

WORLD
in Stockholm,
September 1–6, 2013 **WATER**
WEEK

Presentation from the
2013 World Water Week in Stockholm

www.worldwaterweek.org



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Challenges in presenting new technology – how do we explain the necessary science to the actors?

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	Bonang Nkoane,	Gaborone, Botswana
	Fiona Selato	

Outline:	Moringa project – natural water purification
	Scientific results
	Spreading the knowledge

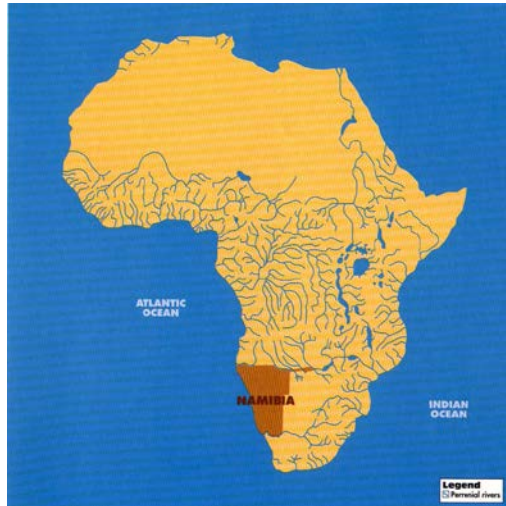
Funding: Swedish International Development Cooperation Agency (SIDA) through the Swedish Research Links Program (VR/SIDA)



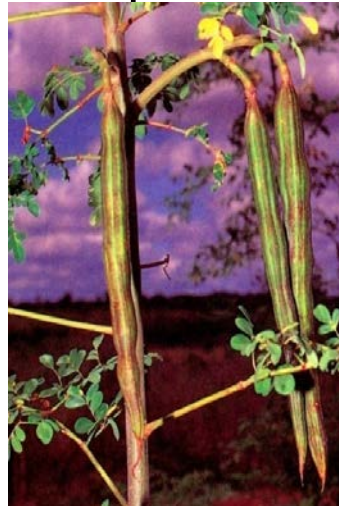
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Introduction

Perennial rivers in Africa



Moringa tree,
seed pods



Moringa tree	Use
Leaves	Nutrition, Medicine
Flowers	Medicine
Pods	Nutrition, Medicine
Bark	Medicine
Roots	Medicine
Gum	Medicine
Seeds	Water purification, Medicine, Cooking oil, Cosmetics, Lubricant

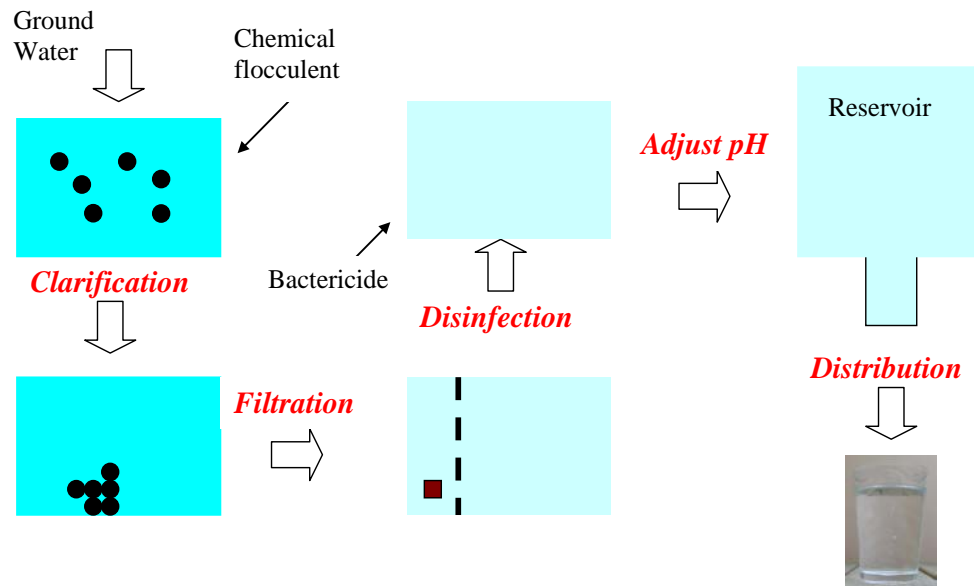
- Study of water purification using natural product from Moringa tree
- Used on village-scale in rural Africa
- Aim: optimise use of this natural product
- Outlook: scaling up from village scale to large scale water plant



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Water purification

Major Steps in Purification



Details vary according to initial
water source and requirements



Water purification plant,
Windhoek, Namibia



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Moringa seeds and water purification

Protein extracted from seeds of Moringa tree (Miracle tree)

7-13 kDa, Cationic at neutral pH

Sequence known

Hydrodynamic radius ~ 1.5 nm

- 92 to 99% reduction in turbidity
- Efficiency as good as Al^{3+} salts
- Binds minerals and bacteria

How does it work?



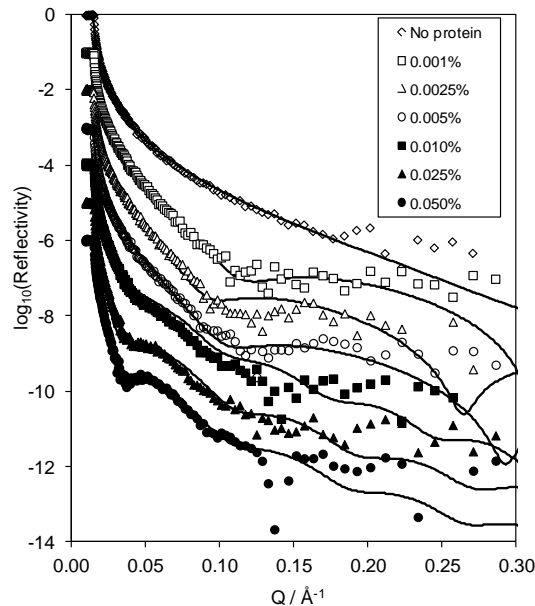
Gassenschmidt et al. *Biochimica et Biophysica Acta* **1243**, (1995) 47
H. M. Kwaambwa, A. R. Rennie (2012) *Biopolymers* **97**, 209-218.



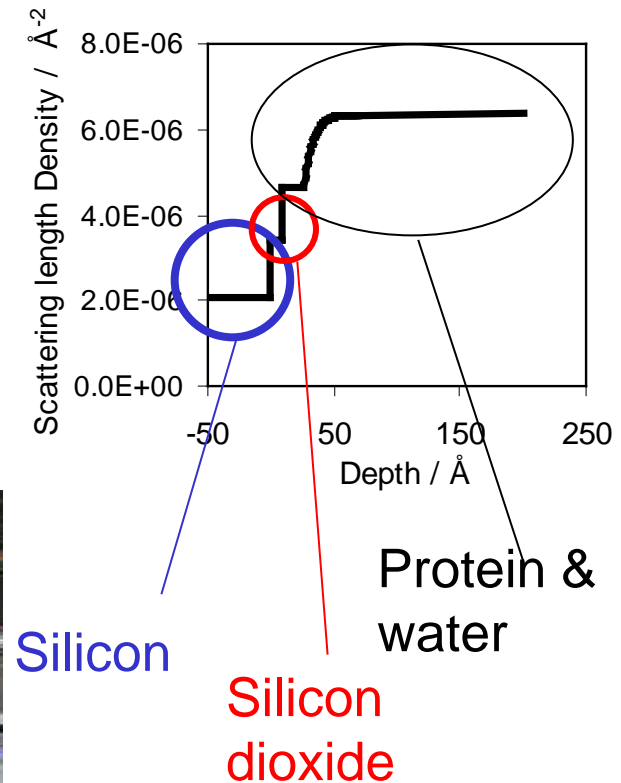
Results from Moringa study

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- Surface tension
- Light scattering
- Zeta potential
- Spectroscopy
- Neutron scattering



Adsorption to model mineral surface





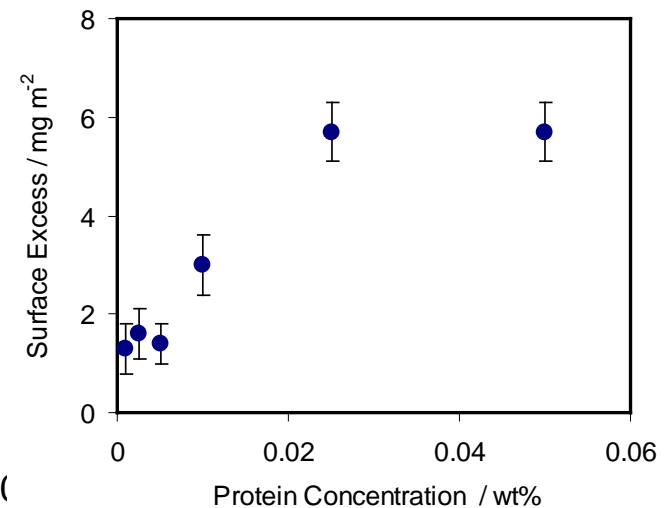
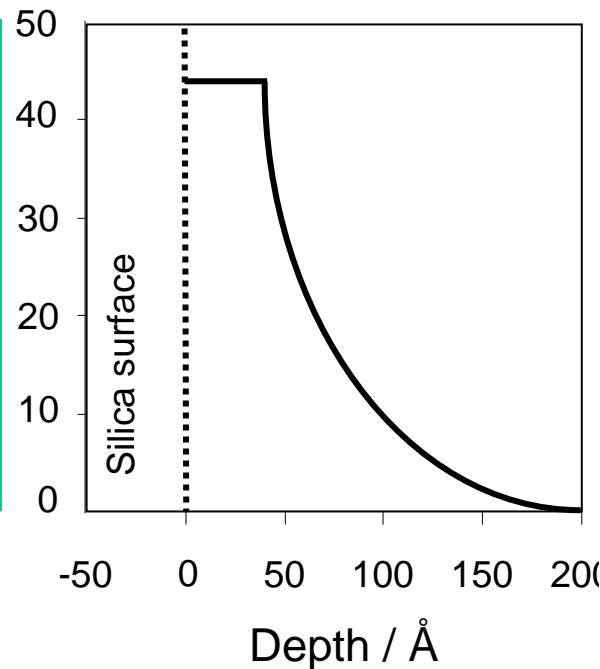
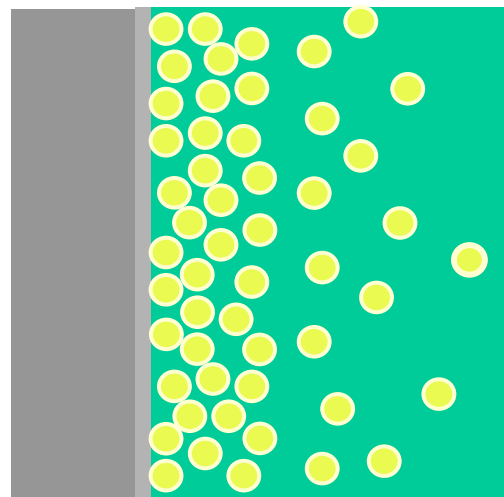
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Results from Moringa study

Neutron scattering, Adsorption to model mineral surface

0.05 % Protein solution

Protein %



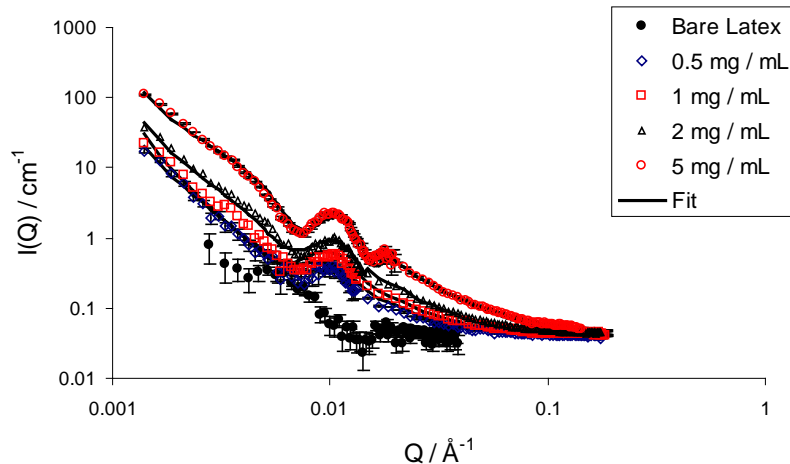
Plateau in adsorption to
model mineral surface



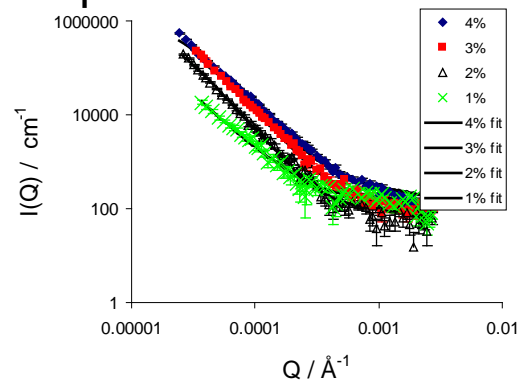
Results from Moringa study

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Protein adsorption to model dirt particles

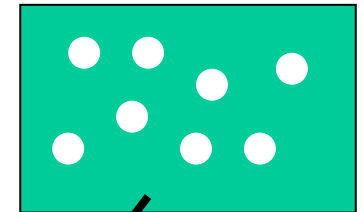
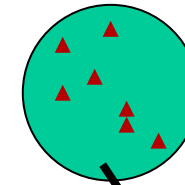


Properties of formed flocs

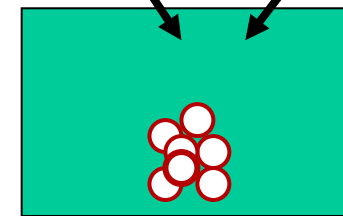


Moringa seed
protein

Model dirt
particles



mix



Dense
sediment

Protein required depends
on amount of impurities

Flocculent is removed
with impurities

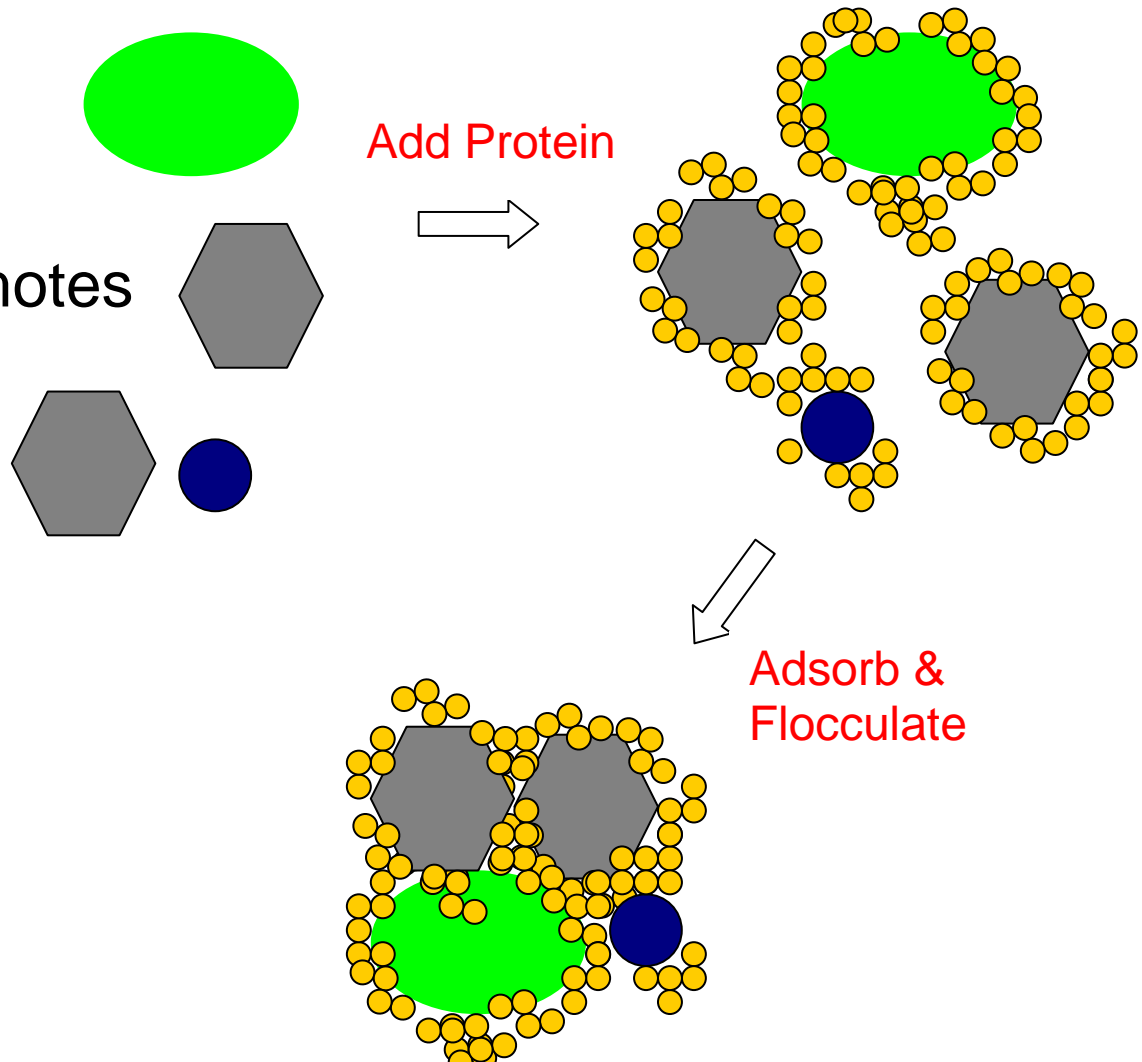
In contrast, precipitation
with ions leaves
dissolved salt in the
water



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How does Moringa protein work?

Adsorption to range of
different particles promotes
heterocoagulation





Sharing our knowledge

Our research



MO leaflet to optimise small scale use



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Media:
Newspaper
TV
University
<http://www.uu.se>



Moringa seeds (right) and kernels (left)



Seeds from Moringa tree can purify water

Published 2010-05-15



Photograph: Photo: Mapeye Kwambwa

Pure water is vital to humans, and in many countries there is a great need for purification methods. In collaboration with the University of Botswana, Uppsala University has been able to show how extracts from seeds of the Moringa tree can purify water.

"It's amazing to see that simple interactions between molecules can lead to such a complex process. Understanding this process can lead to further developments in water purification, and to the discovery of new, environmentally friendly materials," says Adrian R. S. de Sá, a researcher at Uppsala University.

A common first step in the water purification process is to remove suspended particles. This is often done with aluminum or iron salts. Aluminum in particular is toxic. In Africa, alternative purification processes are used that involve the use of the Moringa oleifera tree.

Water treatment procedure using *Moringa oleifera* seeds - continued

Water from varying sources will need different amounts of powder because the impurities present will not be the same. 50 - 150 mg of ground *Moringa* seeds treats one liter of water, depending on how clear the water is. Experimenting with a jar will help in working out the correct amount of seeds and stirring times so as to find out what works for you. A general rule of thumb according to Lowell Fuglie is that powder from one *Moringa* kernel to two liters if water is a good amount when water is slightly turbid, and to one liter when water is very turbid.

Both the seeds and the seed powder can be stored but the paste (solution made in stage 4) needs to be fresh for purifying the water. It should be freshly made every time water is to be purified.

Water treatment procedure using
Moringa oleifera seeds



Allow the *Moringa* seeds pods to dry naturally on the tree before harvesting.

Remove the seed wings and husks (brown seed coat), leaving a whitish kernel. Discard any seed kernels that have dark spots or any other signs of damage.

Crush or pound the seed kernels to a fine powder with a stone or mortar.

Mix the powder (e.g. 2g or 2 small spoons) to one cup of clean water, pour into a bottle and shake for 5 minutes.

Filter the mixture through a clean cloth into a bucket of dirty water that is to be treated.

Stir the water quickly for 2 minutes and slowly for 10-15 minutes (do not use metal implements). During this slow mixing, the fine particles and bacteria begin to clump together and sink and settle to the bottom of the bucket.

Cover the bucket and leave it undisturbed for an hour or until the water becomes clear and the impurities have sunk to the bottom.

The clean water may be siphoned, or poured off the top of the container or filtered through a clean cloth. The process removes 90-99% of the bacteria and impurities that cause turbidity.

For drinking water though, the water needs to be purified further by boiling, using a simple sand filter or placing in the direct sun in a clear bottle for 2 hours (solarizing).

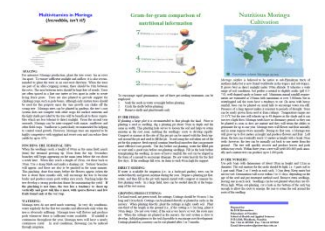
Moringa oleifera
the Miracle tree



Moringa plant parts and their benefits

Tree part	Uses or benefits
Leaves	Nutritional, medicinal, biomass, plant growth hormone, forage
Flowers	Nutritional, medicinal, honey
Pods	Nutritional, medicinal
Bark	Medicinal, rope making, gum for tanning hides
Roots	Medicinal
Gum	Medicinal
Wood	Paper, animal feed, medicinal, alcohol production
Seeds	Water treatment, food, cosmetics, cooking oil, lubricant

Thank you to the Swedish International Development Agency (SIDA) through the Swedish Research Links Programme for funding the Workshop on Colloid Science to Improve Water Purification and Contaminated Soil Remediation with Natural Products



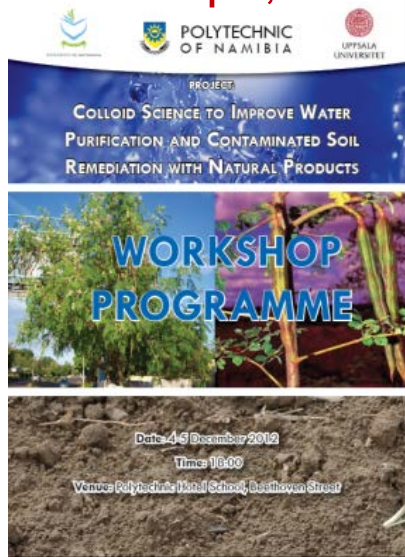
to enable research

steps



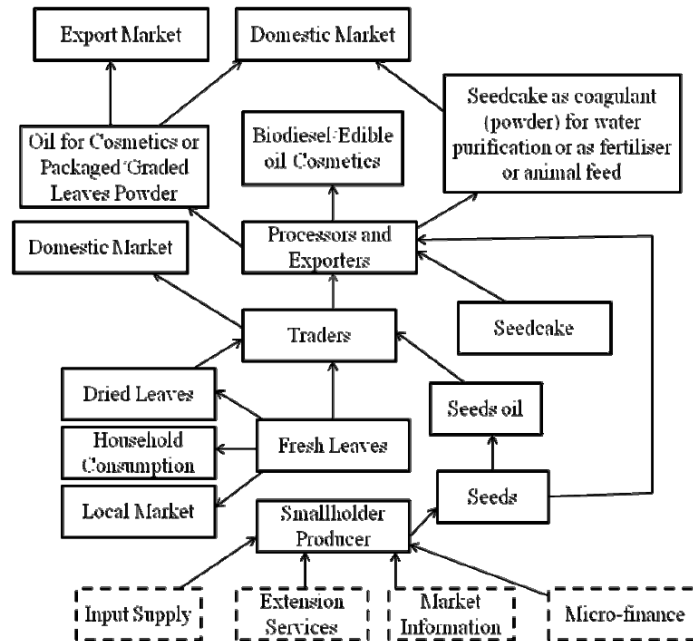
Popular Science
S. Nelson and
'Moringa: The
Miracle Tree'
17, 21-26 (20

Work shops, outcome



Windhoek, Namibia
 December 2012
 Opening address:
 Minister of Agriculture,
 Water & Forestry

Potential Moringa value chain map
 in Namibia, from work shop report



Comparative ongoing
 studies:
Moringa oleifera,
stenopetala, *ovalifolia*..
 (14 known species of
 genus Moringa)

Jar tests:



Gabarone, Botswana, July 2013

Opening address: Chief Executive Officer of
 Botswana Water Utilities Corporation

Offer: funding research at 5% of water
 treatment chemicals budget.

How do we improve impact?

