Research Paper

Qualitative exploration of local knowledge, attitudes and use of *Moringa oleifera* seeds for home-based water purification and diarrhoea prevention in Niger State, Nigeria

Agatha Aduro and Bassey Ebenso

ABSTRACT

This qualitative study explored stakeholders' knowledge of diarrhoea; their attitude to and perceptions of the use of *Moringa oleifera* seeds for home-based water treatment (HWT) and diarrhoea prevention in a low resource setting. Data were collected using semi-structured interviews with 13 respondents comprising rural community dwellers, health implementers and policy makers, and analysed using thematic analysis. Most rural community members interviewed had no knowledge of specific causes of diarrhoea or of the link between unsafe water and diarrhoeal diseases. They also practised inadequate or no methods of HWT. Although respondents were unaware of the use of *M. oleifera* seeds for HWT, community members and policymakers were keen on adopting it after observing demonstrations of its use for this purpose. Reasons for this behaviour change included easy accessibility to and a familiarity with *M. oleifera* for other uses. These results highlight the importance of providing health education on diarrhoea and water safety to motivate and empower community members to adopt healthy HWT behaviours. The use of *M. oleifera* seeds for HWT should be taught and advocated because it is a cheap, efficient and acceptable method of water purification for stakeholders.

Key words | diarrhoea prevention, home-based water treatment, *Moringa oleifera*, Nigeria, perceptions, water safety

Agatha Aduro (corresponding author)
Opposite Minna Industrial Estate,
Sauka Kahuta, Minna, Niger State,
Nigeria
E-mail: *agatha.aduro@gmail.com*

Bassey Ebenso
Leeds Institute of Health Science,
Leeds,
UK

INTRODUCTION

Background – diarrhoea and home-based water treatment

Diarrhoea is the second leading cause of childhood mortality worldwide, responsible for >500,000 childhood deaths annually (WHO 2017). Predisposing factors to diarrhoea and other water-related illness include a lack of access to water supply and sanitation services, and poor personal and environmental hygiene (WHO 2017). Unsurprisingly, morbidity and mortality from diarrhoea is highest in low and middle income countries, and especially in sub-Saharan Africa, where the global gains made towards improving access to safe drinking water and basic sanitation have not been as pervasive (UNICEF & WHO 2015).

Nigeria is the largest country in West Africa, with a population of about 180 million. It is ranked second

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among the 15 countries with the highest diarrhoea burden (IVAC 2013). In 2016, diarrhoea was responsible for 10.2% of the country's under-5 year olds' deaths (WHO 2016). The 2013 Demographic and Health Survey revealed that about 40% of the population lack access to an improved source of water supply; most of them in rural areas, and only about 4.7% of the population practised an appropriate method of water treatment, defined as either boiling, filtration, chlorination or solar disinfection (NPC & ICF 2014).

Nigeria made progress in improving sustainable access to clean water for the Millennium Development Goals (MDGs), although the gains occurred more in urban than rural areas. Less success was recorded in provision of sanitation services (OSSAP-MDGs 2015). Altogether, Nigeria failed to meet the seventh MDG. It also failed to meet targets for reducing under-5 year olds' mortality, which is embedded in the fourth MDG (OSSAP-MDGs 2015), contributed to in part by high mortality from diarrhoeal disease. A review of the impact of the various diarrhoea interventions revealed that a significant reduction in diarrhoeal illnesses (28–45%) can be achieved through effective and consistent application of home-based water treatment (HWT) and safe storage, compared to other measures (WHO 2014). HWT is also the most cost effective of all the diarrhoea interventions (Haller *et al.* 2007).

As only 29% of children with diarrhoea in Nigeria are seen by a health practitioner (NPC & ICF 2014), preventive measures, especially HWT and safe storage, must be championed as feasible ways of combating the heavy diarrhoea burden. This is important for ensuring that Nigeria makes progress towards achieving the third and sixth Sustainable Development Goals.

Moringa oleifera

Moringa oleifera, a plant of the *Moringaceae* family, collectively known as the 'horseradish' or 'drumstick' plant tree, has a ubiquitous geographical distribution in Nigeria, and is adaptable to the varying growing conditions throughout the country (Popoola & Obembe 2013). Its leaves, root, bark and seeds are used for various purposes including food, medicine, firewood, fencing purposes and as a coagulant in Nigeria (Popoola & Obembe 2013; Stevens *et al.* 2013). Its seeds have been identified from historic use (Folkard *et al.* 1999; Schneemann 2011) and through extensive research, as a viable low-cost, less labour-intensive and environment-friendly alternative to the popular HWT methods (Shan *et al.* 2016). *M. oleifera* possesses flocculent properties and thus coagulates and sediments particulate impurities present in water; it has antibacterial properties and is active against coliform bacteria, Shigella, *Cryptosporidium parvum*, etc.; and is shown to remove some heavy metals from water (Madsen *et al.* 1987; Olsen 1987; Petersen *et al.* 2016; Shan *et al.* 2016). *M. oleifera* is highly effective in the treatment of turbid water and is considered non-toxic as it neither significantly affects the pH nor the ionic content of the treated water (Ndabigengesere *et al.* 1995) while ensuring the water satisfies WHO guidelines for drinking water (Nkurunziza *et al.* 2009). The conventional recommended dose is one seed per litre for slightly contaminated water and two seeds per litre for heavily contaminated water (Mall & Tripathi 2017). Despite this increasing body of knowledge attesting to the efficacy and potential benefits of using *M. oleifera* for point-of-use water purification, empirical documentation of its use for HWT and diarrhoea prevention is scarce in Nigeria.

The study

This study aimed at exploring the understanding and attitudes of local stakeholders on the use of *M. oleifera* seeds for home-based water purification and diarrhoea prevention in Niger State, one of the states with a high diarrhoea burden and low HWT practice in Nigeria (NPC and ICF 2014). The specific objectives were to explore the following:

1. Community members' knowledge of the link between unsafe water and diarrhoea.
2. Home-based water purification methods (including natural methods) practised in Niger State.
3. Perceptions of local uses of *M. oleifera* plant in Niger State.
4. Understanding, opinions and attitudes of community members, health implementers and policy makers on

the use of *M. oleifera* seeds for water purification and diarrhoea prevention in Niger State.

METHODS

Study design

To elicit data-rich information about local knowledge, perceptions, and attitudes of a range of stakeholders regarding the use of *M. oleifera* for HWT, we adopted a qualitative design for the study. The aim of the study was to ask 'what' and 'why' questions, which are often best answered through qualitative methods (Creswell 2007). This cross-sectional exploratory research thus focused on an unexplored aspect of previous research, i.e. people's perceptions and practices of the use of *M. oleifera* seeds for home-based water purification.

Study setting

The study was conducted in Niger State, north-central Nigeria (10.2155°N, 5.3940°E), where the majority of the population reside in rural areas with difficult terrains that limit access to basic amenities and health services. The project was hosted by the Niger State Primary Healthcare Development Agency (NSPHCDA) which runs a CIDA (Canadian International Development Agency)-funded intervention in collaboration with UNICEF. This intervention, known as the Hard-To-Reach (HTR) Programme, aimed at increasing access to Maternal, Neonatal and Child Health (MNCH) services for 850 HTR communities in rural areas. The HTR communities formed the pool from which we selected two study communities. All HTR communities met the study criteria of being rural or semi-rural communities with high diarrhoea burden as evidenced by uptake of diarrhoea treatment from the HTR teams and limited access to basic amenities such as improved water supply and health services.

Two study-communities that were 50–70 km from Minna, the state capital, were selected:

1. Takalafia Fulani in Wushishi Local Government Area (LGA) – The main languages are Fulfude and Hausa. Interviews were conducted in Hausa, in which researchers have some degree of fluency.
2. Sharuwadna in Shiroro LGA – Its inhabitants are of the Gbagyi ethnic group and mainly speak Gbagyi language, in which interviews were conducted.

Participant recruitment

Altogether 13 stakeholders – eight community members, two health implementers and three policy makers – were recruited as respondents and interviewed. Community members were recruited because they are caregivers to children under five years of age who are hardest hit by diarrhoea morbidity and mortality and because their disease prevention/health-seeking behaviour determines the incidence and severity of diarrhoea episodes. They are also responsible for HWT practices, if any. Health implementers serve as health promotion officers in the selected communities. They are often the first and sometimes the only access the community members have to health services. They provide health education, including water safety and sanitation information to the clients. Policy makers were senior level staff of the NSPHCDA of the State Ministry of Health, whose responsibility it is to formulate and oversee implementation of policies regarding health promotion, which are then communicated to the community members by the implementers.

Of the 13 stakeholders, eight were female. We purposively selected a range of stakeholders as we were interested in the variety and diversity of information that will help achieve our study objectives (Creswell 2007). Convenience sampling was used to recruit community members who routinely accessed services at the HTR health post as households are scattered over a wide expanse of difficult terrain.

Interviews and data collection

Data were collected using a semi-structured interview guide, after obtaining informed verbal and/or written consent from participants. Information sheets and consent forms were given to respondents and translated by interpreters for uneducated community members. Thumb printing was

accepted as a means of consent for those unable to sign their names, as is the accepted practice in Nigeria. Respondents were given up to 24 hours to decide whether they wanted to participate in the study.

Due to cultural considerations, interviews with community members were conducted either at the health post or a place of choice in the community that was out of hearing distance from other community members. On-spot translation was done, with all interviews audio-recorded. The health implementers' and policy makers' interviews were conducted in English, privately, in their various offices.

Following the lack of familiarity of community members with using *M. oleifera* seeds for water purification, the researchers gave a demonstration in Sharuwadna community. Three identical transparent plastic bottles (A, B and C) were filled with water (see Figure 1(a) and 1(b)). In Figure 1(a), bottle A contains commercially obtained bottled water (Eva®), while bottles B and C are filled with water from the local river. A single dried *M. oleifera* seed was shelled, crushed and added to bottle B and shaken while bottle C was left untreated. Both B and C looked turbid and brown in colour at the beginning of the test.

Figure 1(b) shows the bottles after 3 hours, with the water in bottle B looking significantly clearer – notice *M. oleifera* seed particles at bottom of bottle, while bottle C remained turbid and dirty brown in colour even after 3 hours of standing.

Ethical approval

Ethical approval was obtained from the University of Leeds Ethical Committee and the Research and Ethics Committee of the Niger State Ministry of Health.

Data analysis

Data were analysed using thematic analysis as is appropriate for exploratory studies (Green & Thorogood 2004). Interviews were first fully transcribed and read closely for familiarisation. Sections of the texts were highlighted and coded using phrases to describe the content. Similar or recurring ideas coming under the same codes in the different transcripts were highlighted using the same colour. These codes were used to generate a list of themes and subthemes in a different document. Attention was also paid to emerging themes that the researcher had not considered prior to the research.

RESULTS

Interview findings revolved around five themes namely: (1) Difficulty in obtaining water; (2) Knowledge of link between unsafe water and diarrhoea; (3) Knowledge and practice of water purification methods; (4) Knowledge and uses of *M. oleifera* plant; and (5) Policy and implementation.

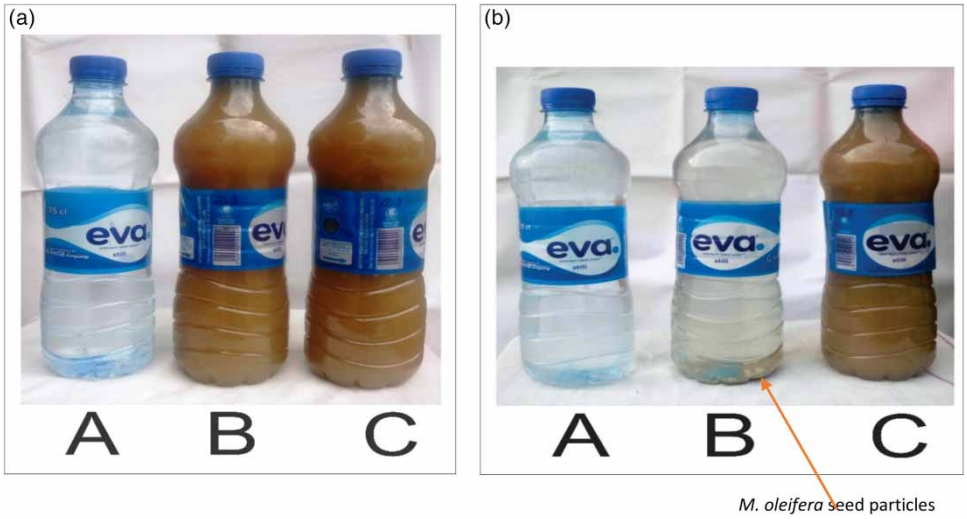

Figure 1 | (a) and (b): Effect of *M. oleifera* seed on water purification in Sharuwadna (*Source:* Aduro 2017).

Difficulty in obtaining water

Residents of the two communities primarily depend on polluted surface water for their water supply, i.e. the River Kaduna for Takalafiya Fulani community, and the Sharuwadna river for Sharuwadna community. Both rivers are located 25–30 km from the respective communities and often dry up during the dry season months of October to June each year. Thus, the water becomes dirtier and even harder to get in the dry season, as attested to thus:

> *'When the river dries up, community members go to the riverbed to dig until we get water. When we get the water, the women will form a queue to fetch, one after the other'* – Community member, Sharuwadna.

Although the rivers are the primary sources of water for the two communities, it emerged during interviews that community members in Sharuwadna are forced to purchase water from a borehole in Shakwatu, a nearby semi-urban community. This secondary water source is regarded as unimproved for this community as it is fraught with challenges, i.e. the water is purchased at a price that is dependent on the availability of electricity supply, which is often irregular in the area:

> *'We buy a gallon for N50 when there is electricity [to power the borehole] and when there is no electricity, we buy for N70… But the transformer that services the area is spoilt now [meaning water is costlier]'* – Community member, Sharuwadna.

Knowledge of the link between unsafe water and diarrhoea

Six of eight community respondents were knowledgeable of the link between unsafe water and ill-health, citing stomach pain or diarrhoea as consequences of consuming dirty water, although they could not mention the risk factors for contracting diarrhoea (e.g. lack of access to safe water, poor personal and environmental hygiene). The following extract supports these points of view:

> *'Honestly, if we drink the water like that [without using any purification method], it will definitely cause illness'* – Community member, Takalafiya Fulani.

Of the remaining two community members who thought dirty water neither caused ill-health nor diarrhoea, one respondent thought drinking unsafe water caused stomach pain but not diarrhoea.

> *'No, I don't think anything will happen. We drink this water, nothing happens to us'* – Community member, Takalafiya Fulani.

Some community members also linked the onset of the rainy season with an increase in the frequency of diarrhoea in the community, although they did not understand the reasons why. This was later explained by policy makers and health implementers as being due to increased contamination of water sources with faecal matter deposited close to water sources, which is more easily swept into water sources by the rains. This is a direct consequence of open defecation due to lack of sanitation facilities.

Knowledge and practice of HWT methods

The majority of the respondents knew at least one method of water purification. The most popular method cited was sedimentation and flocculation using alum (*Aluminum sulphate*). Unfortunately, knowledge of water purification methods did not translate to widespread or consistent practice for several reasons, chief of which were; the cost of purchasing Alum, the time needed to purify the water and the energy costs, as shown by the following quotes:

> *'… Well you know we have to buy the Alum [to clean the water] and there's no money to do so'* – Community member, Takalafiya Fulani.

> *'When I don't have to put alum, I fetch it in the morning and leave it and wait till evening to use it'* – Community member, Sharuwadna.

Unwanted properties and side effects such as a change in the taste of water and diarrhoea were attributed to use of excessive quantities of Alum, captured in this account:

> *'Well, if it's too little in the water the Alum may not […] purify the water to the extent that is required. And if the*

Alum is too much, it can change the taste of the water and it can even lead to […] diarrhoea in some people. Some people can react to it and also have diarrhoea' – Policy maker.

When asked about boiling as a method of HWT, some community members were unaware that boiling water was a method of purification per se, as this remark demonstrates:

'We just boil the water when we want to cook [but not to make it clear] and if we don't get alum sometimes, we just use the water like that' – Community member, Sharuwadna.

Contrary to the foregoing, health implementers and policymakers thought that community members knew of the water purifying properties of the boiling method. However, when explored further, both programme implementers and policymakers admitted the possibility of instances in which knowledge failed to translate to practice, in part because of the time it takes to boil water and the cost of firewood, coal or kerosene required for boiling the water.

Knowledge of *M. oleifera*

All 13 respondents knew the *M. oleifera* plant, locally known as Zogale. There was broad agreement among respondents about the various uses of its leaves and roots, whereas there was less agreement on uses of its seeds. The most common use cited for the leaves was for eating:

'I cook the leaves and I sometimes make soup with it for eating' – Community member, Takalafiya Fulani.

'Yes, this is something that is known to so many people in the state; it is used […] routinely eaten like in salads, and it is used in many other ways in Niger state' – Policy maker.

Other respondents mentioned using *M. oleifera* leaves for its medicinal properties, e.g. for treating ailments such as fever, typhoid, stomach pain, hypertension and diabetes, as shown by this remark:

'I eat it, when we boil the water with Zogale, we use to take it. […] if the baby is feverish, we give the baby the water' – Community member, Sharuwadna.

'The seeds, I know that they are used […] Yes, and they also use some of them, use it like tablets. […] They peel it, after… they also say it's medicinal, and they swallow it or chew it' – Health implementer.

Regarding the seeds, six of the eight community members mentioned that the seeds were only good for planting purposes; the remaining two community members, the health implementers, and a policy maker and said that any excess seeds that were not planted were either thrown away or sold in the market to make money.

None of the 13 respondents had heard of their use for water purification prior to this study. However, following the demonstration, all respondents present wanted to try it for themselves, pledging to adopt and promote the method among their friends. A remark typical of this enthusiasm read:

'I would like it very much. If the water becomes clear for me to see, I would be very happy to drink it and would continue using it' – Community member, Takalafiya Fulani.

The willingness to adopt *M. oleifera* for HWT may be attributed to: (i) familiarity with, and already established use of Zogale among this population, (ii) easy access to the seeds, and (iii) perceived low energy costs of using the method.

POLICY AND IMPLEMENTATION

All three policy makers acknowledged that though water safety and HWT were covered during sporadic health education campaigns, there was no formal policy for the population level use of *M. oleifera* seeds for HWT in Niger State. They also reported that although there was no fixed schedule for health education, community sensitization about water safety was currently provided as part of disease-specific campaigns such as Guinea Worm Eradication campaigns, on-going Neglected Tropical Diseases programme, and during annual MNCH weeks. They lamented about health education exercises being mostly facility-based, implying that most of the population who did not have access to health services were therefore denied access to health information about water safety and HWT, except in the rare instances where interventions such as

the HTR project were implemented in their communities. A policymaker remarked:

> *'Right now, our level of health promotion is restricted to where we have access – the community or the facility centres […]. So, I know that is not enough, but this is consistent with what we know already – the health services and approach is limited to only 30% of Nigerlites; 70% are out there that are not reached'* – Policy maker.

However, when HWT is included in health education campaigns, community members are told about common methods of purification such as the use of Alum, boiling and sedimentation, and filtration. The policy makers admitted that practice of HWT in the communities was probably difficult due to the factors mentioned above. However, following our interviews, policymakers were willing to promote population use of *M. oleifera* seeds for HWT if provided with proof of its effectiveness.

DISCUSSION

This qualitative study conducted in north-central Nigeria focused on using HWT for diarrhoea prevention in a low resource setting, especially as the condition remains a leading cause of child mortality in developing countries (UNICEF 2008). Clean water plays an important role in the prevention and treatment of diarrhoea – many diarrhoea interventions, including hand washing and the use of oral rehydration solution (ORS), are dependent on the availability of water. Surface water, such as rivers and streams, are the sites of various domestic and agricultural activities such as bathing, washing, fishing and livestock care, in addition to serving as sources of drinking water to the communities. This makes for easy contamination and predisposition to diarrhoea.

Our study identified three main findings. First, community members were knowledgeable of the link between unsafe water and diarrhoea although they failed to mention specific predisposing factors to diarrhoea such as lack of access to water supply, and poor personal and/or environmental hygiene. This deficient knowledge of risk factors of diarrhoea is not unconnected with current sporadic nature of health education provided to the populace in Niger State, and highlights the significance of regularity and consistency in providing reliable health information at the population level. This is important because of the finding by Jalan & Somanathan (2008) that provision of knowledge regarding water safety led to an 11% increase in practice of HWT within a short period.

Second, community members were knowledgeable about the use of sedimentation and flocculation (Alum) for HWT although they were less certain that boiling their water could help to purify it. However, knowledge of common HWT methods did not translate to widespread use due to reasons already identified by other researchers (Pritchard *et al.* 2010) and listed above.

Third, similar to findings from other scholars (Popoola & Obembe 2013), participants were knowledgeable about *M. oleifera's* medicinal uses and nutritional benefits. Yet, none of them had heard of its use for HWT and diarrhoea prevention before this study. Despite this, they demonstrated enthusiasm and willingness to adopt the method, possibly due to ease of access, low financial burden, low energy requirements and local acceptance of the plant in Niger State. Importantly, community respondents were planning to plant more *M. oleifera* trees to ensure increased accessibility to seeds. Policy makers expressed support for the idea of promoting *M. oleifera* seeds for HWT in the communities on the provision of scientific evidence that it works. They also raised the prospect of further research into its use for both for HWT and for remediation of lead-contaminated water, which is a problem in some parts of the states and is one of the documented properties of *M. oleifera* seeds.

CONCLUSIONS

Although this research was primarily directed at HWT and diarrhoea prevention and the potential for *M. oleifera* seeds as a viable, cost effective and energy-saving alternative to other known HWT methods, this qualitative study highlights the importance of providing accurate information and consistent health education to empower people to adopt healthy HWT behaviours.

RECOMMENDATIONS

The following recommendations are based on the study findings:

1. Sustained community-level health education and diarrhoea information should be provided. An understanding of the causes and transmission routes for diarrhoea will help people adopt diarrhoea prevention activities. These preventive services are currently facility-based and fail to reach a large majority of the population. Working with community leaders and volunteers to provide more regular and sustained health information will ensure more accurate information is accessible to people.
2. HWT should be promoted as an important anti-diarrhoea intervention along with regular hand washing and the use of ORS. As a matter of policy, HWT should be promoted for diarrhoea prevention and treatment because of the important role that potable water plays in diarrhoea prevention and treatment, as ORS use is dependent on the availability of clean water. HWT improves access to clean water within the home, regardless of the original source of water. Deploying relevant development and healthcare practitioners can facilitate the promotion of HWT as an important anti-diarrhoea intervention.
3. Widespread use of *M. oleifera* seeds should be promoted for HWT. The NSPHCDA should work with healthcare practitioners and community members to promote the correct use of *M. oleifera* seeds for HWT. There is a higher chance of adopting this HWT practice due to prevailing acceptability and ease of accessibility of *M. oleifera* within the communities, with none of the limitations associated with other methods of HWT.
4. There should be active promotion of and increased planting of *M. oleifera* trees. Working with the Ministry of Agriculture to encourage large-scale planting of *M. oleifera* trees would ensure a steady supply of seeds for HWT. In addition to the HWT importance, the trees can serve several other purposes including selling the seeds for their economic value and the leaves used for their nutritional value.

LIMITATIONS

The following limitations were observed by the researchers during the study:

1. Urban dwellers were excluded from this exploratory study based on the assumption that they had access to improved sources of water supply. However, interaction with staff of the NSPHCDA revealed that urban dwellers were equally interested in testing *M. oleifera* for HWT due to a perceived lack of trust in the quality of water obtained from seemingly improved sources. It may therefore be useful to include this demographic in future studies.
2. A small sample size of 13 people was used. Perhaps a larger sample size would have yielded more diverse results. However, this was balanced by interviewing across stakeholder groups of community members, health workers and policymakers.

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