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A CASE FOR THE USE OF *MORINGA OLIFERA* AS A NATURAL COAGULANT TO IMPROVE WATER SUPPLY IN RURAL FARMS IN NIGERIA

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ABSTRACT

Reports of potable water supply situation in Nigeria recently showed poor performance, most especially in the rural areas, probably owing to shortage of funds to provide water supply facilities and sometimes negligence. This has led to the consumption of water from various unwholesome sources by the rural dwellers, usually without treatment. This, therefore, suggested the need for an alternative to the conventional water treatment method which is also believed to be costly, with health effects and unfriendly to the environment. Hence, a case was made for the use of an affordable, safe and environmentally friendly natural coagulant, Moringa oleifera, for water treatment in the rural areas since its use has been proved effective by researches. With the use of the plant, it is expected that cost of water treatment will reduce and thus improve potable water supply in the rural areas. This will further enhance healthy living and poverty reduction amongst the farmers, in addition to other economic benefits derivable from the cultivation of the plant. However, since researches are still ongoing on the use of M. oleifera for water treatment, it was recommended that adequate care should be taken on the appropriate procedure and dosage. There was also the need to encourage more researches to ensure timely resolution of all issues surrounding the use of the plant. Creation of awareness amongst the rural farmers on the usefulness of the plant was capable of increasing its cultivation which will have overall economic benefit to the entire country.

Keywords: M. oleifera, natural coagulant, water supply, economic benefits

INTRODUCTION

In spite of the importance of water as a vital resource for human existence, its supply in many developing countries is highly inadequate. Water is indeed a necessity for living as there is no life without it (AKoteyon et al., 2011**;** Nwankwoala and Nwagbogwu, 2012; Subramani et al., 2012**).** Provision of potable water has been a recurrent problem which requires urgent attention in many of the developing countries (Shittu et al., 2004); the situation is more worrisome in both urban and rural settlements of Nigeria. In recent reports by the World Health Organisation (WHO) and the United Nations Children's Fund (UNICEF), Nigeria was ranked third globally on the list of countries with inadequate water supply and sanitation coverage (Daily Times, 2012; National Mirror, 2013). The report further adjudged Nigeria as one of the countries that are "off-track'' in meeting the water and sanitation targets of the MDGs by 2015, due to lack of coordination, abandonment and poor funding of various water projects. Earlier, The Punch (2012) had reported the WHO/UNICEF placement of Nigeria behind China and India, as countries with large population without adequate water supply and sanitation coverage.

These revelations notwithstanding, the situation of potable water supply in many rural areas is worse than imaginable. Whereas many urban areas can still boast of between 60 and 75%

potable water supply, the percentage in many rural settlements may be less than 50% depending on the location (National Mirror, 2013; The Punch, 2012), however, about 50% of the urban and 20% of the semi-urban population have access to reliable water supply of acceptable quality (FRN, 2000). The reason for this situation is not far-fetched, many governments believe in satisfying the urban populace since they serve as the seat of government where many top government officials reside. In addition, the performance of governments is often evaluated with the situations in the urban towns and cities. Furthermore, though responsibility for water supply is shared between three levels of government – federal, state and local in Nigeria, the local governments that are in charge of the rural areas do no possess the needed resources (both human and materials) to perform the responsibility. In fact, the rural areas are hardly adequately catered for in the provision of basic amenities, especially water supply yet the people need the resource for day-to-day living.

In view of the foregoing, water from many unsafe sources such as streams, rivers, small ponds which are usually heavily polluted has become unavoidable alternatives and is in most cases used directly for various domestic purposes without any treatment. Perhaps, treatment of the water before consumption would have been undertaken; cost of chemicals required for that purpose is often on the high side in Nigeria. Therefore, there is high risk of exposure to various water borne diseases by the rural farmers and dwellers. Hence, there is the need to explore a cheaper means of water treatment to salvage the situation. The basic requirements of water are that it should be aesthetically attractive, containing no harmful organisms, and without any concentration of harmful chemical compounds. This is often conventionally achieved through the chemical treatment of water by coagulation. However, coagulation through the use of chemicals is very costly as earlier mentioned and may have side effects on human health. To this end, this paper has the objective of making a case for the use of *M. oleifera* as a natural coagulant, to improve water supply in rural farms in Nigeria.

THE PREVAILING SITUATION OF WATER SUPPLY IN RURAL FARMS IN NIGERIA

As mentioned previously, water supply in most rural settlements in Nigeria is at its lowest ebb. The situation is more worrisome in remote farms where the inhabitants do not normally have adequate representations in the government of the day. In recognition of the poor state of infrastructure in the rural farm settlements, the then military government in the late 80s established various agencies including Directorate of Food Road and Rural Infrastructure (DIFFRI), National Agricultural Land Development Authority (NALDA), Better Life for Rural Women and many others to arrest the situation. Although when these agencies existed, there were many activities towards increasing infrastructural supply, including water provision in the rural areas, since their scrapping, many of the water supply facilities provided have not been taken care of by appropriate authorities. In addition to this, many boreholes sunk by the successive governments are either not properly done or well-maintained to last long in the rural farms (FRN, 2000). Many rural areas of the country have also benefitted from interventions by non-governmental organisations such as DFID, UNESCO, USAID, WaterAid, etc. As at 2010, a total of 6,960 new safe water facilities (boreholes, dug wells and protected springs) were reported to have been provided by UNICEF (Wikipedia, 2013). Ironically, only few of the local governments in the country whose responsibility is the provisions of potable water in the rural areas have divisions/department for rural water supply. As a result, when breakdown of existing water supply facilities are reported to them, they are usually handicapped and therefore not able to provide immediate solution.

A survey of small towns conducted in 1997 (Figure 1) showed that not more than 5% of the population in the rural areas had access to water from protected boreholes while 13% used water from communal wells amongst other sources, owing to negligence by many state water agencies (SWAs) (FRN, 2000). In a recent study by Ishaku et al. (2011), more than 70% of the rural dwellers were said to lack access to potable water supply. This leaves the rural farmers with the options of using water from various unwholesome sources such as rivers, perennial streams, water ponds and unprotected wells. Unfortunately, less than 15% of the rural dwellers have access to safe excreta facilities while about 75% use pit latrines (FRN, 2000), therefore increasing the possibility of pollution in their surface water supply. Besides, many of the surface water resources are also used in the processing of agricultural products like oil palm, cassava, melon, etc. thereby further raising their level of contamination (Ishaku et al. 2011).

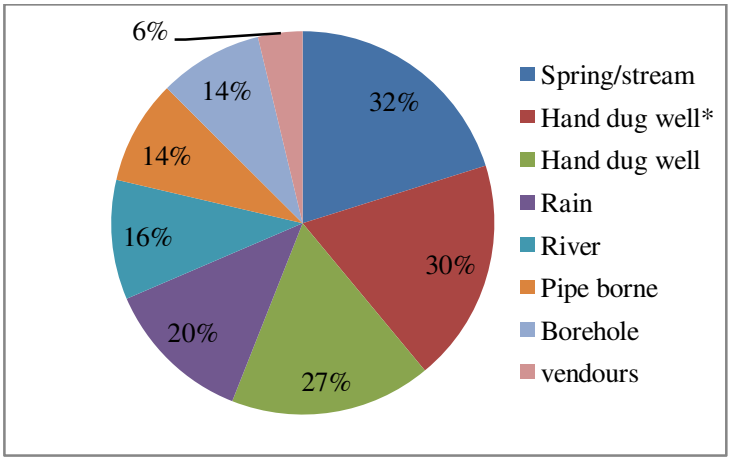

Figure 1. Small Towns Water Supply and Sanitation Program development studies (FRN, 2000)

Figure 2. Eradicating Rural Poverty in Nigeria (IFAD, 2012)

Consequently, the rural farmers/dwellers become more susceptible to water borne diseases such as typhoid fever, cholera, dysentery, malaria parasites. Where a few water supply facilities are available, a lot of useful time is usually wasted by many housewives since they have to queue for hours (Figure 2). The rural farmers are usually faced with the twin challenges of wasting useful time on sourcing for water and visiting health centres when diseased are contracted after consumption of contaminated water. This is in spite the research

finding that water supply has more impact on poverty reduction and that better access to potable water has the potential to reduce the burden of diseases as much as improved health care facilities (FRN, 2000).

A REVIEW OF THE USE OF NATURAL COAGULANTS FOR WATER TREATMENT

Coagulation which can also be described as flocculation followed by sedimentation, filtration and disinfection usually by chlorine is a widely applied water treatment method by many industries and water agencies around the world. Generally, coagulants can be grouped into inorganic, synthetic organic polymer and naturally occurring coagulants. However, PAC (Poly-Aluminium Chloride) an inorganic polymer and aluminium salts, which are most widely used as coagulants in water treatment, have been very costly in recent times. Also, there is a suspicion that aluminium which is a major component of PAC and alum may induce Alzheimer's disease (Abaliwano et al., 2008) in addition to its being indicated as a causative agent in neurological diseases. Similarly, synthetic organic polymers are also believed to have strong carcinogenic properties. This has therefore necessitated the need to find other means which are generally acceptable to be safe for human health.

Naturally occurring coagulants are usually presumed safe for human health. Their use for water treatment predated the advent of chemical salt but they have not been able to compete effectively because of inadequate scientific understanding of their effectiveness and mechanism of action. The use of plant materials as natural coagulants to clarify turbidity of wastewaters has been a common practice since ancient times (Rao, 2005). In Peru as far back as the 16th and 17th century, powdered roasted grains of *Zea mays* were used by soldiers as a means of settling impurities. In India, the seed of Nirmali tree (*Strychnos potatorum)* was said to have been used as a clarifier in the ancient times (Rao, 2005) while in Chili, sap of tuna cactus (*Opuntia fiscus indica*) is widely used as water purifying agent. Other plants such as dried beans (*Vicia faba*) and peach seeds (*Percica vulgaris*) are as well being used in Bolivia and Peru as primary coagulants (Rao, 2005). Apart from its safety, with the use of natural coagulants, chemicals and sludge handling cost may be drastically reduced (Bina et al., 2009). This is particularly one major reason why the use of natural coagulants is being embraced by many developing countries of the world especially in Africa and Asia. In Africa, a study of the use of *M. oleifera*, a natural coagulant, has been conducted in both Malawi and Zimbabwe with favourable results (Folkard et al., 1993; Sutherland et al., 1995). Results of the studies also conducted in Malaysia (e.g. Kayaton et al., 2006; Montakhab et al., 2010) and Bangladesh (e.g. Asrafuzzaman et al. 2011; Bina et al., 2009) have proved the use of natural coagulants as very effective for water treatment. Shilpa et al. (2012) also reported high efficiency for Cactus and Hyacinth Bean Peels when used as natural coagulants in India.

In Nigeria, while many of the naturally occurring coagulants are found growing wild and few cultivated, their use as coagulants is not well-known and therefore not commonly explored. The plant is far more used as a vegetable in soup, a medicinal herb and in farmland demarcation and fencing especially in the Northern Nigeria. However, researches conducted to establish its usefulness in the country so far have shown encouraging results. Kawo and Daneji (2011) in their study conducted in Kano, Nigeria reported *M. oleifera* seed as having the potential to act as a substitute for chemicals used in water treatment in view of its ability to reduce turbidity in water. Similar study conducted by Shittu et al (2004) in Abeokuta using *Calotropis procera* also concluded that the leaves of the plant have the potentials for the treatment of water as drastic reduction in turbidity, pH and microbial load was observed in the water samples used. In addition, Nwaiwu et al. (2012) discovered varying performances in the *M. oleifera* seeds plucked from Borno, Yobe and Adamawa states in the North East

part of Nigeria. Nevertheless, all the seeds were found to have possessed good antimicrobial quality which is an important requirement in water treatment. The result of the study conducted in Maiduguri by Arku et al. (2012) on the contrary, showed that water treated with some natural coagulants could only be used for unrestricted (drip) irrigation but not for drinking.

MORINGA OLEIFERA AS A NATURAL COAGULANT

Moringa oleifera (Figure 3) is one of the most widespread plant species that grow quickly at low altitude in many tropical countries of the world. *The plant is* a vegetable tree commonly grown in Africa, Central and South America, the Indian subcontinent, and South East Asia (Lea, 2010). It is probably one of the world's most useful trees considering its ability to yield cooking and lighting oil; acts as soil fertilizer, as well as highly nutritious food in the form of its pods, leaves, seeds and flowers (Lea, 2010). Probably, the use of its seeds to purify drinking water at virtually no cost is the most important quality of the plant. *When the seeds are* crushed into powder, it can be used as a water-soluble extract in suspension, leading to an effective natural clarifier for highly turbid and untreated pathogenic surface water. Apart from improving drinkability, this technique reduces water turbidity (cloudiness) making the result aesthetically as well as microbiologically more pleasing for human consumption (Lea, 2010). This is because seed powder of the plant can leave water clear with 90-99% of the bacteria removed (Katayon et al., 2007). In addition, it has high capacity to cause reduction of bacteria during water treatment and as well as having natural buffering capacity to solve pH problems. In many rural homes in developing countries of Asia, *M. oleifera* seed (crude extract) is preferred to alum by rural women to remove turbidity in water because of the fear of possible gastro-intestinal disturbances and the resultant abortion in pregnant women that can arise when alum is used (Katayon et al., 2007).

Figure 3. Fresh *Moringa oleifera* Tree and fruits

In many developing countries of the world, researches have been conducted to ascertain the efficiency of the plants when used solely and in combination with other plants or chemicals. It has also been tested on varieties of wastewater and polluted water from diverse sources at varying dosages. Muyibi and Alfugara (2003) in Malaysia used a pilot scale water treatment plant to treat turbid raw water with turbidities ranging from 21 NTU to 479 NTU using *M. oleifera* seed extract as a primary coagulant and reported a residual turbidities of 2.7 and 1.9 NTU respectively. Similarly, when alum was applied as a primary coagulant with *M. oleifera* as a coagulant-aid, residual turbidities of 1.5 NTU and 2.1 NTU were obtained with a reduction in alum dosage of up to 40% of the normal dosage. Bhatia et al. (2006) in Penang, Malaysia discovered in their research that the *M. oleifera* seeds after oil extraction gave a

higher removal in suspended solids (95%) and COD reduction (52.2%) on palm oil mill effluents. By combining *M. oleifera* with the flocculant (NALCO 7751), the removal of suspended solids was increased to 99.3% and COD reduction as 52.5%. It was also concluded that the removal of suspended solids and COD reduction is affected by the operating temperature and best performance was observed at temperature of 30^0C. A 99.2% suspended solids removal and 52.5% COD reduction was also reported by Othman et al. (2008) when *M. oleifera* seeds were used for coagulation and flocculation of palm oil mill effluents.

In Iran Yarahmadi et al. (2009) showed that *M. oleifera* has the potential to become an alternative coagulant to chemical with its high effectiveness even at varying pH levels and increasing cultivation in the country. Muyibi and Evison (1995) in their study in Britain found that increased dosage of *M. Oleifera* led to higher removal efficiency of water hardness and that pH had no effects on the efficiency of the plant as a coagulant. Abaliwano et al. (2008) in their research conducted in The Netherlands reported an efficiency of up to 97% and 86% of *M. oleifera* for turbidity removals of high turbid waters and lower turbid waters, respectively. *M. Oleifera* seeds have also been found effective for the removal of heavy metals such as cadmium by adsorption (Sharma et al., 2006). It can therefore be reasoned that the performance of *M. oleifera* in all the researches showed that the plant is an effective natural coagulants for water treatment.

POSSIBLE BENEFITS OF THE USE OF *MORINGA OLEIFERA* AS A NATURAL COAGULANT IN THE RURAL FARMS

Asrafuzzaman et al. (2011) stated that locally available natural coagulants when used for water treatment provide an easy, suitable and environmentally friendly option for improving water potability. In the first instance, farmers can now treat the water sourced from many unwholesome sources for use with *M. oleifera* at virtually no cost (Lea, 2010). This will further enhance the quality of life of the farmers with increasing health status as many of the diseases being suffered by them are water borne. The use of *M. oleifera* can also help in reducing consumption of chemicals such as Aluminium salts which can cause Alzheimer's disease (Muyibi et al., 2004) and are sometimes applied overdose by many water agencies in the country. It may also reduce soap wastage because when alum is used in excess for water treatment, more soap is usually required to make foams for washing and other domestic cleaning activities. It can also help in overcoming the problem of low pH and a low efficiency in coagulation of cold waters (Ndabigengesere and Narasiah, 1998), because *M. oleifera* does not significantly affect the pH or alkalinity of water after treatment (Muyibi et al., 2004; Yarahmadi et al., 2009). The plant possesses antimicrobial properties against mesophilic bacteria, mesophilic fungi and coliform bacteria (Abaliwano et al., 2008; Alo, et al., 2012 and Nwaiwu et al., 2012) and thus water treated with it is microbiologically safe for consumption and of good taste. Furthermore, results have shown that the volume of sludge produced when *M. oleifera* is used is considerably less as compared to alum and ferric chloride, therefore making the method environmentally friendly (Abdulsalam et al., 2007) and reduce the energy required in sludge treatment and disposal. The use of *M. oleifera*, can also reduce the farmers dependence on government for water supply since water treatment with the plant has been reported to be about 99% efficient (Katayon et al., 2007; Othman et al. 2008).

On the overall, the economic benefit of the plant seems to have no limit as virtually every of its parts is useful (Abaliwano et al., 2008; RMRDC, 2010) and can fetch farmers additional income with increased cultivation when such parts as root, leaves, back and stem are sold. The nutritional intake of the farmers can also improve since the plant can provide plant protein apart from its medicinal values when consumed. The farmers will also depend less on

treated water from the highly inefficient water works and further safe time being spent on queue when fetching water from public wells/boreholes.

CONCLUSION

With the present economic situation around the world and particularly in Nigeria, governments at all levels are already finding it difficult to adequately provide social amenities for the citizens of which water supply is not an exception. As a result of this, there have been calls for community participation in the supply of many of the amenities, including water. It has also been reported that when communities get involved in the provision of certain amenities, they tend to be more committed to its maintenance (FRN, 2000; IFAD, 2012). Yet, an important component of the Millenium Development Goals is the raising of water supply in both urban and rural areas in the country by the year 2015 (Abaliwano et al., 2008). Therefore, considering the effectiveness of the use of M. *oleifera* as a natural coagulant already reported by many researchers and recognizing the seeming inability of the governments to meet the water needs of the rural dwellers in the nearest future, it could be concluded that its adoption by the rural farmers will improve access to potable water in the rural areas. This might further reduce the cost of purchasing chemicals for water treatment in the coming years and as well help governments to achieve the target of over 65% water supply in the rural areas as stated in the MDGs. However, since researches are still ongoing on the appropriate dosage of M. *oleifera*, adequate care should be taken in its use for water treatment. Governments at all levels should encourage and coordinate researches that will lead to the emergence of definite procedure and dosage for the use of the plant as a natural coagulant for water treatment. There is also the need for the creation of awareness on the use of the plant for this purpose amongst the rural dwellers since it is usually within their living environment. Finally, farmers should be encouraged to embark on the cultivation of the plant, perhaps to serve as hedges since it has other economic benefits apart from its use for water treatment.

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