Key Protein Molecules Associated with the Unique Water Purification Properties of Moringa Seeds Revealed

Researchers have used neutrons and X-rays to identify and characterise key proteins underlying the unique water purification properties of Moringa seeds. This information may allow better exploitation of this abundant resource which has been used for centuries to help purify water in regions where clean water is not available.

Moringa Olifiera Seeds

Seeds from the Moringa tree have unique water purification properties. The seed extract can separate unwanted particulates from water sedimenting impurities. They also have potential as anti-microbial treatment – the unprocessed seed powder may sediment over 90% of the bacteria from raw water [1].

Clean water is critical to good health, yet according to the World Health Organisation, [2] in 3 people globally still do not have access to safe drinking water1. In new collaborative studies* researchers have identified what happens at the molecular level during these processes, where contaminants clump together and are filtered out, or deposited at the bottom. This can help optimise the use of this valuable natural resource – which grows around the world, in Asia, Africa, South and Central America – to develop reliable and sustainable infrastructures for safe drinking water across the globe.

Life Sciences Group at Institut Laue-Langevin – Credit: Martine Moulin

Extracts from the seed could be promising alternatives to chemical water treatment, food preservatives, or antibacterial treatments – especially where the pathogen has become resistant to front-line antibiotics. The low cost and high availability of this seed material also represents an important opportunity in developing sustainable water purification and could help provide clean water to small communities in developing countries where Moringa grows.

As part of an international collaboration between universities in Europe and Africa, researchers at the facilities Institut Laue-Langevin (ILL – the world's flagship centre for neutron science) and the European Synchrotron Radiation Facility (ESRF) have shown how specific proteins from Moringa oleifera seed interact. The scientists have isolated one component of the crude extract for study. They used neutron and X-ray analytical techniques at the ILL and ESRF to establish the structure of the Moringa protein Mo-CBP3-4 and to understand the nature of the surface behaviour of various components related to this protein.

Moringa Olifiera tree Botswana Credit HM Kwaambwa

In previous studies at ILL [3,4] scientists have examined how the unprocessed seed extract can be used for purification – discovering the application of a naturally occurring system. However, this extract contains many different components. By focusing on a particular protein, the researchers have been able to identify specific mechanisms underlying the water purification properties of Moringa seeds – which will support the development of synthetic solutions for future applications, avoiding the need to add whole seed extract to water and minimise the presence of unnecessary organic matter that could encourage the growth of further micro-organisms.

"Neutrons and X-rays are valuable tools in these sorts of experiments, where a high level of detail is required. Neutron reflectometry is specifically designed for characterising surfaces and solutions," said Dr Martine Moulin, the lead author of the study.

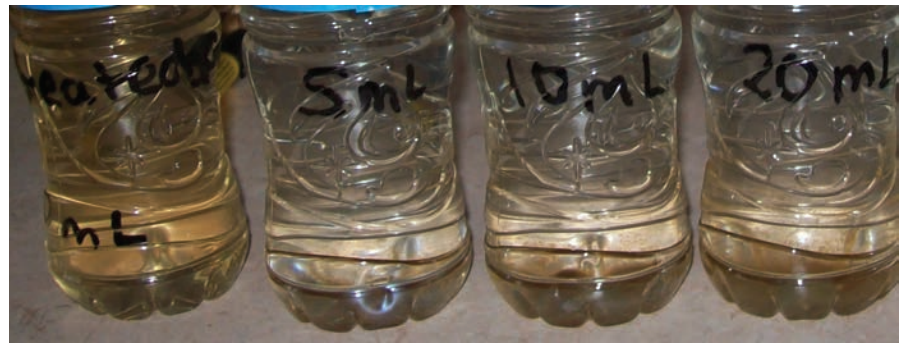
"Individual proteins play a key role in the water purification capabilities of the Moringa seed. By using neutrons at the Institut Laue-Langevin (ILL) to explore the influence of proteins such as Mo-CBP3-4 at a molecular level, we can identify what these proteins are and then look to recreate them biosynthetically. The latter can help us to develop more efficient water purification systems in future.

Grinding Moringa Seeds in Botswana Credit HM Kwaambwa

"Using neutrons to measure the structures at play at ILL, we were able to analyse the composition of the surface behaviour of the proteins – the most important agent in the water purification process. This neutron diffraction was used in combination with mass spectrometry and chromatography, as well as X-ray crystallography at our partner the European Synchrotron Radiation Facility (ESRF).

"Globally, the aim is to capitalise on this traditional water purification process to improve access to clean drinking water. We are looking to share our understanding of Moringa's potential at a government level in Africa and hope this work can be scaled-up and used for any future technologies that emerge."

Professor Adrian Rennie, the corresponding author, said: "We are hoping to continue identifying the roles played by other components in the seeds and recognise which varieties are best suited to various practical applications. In parallel, there are already efforts to disseminate the understanding from our work for practical use in countries across Africa where Moringa grows."



Testing Water purification properties of raw seed extract on water samples in Gabarone, Botswana. Credit HM Kwaambwa

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The neutron reflection instrument D17 at the ILL was used in this study. You can find out more about D17 here: https://www.ill.eu/users/instruments/instruments-list/d17/description/instrument-layout/

The structural biology beamlines at ESRF were also used as part of this study – further detail is available here: https://www.esrf.eu/UsersAndScience/Experiments/MX