Fluctuations of indicator and index microbes as indication of pollution over three years in the Plankenburg and Eerste Rivers, Western Cape, South Africa

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ABSTRACT

The Plankenburg and Eerste Rivers (Western Cape) have been reported to be contaminated with faecal coliforms. Water is drawn from both rivers for irrigation of fresh produce. The potential risk in the use of these rivers as irrigation sources was assessed by determining the fluctuations of 'indicator' and 'index' microbes over 3 years. Selected physico-chemical (water temperature, pH, COD, conductivity and alkalinity) and microbiological parameters, including coliforms, faecal coliforms, *Escherichia coli* and enterococci, as 'indicators' of faecal pollution, and *Salmonella*, *Listeria* and *Staphylococcus*, as 'index' of the presence of potential pathogens, were monitored.

No correlation was found between water temperature and COD ($r^2 = 0.0003$), whereas for temperature and pH a significant trend ($p = 0.0004$), but low correlation ($r^2 = 0.108$), was observed. With the exception of the faecal coliforms (*E. coli*), no significant trends and no correlations between temperature and the dependent variables were found. For the faecal coliforms there was a significant trend ($p = 0.0289$) with temperature but not a good correlation ($r^2 = 0.0434$), but the impact of temperature over time was significant ($p = 0.0047$). This is important, when the World Health Organisation (WHO) and South African Department of Water Affairs (DWA) guidelines for faecal coliforms are applied, as it indicates that temperature does impact the faecal coliform numbers. The presence of indicator organisms did not only indicate unsanitary conditions, but also the presence of potential pathogens such as *Staphylococcus*, *Klebsiella*, *Listeria* and *Salmonella*. Based on these results the microbial quality of these rivers was found to be unacceptable and does not meet the WHO and DWA guidelines for safe irrigation. There was also a high risk of exposure to human pathogens when water from these rivers is used to irrigate produce that is consumed without further processing.

Keywords: Irrigation water, faecal pollution, indicator and index organisms, Plankenburg and Eerste Rivers

INTRODUCTION

Many South African rivers have been found to be unsuitable for irrigation of fresh produce, mainly because of the high levels of faecal contamination. In all the reports published to date (Barnes and Taylor, 2004; Germs et al., 2004; Griesel and Jagals, 2002; Olaniran et al., 2009; Paulse et al., 2009), it was found that faecal indicator organisms exceeded the South African Department of Water Affairs (DWA) and World Health Organisation (WHO) guideline limits of 1 000 *E. coli* per 100 mℓ water for irrigation of fresh produce (DWAF, 1996; WHO, 1989).

The Plankenburg River has specifically been reported (Barnes and Taylor, 2004) to be highly contaminated with faecal coliforms, with counts of up to 12 x 10^6 *E. coli* per 100 mℓ. From June 2004 to June 2005, faecal coliform counts as high as 3.6 x 10^6 *E. coli* per 100 mℓ were reported by Paulse et al. (2009) for the Plankenburg River. The Plankenburg and Eerste Rivers pass through the town of Stellenbosch and are both used upstream and downstream of the town for irrigation of fruit and vegetables during the summer months. This is mainly because the water from the river is readily available and easily accessible.

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Received 20 July 2012; accepted in revised form 3 July 2013.

Fresh produce is recommended as part of a healthy diet to help prevent illnesses such as cardiovascular diseases. However, there is increasing evidence that consumption of fresh produce can be a major contributing factor to human gastrointestinal illness due to the potential for contamination with pathogenic microbes. Several studies have linked fresh produce foodborne outbreaks to polluted irrigation water as the major source of contamination (Pachepsky et al., 2011). According to Warriner and co-workers (Warriner et al., 2009) the presence and types of waterborne pathogens carried over to fresh produce vary greatly and can include a wide range of bacteria, protozoa and viruses. This sort of carryover has been reported to be high, especially in developing countries (Pachepsky et al., 2011). The scarcity of the water resources in South Africa, and the increasing evidence of pollution of the rivers, leaves little doubt that more attention needs to be paid to the types, fate and carryover potential of pathogens in waters that are utilised for irrigation of produce that will be consumed without any further processing steps.

On a national level, little is known about the level of pollution, and specifically faecal contamination, of South African rivers that are tapped for irrigation purposes. To get a clearer understanding of the problem, a national study was initiated in 2007 by the South African Water Research Commission (WRC, 2008) to determine the extent of the microbial contamination of South African rivers that are used for irrigation.

If DWA and WHO guidelines are applied to the data from previous short-term studies it must be concluded that the water

http://dx.doi.org/10.4314/wsa.v39i4.3
Available on website http://www.wrc.org.za
ISSN 0378-4738 (Print) = Water SA Vol. 39 No. 4 July 2013
ISSN 1816-7950 (On-line) = Water SA Vol. 39 No. 4 July 2013