunis, P.F.M., et al., *The Dose-Response Relation in Human Volunteers for Gastro-intestinal Pathogens. RIVM Report, 284550002. National Institute of Health and the Environment, Bilthoven, The Netherlands.* 1996.

17. Baig, S.A., X. Xu, and R. Khan, *Microbial water quality risks to public health: potable water assessment for a flood-affected town in northern Pakistan Rural and Remote Health 12: 2196.* 2012.

18. Grigoryan, K., et al., *Assessment of microbiological safety of ground water used in rainbow trout farms.* LWT - Food Science and Technology, (0).

19. Schijven, J.F., et al., *QMRAspot: A tool for Quantitative Microbial Risk Assessment from surface water to potable water.* Water Research, 2011. **45**(17): p. 5564-5576.

20. O'Toole, J., et al., *Microbial quality assessment of household greywater.* Water Research, 2012. **46**(13): p. 4301-4313.

21. Machdar, E., et al., *Application of Quantitative Microbial Risk Assessment to analyze the public health risk from poor drinking water quality in a low income area in Accra, Ghana.* Science of The Total Environment, 2013. **449**(0): p. 134-142.

22. Olaoye, O.A. and A.A. Onilude, *Assessment of microbiological quality of sachet-packaged drinking water in Western Nigeria and its public health significance.* Public Health, 2009. **123**(11): p. 729-734.