IRRIGATION AND WATER QUALITY

Drug resistant pathogens – Are we ingesting more than nutrients with our vegetables?

Spinach – it helped Popeye sprout supersized muscles. And your ma might have made you swallow it down or certainly ordered you to eat your greens. Turns out, Sailor Man and mother were right. Fresh vegetables are a valuable source of nutrients and vitamins, writes Matthew Hattingh.

Increasingly, people in sub-Saharan Africa have become aware of the nutritional benefits of fresh fruit and veg. In South Africa, its affordability relative to meat and other foodstuffs only adds to the appeal.

Department of Agriculture, Land Reform and Rural Development figures show a growing harvest of almost all the most popular vegetable types. An eye-watering 709 000 tons of onions came to market in 2017/18 compared with 619 000 tons 2013/14. Cabbage was on a roll too – up from 146 000 to 160 000 tons over the same period. And South Africans got sweeter on sweet corn and green mealies, with production rising 28 000 tons to 390 000 tons, also over the five years.

But there's a worm in the public health apple.

Fresh vegetables, especially the leafy green kind, often get little in the way of washing or other processing or are eaten raw. This puts consumers at risk of illness or worse from the potential disease-causing bacteria – pathogens – these vegetables may carry. Over the past decade food-borne illnesses have attracted considerable publicity in Europe and the US, with thousands of people falling ill, scores hospitalised and a number of deaths.

Where do these pathogens come from? Irrigation water is increasingly polluted. This is in part the consequence of poorly-performing sewage systems in our cities and townships. But throughout the process of growing, harvesting, washing, cutting, preparing, packing and transporting produce, bacteria can latch on and multiply. And these bacteria are becoming increasingly resistant to treatment with antibiotic drugs.

It's a vexing matter and the subject of a report, ***Measurement of water pollution determining the sources and changes of microbial contamination and impact on food safety from farming to retail level for fresh vegetables***. The report (**WRC Report No. 2706/1/21**), published by the Water Research Commission earlier this year, was particularly interested in how the processing of vegetables affected food safety and took a detailed look at the occurrence of multidrug resistant human pathogenic bacteria.

Its authors, Erika du Plessis, Stacey Duvenage and Lise Korsten, of the University of Pretoria's Department of Plant and Soil Sciences, focused on fresh veg grown for the Cape Town and Tshwane metropoles. They noted the presence of pathogens on produce in formal markets, which were similar to previously reported pathogens that cause foodborne disease outbreaks internationally. But remarked that little was known about how the problem was affecting the informal sector, despite its economic importance.

Their research teams worked to fill the gap. They collected samples for testing from street-side sellers and used questionnaires to gauge the food safety knowledge and views of vendors and consumers.

Perhaps unsurprisingly, the researchers learnt that informal vendors often operated under rough-and-ready conditions. Storage was frequently found to be rudimentary, potable water in short supply and refrigeration non-existent. The surroundings might be less than salubrious too, as was the case of the vendor trading near a well-known shopping centre in Pretoria's Mamelodi township. "Behind the stall," noted the report, "there was a rubbish dump."

Another veg vendor, this time in Pretoria's Atteridgeville township, set up shop near a cooked-chicken joint that also happened to slaughter its birds on site. Yet another, in the Brazzaville quarter of the same township, was "located along a busy main road that is dusty and always wet with water that flows from busted pipes". Fresh veg was sometimes stored on or near the floor or in the case of spinach, dipped in bins or bowls of water to stave off wilting.

As for the vendors themselves, many do not have access to clean toilets and wash hand basins.

But amid the difficult conditions, it was heartening to note a general appreciation of the need for good hygiene – both among the vendors and their customers. The majority of those surveyed in Tshwane and Cape Town's informal settlements possessed a "good general attitude towards food safety".

Among consumers in the formal sectors this was even more the case. "Most people know about the importance of fresh produce safety and most show a good general attitude towards hygienic practices. They realised the importance of washing hands and clean environments to prevent cross contamination."

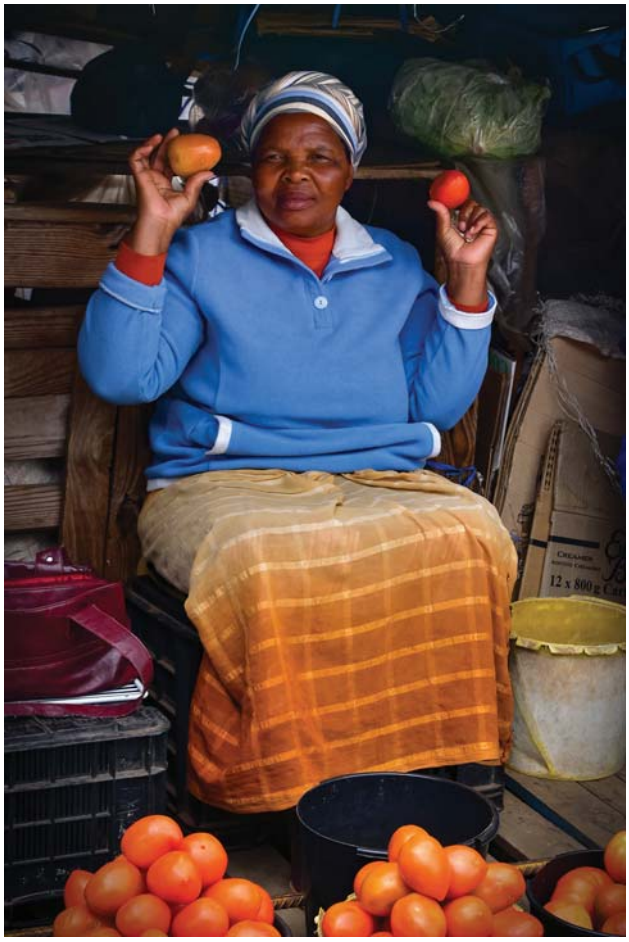
That said, less than half of those surveyed in the informal sector reported washing their hands with soap. "Another concern is that most people use the same cutting board for raw meat and fresh produce and a large proportion just use water to rinse in between the two different products."

The route fresh veg follows from field to plate varies. A big commercial farm might supply a supermarket group directly, for distribution to stores through the group's central procurement operation. Produce might pass through a packing or processing plant along the way. Or the groups (Shoprite being the biggest) might buy from one of the country's 19 local fresh produce markets, which in 2017/18 handled 47% of the country's veg (excluding potatoes).

Informal traders also buy from local fresh produce markets or often directly from small-scale farmers. Farmers' markets are increasingly popular too, particularly for the direct supply of organic produce to well-heeled consumers.

So, there was much ground to cover – and many points along the way where pathogens might enter. Initially the water and food safety research team from the University of Pretoria and Stellenbosch University collected fresh vegetables from 10 retail suppliers; 20 informal markets (half of which were street traders and the balance mobile vendors); and 13 stalls at farmers markets in Tshwane. The researchers bought a total of 545 samples from September 2017 through to May of the following year. Depending on what was available, these included spinach bunches or baby leaves (including in pillow-packs), rape, chinensis, cucumbers, tomatoes, lettuce (heads and mixed leaves in bags) and green beans.

The deteriorating quality of irrigation water is a concern for researchers studying microbiological pollution.



The research team found a general appreciation of the need for good hygiene – both among the vendors and their customers in the areas they surveyed.

Following the food chain, the team visited Gauteng and North West farms where they collected water samples at source, irrigation point and during processing or washing. Source water included borehole inlet points, holding dams or reservoirs, pivots or sprinklers and flooding irrigation points.

Soil samples were taken and the team collected veg samples from the field, before or after processing (such as cutting and washing) and after packaging.

Packhouse crates, tables and conveyor belt surfaces were swabbed for samples, as were samples at traders and retailers. Similar sampling in Cape Town took in a commercial fresh veg processing and packaging facility in Philippi and informal vendors and retailers. The Philippi packhouse processed a variety of veg in different ways, including broccoli, cabbage, and carrots for fresh-cut coleslaw bags. The teams took samples at different stages in the packhouse to determine potential contamination points.

Lettuce and one other fresh vegetable were sampled at five different informal vendors over five weeks. Then, it was to the lab for testing and analysis.

What did the researchers discover? With so many samples of different produce and from different places the results were a bit like some of those salads mentioned earlier – a mixed bag. But a number of broad observations were made.

First up – fresh veg bought from Tshwane retailers. ***Escherichia coli*** counts ranged from 0 up to 5 log CFU/g, with the higher counts mostly at informal vendors and fresh produce markets. In layman's language, that's a maximum of 10 to the power of 5 colony-forming units per gram of ***E. coli***, a bacterium commonly found in faecal matter and in certain strains also causes food poisoning.

Average coliform counts on fresh vegetables exceeded the previous Department of Health limit guidelines. Coliforms are a type of bacteria whose presence indicates other pathogenic organisms of faecal origin may be present. Significantly, the authors noted, "the hygiene indicator bacteria counts were mostly not significantly different between formal and informal markets".

The researchers also looked specifically at leafy green veg supplied to Tshwane retailers. They followed five different supply chains, from commercial farms, through processing to retail. ***E. coli*** levels at the different production stages ranged from zero upwards. Coliform counts exceeded the maximum limit of 2.3 log CFU/g.

Enterobacteriaceae counts on the leafy green vegetables were similar to the coliform counts and counts of up to 6 log CFU/g were obtained. ***Enterobacteriaceae*** are a large family of bacteria that include pathogens such as ***Klebsiella***, ***Enterobacter***, ***Citrobacter***, ***Salmonella***, ***Escherichia coli***, ***Shigella***, ***Proteus*** and ***Serratia***.

Informal vendors in Cape Town were "well above the advised coliform limits". No Salmonella or ***Listeria monocytogenes*** were detected in any of the fresh produce, while ***E. coli*** was "sporadically detected".

Broccoli coleslaw (broccoli stems, carrots and cabbage) and lettuce samples were collected at different processing points at the Philippi packhouse and from retailers. Analysis showed that processing, including washing in a chlorine solution of 150-200 parts per million and peeling, lowered the microbial counts on the vegetables significantly. However, microbial counts increased significantly in shredded samples and bagged mix coleslaw samples.

"That the ***E. coli*** was only detected at such a late stage in the product cycle could either be due to ***E.coli*** growth from previously undetectable levels or through post-processing contamination," said the report. It cautioned that the coleslaw mix sold at retailers was consumed raw and sometimes with no further washing.

What about irrigation water and pathogens? ***Listeria monocytogenes*** was detected in irrigation water on occasion while none was detected on any of the fresh produce samples. ***E. coli*** levels in river water used on commercial fresh produce farms seldom exceeded the maximum limit of less than 1000 ***E. coli***/ per 100 ml for safe irrigation water.

E. coli numbers were generally lower in water from holding dams and irrigation pivot points, with some exceptions blamed on bird droppings. Where river water contaminated with ***E. coli*** was used for overhead irrigation, ***E. coli*** was detected at low levels from the irrigation pivot point, wash water and from the spinach samples throughout the supply chain. However, to put things into perspective, the levels detected would be acceptable according to many international standards that allow 100 CFU/g of ***E. coli***/ for fresh produce. It should also be remembered that not all ***E. Coli*** are pathogenic.

An additional aim of the research was to gauge the extent to which pathogens found on vegetables and related samples were resistant to antibiotics. The report noted the increasing use of antimicrobials in healthcare and intensive livestock farming had raised levels of antibiotic resistance, "thus exerting selection pressures and inducing the transfer of antibiotic resistance genes to potential human pathogenic bacteria".

What did the analysis show? Briefly:
• Where ***E. coli*** was isolated on fresh veg samples and irrigation water, more than 40% of the isolates were multidrug resistant.
• Multidrug resistance was observed in 80-98% of ESBL/AmpC-enzyme producing ***Enterobacteriaceae*** isolated from water and irrigated fresh vegetables samples. These enzymes render a wide variety of antibiotics ineffective. There is also a risk of transfer of these harmful qualities to "friendly" commensal bacteria.

What should be done?
The authors want to see the guidelines for irrigation water expanded beyond the hygiene indicator microorganisms (coliforms, ***E. coli***) traditionally used. "Other members of, for example, the ***Enterobacteriaceae*** family such as ***Salmonella***… should also be considered."

Further investigation was needed to plan a response to antimicrobial resistance bacteria, they said. And they called for mapping of potential contributors to the problems, such as sewage plants and animal husbandry; and recommended a national database be established to bring together the results of antimicrobial resistance surveillance.

Risk assessments, training, education, and lobbying of policymakers and the government by scientists were needed. Better cooperation and communication among the different tiers of government and with academics would help too.

In short, plenty on everyone's plate. And not only greens.

Researchers did not find a significant difference in the hygiene indicator bacteria counts on vegetables sold in formal and informal markets.