

THERE'S SOMETHING IN THE WATER

– Research highlights dangers of pollution to irrigation



Chris Kirshoff/MediaHubSouthAfrica.com

The effects of South Africa's burgeoning population growth, relentless urbanisation and continuous growth of informal settlements, are leaving its mark on two of our most basic needs: water and food. Coupled with concurrent pressure on facilities such as housing and sewage works, a sobering picture has emerged of what increased developmental pressures has put into our water, and is getting on to what we eat as a result. Petro Kotzé investigates.

A recently completed Water Research Commission (WRC)-funded study found conclusively that the quality of the water in some of our rivers used for irrigation are of an unacceptably standard and do not meet World Health Organisation (international) and Department of Water Affairs (national) guidelines for safe irrigation. The study confirmed that pathogenic (bacterial and viral) infestation in certain locations, in

particular downstream of informal settlements, is transferred on to the surfaces of irrigated fresh produce on-farm. Some have described this as the potential development of a “bio-chemical time-bomb” in our rivers.

The study has attracted widespread reaction and calls for serious pause to reflect on the situation. “The findings of the WRC on water quality and food safety that were recently released are of great

concern,” said Agri SA president Johannes Möller in a release after the results were made public. “The report confirms the organisation’s suspicions that river water used for irrigation purposes does not in all instances meet the standards set by the WHO for food safety. Bacterial and viral pollution derived from untreated sewage, in particular, poses a health risk for consumers of vegetables and deciduous fruit irrigated with polluted water.”

The national study was led by food scientist Prof Trevor Britz and colleagues from Stellenbosch University, the University of Pretoria, the University of KwaZulu-Natal and the University of Venda. Co-funded by the Department of Agriculture, Forestry and Fisheries and the WRC, the five-year project was launched in 2007 amidst growing concern that South African river water no longer meets exports standards for fresh produce set by the European Union, nor the health standards of local authorities or the WHO.

The main objective of the research was to investigate which bacterial and viral contaminants are found in polluted irrigation water sources. Further, the goal was to highlight their potential risks and carry-over potential to crops cultivated using such water sources. It was argued that this should give an indication whether faecally contaminated water used for irrigation of fresh produce can potentially lead to disease outbreaks.

The national study included rivers such as the Eerste, Plankenbrug, Mosselbank and the Berg Rivers in the Western Cape, the Baynespruit River in KwaZulu-Natal, the Mutshedzi River in Limpopo, the irrigation canal from Loskop Dam and the Olifants and Wilge Rivers in Mpumalanga, Skeerpoort, Moses and Klip Rivers in North West. These rivers are regularly used to irrigate agricultural produce.

“The results of the national study clearly show how unacceptable the standard of many of our rivers are,”

says Prof Britz. “There is a high risk of exposure to human pathogens when water from the studied rivers is used to irrigate produce that is consumed raw or without any further processing steps.”

WHAT DID RESEARCHERS FIND IN THE WATER?

While the quality of the water was not really surprising, the types of organisms that researchers found in it were, says Prof Britz. While they were expecting high concentrations of faecal microorganisms, the occurrence of enteric viruses was unexpected.

Microbial results showed high concentrations of faecal microorganisms with concentrations reaching

10 000 000 cells, which indicate unsanitary conditions. This is ten thousand times higher than the allowed, safe levels set by the WHO and DWA. In particular, the *E. coli* concentrations in most cases exceeded the maximum acceptable guidelines of the WHO and DWA.

Other potential pathogens including *Staphylococcus* (which can lead to food poisoning), *Klebsiella* (respiratory infections), *Listeria* (listeria infections) and *Salmonella* (food poisoning, diarrhoea or kidney failure), intestinal *Enterococcus*, faecal coliforms, commensal and diarrhoeagenic *E. coli*, diarrhoea causing viruses (NoV GI and GII, and HAV), *Cryptosporidium* oocysts (vomiting, diarrhea, abdominal cramps) and *Giardia* cysts were also measured

“There is a high risk of exposure to human pathogens when water from the studied rivers is used to irrigate produce that is consumed raw or without any further processing steps.”



Stellenbosch University

Top left: Tshepo Kikine, a post-graduate student and team member of the WRC project, sampling the Plankenbrug River at Stellenbosch.

Bottom left: Nicola Huisamen, a post-graduate student and team member of the WRC project, sampling the Mosselbank River to determine the pollution level.

Eating minimally processed produce, such as those bought at roadside stalls, can pose a risk to consumers.



Chris Kirchhoff/Mediaclubsouthafrica.com

in many of the rivers. One or more such enteric virus was found in 18% of river water samples and 9% of irrigation canal samples.

From the results it is evident that many of the bacterial, protozoan and virus strains detected in the irrigation water are of clinical importance as they show relatedness to species associated with gastroenteritis in South Africa and other regions of the world. The detection of closely-related strains worldwide is of public health concern as they may be disseminated through a common vehicle such as the international food market.

In the research it was further shown that direct water to produce linkages could be made. It was concluded that species from the surface of produce were present as a result of transfer from the contaminated irrigation water. There can now be

no doubt that specific carry-over does take place. The potential of pathogenic organisms being transferred from irrigation water to the surface of fresh produce plus their ability to survive in these unfavourable conditions presents the scenario where consumers unknowingly face a high risk of being infected with harmful organisms when consuming fresh produce.

The study also showed that pathogens like *Listeria monocytogenes* if present in irrigation water will rapidly attach within 30 minutes to fresh produce, and will remain viable for several days. This attachment and survival varies from one vegetable to another. The study also confirmed that chlorine washing is effective in removing up to 3 logs of surface *L. monocytogenes* on spinach and tomatoes but shows very

little effectiveness against sub-surface *L. monocytogenes*.

Yet, it is important to note that the study also confirmed that there are adequate post-harvest cleaning procedures in place to ensure that these harmful species does not make it to the shop shelf. In other words, if you buy your produce from a reputable retail outlet, you stand little chance of coming in harm's way.

Dr Gerhard Backeberg (WRC Executive Manager: Water Utilisation in Agriculture) also points out that the study did not prove that produce that is exported and sold is a health risk. More results also showed that contamination could also take place after the food has left the farm, during the harvesting, processing and packaging steps.

Yet, while this might put some veggie-lovers at peace, there is still a very real danger of infection for some.

SO, WHO IS AT RISK?

Those at the highest risk of being affected by waterborne diseases are communities that drink water directly from the river without any treatment, and those that use the water for recreation, washing and irrigation methods. In the latter case, eating minimally processed produce, like those bought at road-stalls or other informal retail outlets poses the highest risk. Any potential waterborne diseases are also likely to have the most detrimental effect on those whose immune systems are already weak, says Prof Britz, such as people suffering from HIV/AIDS.

Among those that face the biggest risk are those that live in the very informal settlements that have been fingered as one of the biggest sources of the contamination.

According to the study, one of the major sources of faecal pollution of natural water courses are the many un-serviced informal settlements that have been established near rivers in the last two decades as the process



Stellenbosch University

A fresh produce sampling site where water from the Berg River is used for irrigation.

of urbanisation of poverty stricken rural people gather momentum.

The study continues to say that the other major contributor to the dangerously high levels of pollution in many of the rivers in South Africa is the failing sewage disposal systems of a large number of villages, towns and cities. These systems in total leak huge amounts of raw sewage into the rivers, either from inadequate sanitation in low-income housing areas or from poor maintenance of sewage reticulation systems and inadequate wastewater treatment works.

However, while the situation may seem dire, it is not without solutions.

THE NEXT STEP

While prevention of river and irrigation water pollution is the ultimate solution, cost-effective treatment techniques for irrigation water are needed in the interim.

Conventional treatment methods (such as stabilisation ponds, storage reservoirs and slow-sand filtration, among others) have been shown to be effective, but the inclusion and/or use of increasingly cost-effective technologies might exhibit potential.

Treatment options will have to take into consideration the volumes of water to be treated, the range of microbial loads and the efficacy of the treatment technique of different microbes found in the irrigation water, as well as the practicalities, maintenance and operating costs and capital expenses.

A number of follow-up research studies have been launched following the publication of the study results, looking at on-farm, strategies that can be implemented to ensure the safety of fresh produce. The WRC is currently funding two related studies.

According to Dr Backeberg, the first study is investigating different methods that farmers can use to treat their irrigation water on-farm. Different options, including physical treatment through the use of sand filters, chemical treatment and ultraviolet treatment, are being

investigated. He says ultraviolet and the combination with filtration systems seems particularly promising.

In turn, the second study is investigating the chain of potential pathogen transmission one step further – from irrigation to fresh produce processing to retail.

Prof Britz is also involved in another study with the National Research Foundation (NRF) to look at the alteration of the harmful species themselves, and in the process looking for potential solutions from another angle.

Yet overall, “prevention is better than cure,” says Prof Britz, who maintains that one of the major solutions is to stop the pollution at source and, he adds, it is everybody’s responsibility. Not only must the municipalities help to fix failing sewerage systems, but people must be educated on both how to prevent the situation, and prevent disease through contamination.

Dr Backeberg reiterates this, saying that the source of the pollution must be fixed at municipal and housing level. This effort must include a combination of governmental departments, such as health, water, agriculture and housing. “The study results have emphasised that everyone must work together,” he says.

Dr Backeberg adds that the producers must also be educated and made aware of the problem. “Know where your irrigation water is from,” he cautions. Furthermore, he recommends that the best is for commercial farmers to rather not use irrigation methods where the water comes in direct contact with the produce.

When commenting on the research result, Dhesigen Naidoo, CEO of the WRC writes that “We have a collective responsibility to defuse the ticking time-bomb, and the science is also saying that we have the technological solutions at our disposal. The key that starts this engine is the political will at local, provincial and national levels of government.”



Stellenbosch University



Chris Kirchoff/Mediaclubsouthafrica.com

Top: A kaleidoscope of different bacteria present in faecally polluted river water.

Above: The black colonies show the presence of Salmonella while the white colonies indicate the presence of Enterobacter on studied fresh produce samples.

Left: The WRC study confirmed that standard post-harvest cleaning procedures ensures that harmful species do not make it to the shop shelf.

- To access the report, *Quantitative investigation into the link between irrigation water quality and food safety (WRC Report No. 1773/1/12 (Volume 1), 1773/2/12 (Volume 2), 1773/3/12 (Volume 3) or 1773/4/12 (Volume 4))* contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.