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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Municipal water services

Harvesting rainwater for domestic purposes

A completed Water Research Commission (WRC) study investigated point-of-use disinfection systems designed for domestic rainwater harvesting (DRWH) tanks for improved water quality in rural communities.

Background

The quality of the essential commodity water is being compromised by contaminants originating from, for example, human-related sources, industrial activities and agriculture. Water scarcity due to severe drought in many regions of the world also represents a significant challenge to the availability of this resource.

Domestic rainwater harvesting (DRWH), which involves the collection and storage of water from rooftops and diverse surfaces, has been successfully implemented worldwide as a sustainable water supplement. Available literature on the chemical and microbial quality of DRWH, with a particular focus on the sources of microbial pollution and the major pathogens associated with the water source was reviewed in this WRC study.

Incidences of disease that have been linked to the consumption and utilisation of harvested rainwater are also discussed. in addition, various procedures and methods used for the disinfection and treatment of harvested rainwater, such as the implementation of filter systems, heat treatment and chlorination, among others, are also presented.

Domestic rRainwater harvesting systems in Kleinmond, Western Cape.

A survey of quality of water collected in DRWH

Rainwater samples were collected from DRWH tanks in a sustainable housing development in Kleinmond, Western Cape. The chemical and microbial parameters were compared to drinking water standards stipulated by national and international guidelines.

The rainwater quality was within all the chemical standards (cations, anions, metal ions, pH and temperature) analysed for potable water, with the concentration of organic matter (COD) ranging from between 4 mg/ℓ to 9.5 mg/ℓ. however, the total coliform, *E. coli*, enterococci, heterotrophic bacteria and faecal coliform counts exceeded the stipulated guidelines in numerous rainwater samples.

The microbial analysis results indicate that the harvested rainwater was not fit for potable use without treatment.

The efficiency of filtration systems

The aim of this part of the project was to evaluate the efficiency of four household point-of-use treatment systems, namely, activated carbon, PVA nanofibre column, slow sand filtration and an activated carbon/PVA nanofibre column, for the treated of the harvested rainwater.

Three polyethylene DRWH tanks (2 000 ℓ) were installed at the Welgevallen experimental farm at Stellenbosch University. The various treatment systems were then intermittently connected to the various DRWH tanks during the high rainfall period (June to October).

Parameters used to monitor the four filtration systems included, among others, metal ion, cation and anion analysis as well as heterotrophic bacteria, ***E. coli*** and total coliform enumeration.

Chemical analyses indicated that while numerous cation and anion concentrations were within drinking water guidelines in the unfiltered and filtered rainwater, the concentrations of isolated cations, such as aluminium, antimony, manganese and iron, increased after filtration through the respective filtration systems.

Results for slow sand filtration and activated carbon filters indicated that the biological layer that had developed on the filtration media had not matured. For this reason chemical and microbial parameters were not reduced to within drinking water guidelines.,

A polyvinyl (alcohol) (PVA) nanofibre membrane without activated carbon in a column filtration system was analysed and results indicated that this system was also not effective in reducing the microbial numbers to within drinking water guidelines.

Lastly, by utilising a PVA nanofibre membrane with activated carbon in a column filtration system, one litre of potable water was produced in which all bacterial counts were reduced to zero and that did meet drinking water guidelines. However, PCR assays indicated that *Klebsiella* spp, *Legionella* spp., *Pseudomonas* spp., and *Yersinia* spp., were not removed by the activated carbon/PVA nanofibre column.

Solar pasteurisation system

The first phase of the study was aimed at pasteurising rainwater samples in laboratory-scale experiements. Analysis of results showed that the thermal death time of the heterotrophic bacteria in harvested rainwater was 30 minutes at a treatment temperature of 72°C. In addition, the majority of the phycrophiles and thermophiles isolated from heat-treated rainwater samples belonged to the *Bacillaceae* family.

The aim of the second phase of the study was then to monitor the efficiency of a solar pasteurisation system in reducing the microbiological load in harvested rainwater and to determine the change in chemical contaminant concentrations after rainwater had undergone pasteurisation.

A solar pasteurisation system was connected to one of the rainwater harvesting tanks installed on the Welgevallen experimental farm and unpasteurised as well as pasteurised rainwater samples were collected for chemical and microbial analysis. The temperature ranges of the pasteurised rainwater samples were 55 to 57°C, 64 to 66°C, 72 to 74°C, 78 to 81°C and 90 to 91°C.

Indicator bacteria and total coliforms were reduced to zero at pasteurisation temperatures of 72°C and above. All cations were within the drinking water guidelines, with the exception of iron, aluminium, lead, and nickel, were detected in the pasteurised rainwater samples and were above the respective guidelines.

It is hypothesized that these elements could have leached from the stainless steel storage tanks of the pasteurisation system and it is therefore recommended that the storage tank of the pasteurisation system be manufactured from an alternative material, such as a high grade polymeric material, which is able to withstand the high temperatures yet will not negatively influence the quality of harvested rainwater.

Further reading:
To order the reports*, Quality of harvested rainwater and the application of point of use treatment systems* (**Report No. TT 603/14**) and *Domestic rainwater harvesting: Survey of perceptions of users in Kleinmond* (**Report No. TT 604/14**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.