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Efficiency of Protein Extracted From Stored *Moringa Oleifera* Seed in Modifying the Physicochemical Properties of Water

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ABSTRACT
Turbid water samples were clarified by coagulation-flocculation and sedimentation, using proteins isolated from stored Moringa oleifera (MO) seed as coagulant in a jar test. Dosages of the coagulant used were 30mg/l, 40mg/l and 50mg/l. Results of the jar test showed that the protein extract from stored MO seed was effective in modifying the physicochemical properties of water during water purification. The different dosages used achieved varying efficiencies in modifying the physicochemical properties of the water.

***Key words: Coagulation, Flocculation, Physicochemical, Turbidity**,*

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I. INTRODUCTION

Fresh water lakes and rivers, are the main sources of water consumption for plants, animals and humans (William, 2016; USGS, 2016). Water (known as a universal solvent) slowly dissolves mineral ions from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer. Anthropogenic activities such as agriculture, manufacturing, commerce, domestic activities and land development contribute in degrading the natural quality of water (American Water Works Association (AWWA), 2002, Alam et al, 2010). These impact on the physicochemical properties of the water resulting in high, medium or low levels of turbidity. The principal physical manifestation of contamination of water is turbidity (Oluduro and Aderiye, 20070. Turbidity is caused by suspended particles and natural organic matter (NOM) present in the water (Bodlund, 2013). The production of potable water from most raw water sources usually entails the use of a flocculation/coagulation stage to remove turbidity in the form of suspended and colloidal material (Birima et al 2013). This turbidity removal is the major problem with surface water during water treatment (Rao, 2005, Rajput, *et al*, 2012). It's removal usually also impacts on other physicochemical properties of the treated water (Oluduro and Aderiye, 2007).

Natural flocculating agents have been used for water purification before the use of synthetic chemicals were adopted (Ndabigengesere et al, 1995). *Moringa oleifera* (MO) seeds have been used traditionally as natural flocculants to clarify drinking water (Suarez *et al*., 2005). MO seeds possess strong coagulative and antimicrobial properties (Jayaraj *et al*., 2004). The protein content of MO seed has been found to be responsible for the coagulation and flocculation properties (Ndbigengesere and Narasiah, 1998). It is important to investigate how effectively the protein extract from stored *Moringa oleifera* seed can affect the physicochemical properties of water during water treatment.

II. MATERIALS AND METHODS

Dried pods of *Moringa oleifera* seeds were harvested from local growers located in Agulu, Anambra state and air-dried for 14days. The seeds were identified by Herbarium Curator, Dr. Mrs B. O. Aziagba, of the Department of Botany, Nnamdi Azikiwe University, Awka. A sample of the seed was kept in Cabinet Number 02, Shelf Number 29 of the Herbarium. Turbid water was collected from Ezu River in Amansea, Anambra State, Nigeria, at Longitude 6° 15′ and Latitude 7° 08′. Turbidity ranged between 65 NTU and 322 NTU, depending on the season the water sample was procured.

The air-dried seeds of *Moringa oleifera* (MO) seed were stored at room temperature of about 30^{o}C for a period of 150days in different forms (winged seeds, shelled seeds and seeds in the pod), using different storage containers (covered baskets, corked glass bottles and cellophane bag). Winged seeds refer to seeds that were removed from the pod but the outer brown covering remained, which has some wing-like components. Shelled seeds are those removed from the pod and the outer covering also removed, exposing the inner white kernel. The *seeds* of MO were ground and defatted with n-hexane using the Soxhlet apparatus in accordance with Harwood *et al*, 1989 and Ali *et al*, 2010. This was followed by aqueous extraction of the coagulant. The coagulant active ingredient (seed protein) was isolated through acetone precipitation (TR 0049, 2009) and used in the purification of the water using the standard jar test apparatus (ASTM D2035-19). Coagulant dosages of 30 mg/l, 40 mg/l and 50 mg/l were used. The experimental procedure was repeated at 30days intervals throughout the period of seed storage until 150days. The physicochemical properties of both untreated and treated water samples were determined using the method of Greenberg et al 1998.

III. RESULTS AND DISCUSSIONS

Physicochemical parameters of the raw water taken at 30-day intervals are shown in Figure 1. The percentage modifications of physicochemical parameters observed after treatment of the water with protein isolated from stored *Moringa oleifera* seed are presented in Figures 2- 7.

(a) Untreated water

Figure 1 shows values of total suspended solids in Ezu river, which ranged from 117mg/l to 1500mg/l, as well as values of turbidity(65 NTU to 322NTU), total dissolved solids(14mg/l to 400mg/l), total hardness(2.22mg/l to 8.4mg/l), pH (6.5 to 6.8) and conductivity(28 µS/cm to 96 µS/cm). The values of total suspended solids as well as values of turbidity in Ezu river were far higher than the Nigerian Drinking Water Quality Standards (NDWQS) of <30mg/l and 5NTU respectively (NDWQS, 2015). Values of every other parameter (total dissolved solid, total hardness, pH and conductivity) were within acceptable limits of Nigerian Drinking Water Quality Standards (NDWQS). This agrees with Wakawa and Nwaiwu(2019), who found that other water quality assessment parameters of the untreated Ezu River water sample, besides total suspended solids and turbidity, were within permissible limits as stipulated by the relevant regulatory bodies (World Health Organization, WHO and Environmental Protection Agency, EPA). In Figure 1, the y-axis takes the unit of each parameter being considered, mg/l for tss, tds and total hardness; NTU for turbidity and micro-siemens per centimeter for conductivity. The high peaks of total suspended solids corresponded with water samples taken on days of heavy rainfall. A lot of debris washed from the shore had contributed to very high levels of total suspended solids in the water on such days of heavy rainfall.

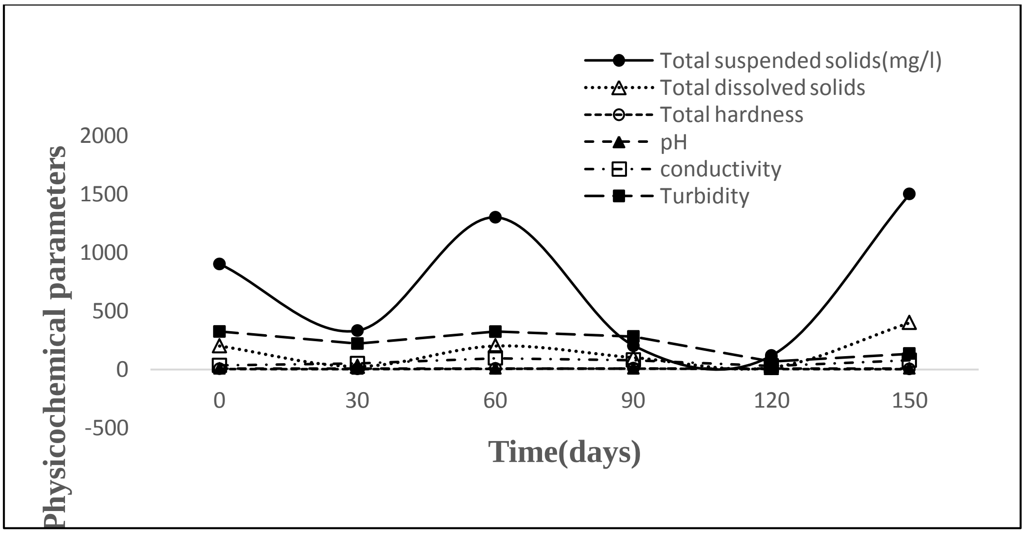

Figure 1: Physicochemical properties of raw water at 30-day intervals

(b) Treated water

The percentage modifications of the values of physicochemical parameters after each 30-day intervals of treatment of the water with the seed protein are shown in Figures 2 - 7

(i) Total suspended solids (TSS)

Figure 2 shows the plot of percentage reductions in values of total suspended solids (tss) against each 30-day experimental interval. In all the modes of storage, high percentage reductions in total suspended solids (53.5%

to 100%) was observed. Total suspended solids were generally reduced to values within the acceptable limits of Nigerian Drinking Water Quality Standards (NDWQS). A greater part of the reductions were close to the 90% and 95% total suspended solids reductions achieved by Oluduro and Aderiye (2007) who used *Moringa oleifera* seed powder to treat both ground water and surface water.

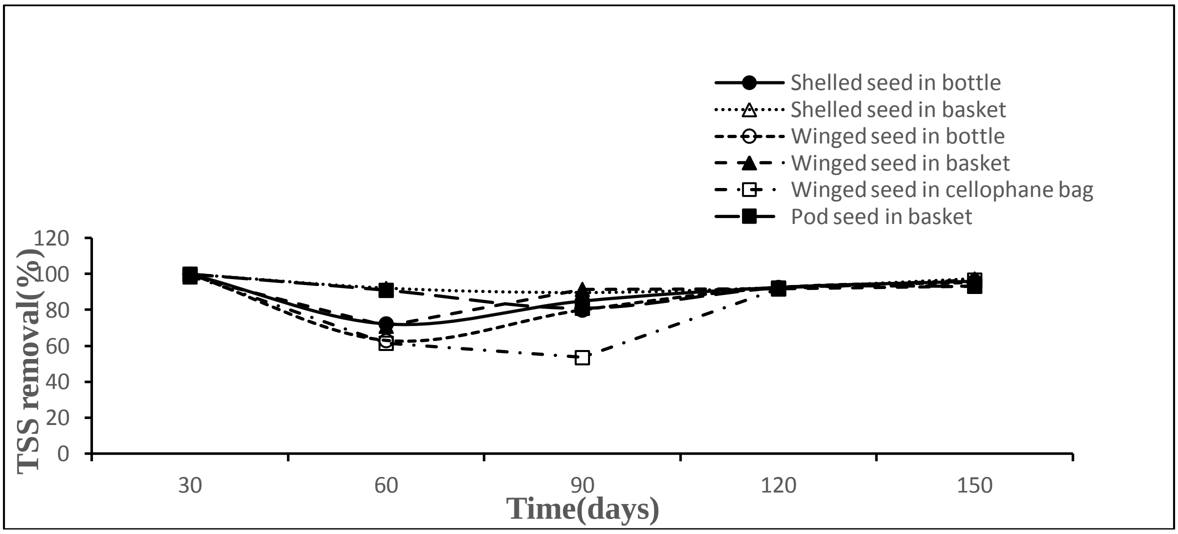

Figure 2. Percentage reduction in total suspended solids versus storage time

(ii) Total dissolved solids (TDS)

Total Dissolved Solids in the raw water ranged from 14mg/l to 700mg/l. This range of values are lower than the maximum acceptable limits of Nigerian Drinking Water Quality Standards (NDWQS). It is observed that total dissolved solids increased in values, though not significantly, after treatment of the water with *Moringa oleifera* seed extract. However, the value has remained within acceptable limits of Nigerian Drinking Water Quality Standards (NDWQS). Figure 3 shows the percentage increase at each 30-day experimental period. The rise in the values of total dissolved solid could be attributed to the possible re-solubilization of the protein extract.

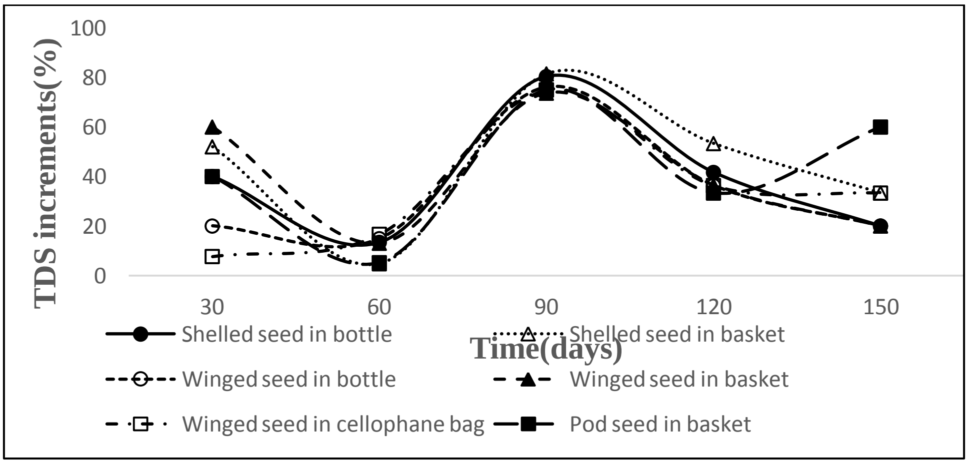

Figure 3. Percentage reduction in total dissolved solids versus storage time

(iii) Total hardness (TH)

Total hardness which ranged from 1.24mg/l to 8.4mg/l was within acceptable limits in the raw untreated water throughout the experimental period. Values of total hardness were further reduced after the application of the extract from all the modes and containers of storage. Percentage reductions in total hardness are presented in Figure 4. The results show that MO seed protein extract can reduce hardness in water. This agrees with Fahmi *et al* (2011) who found that MO seed extract removes water hardness by adsorption mechanism.

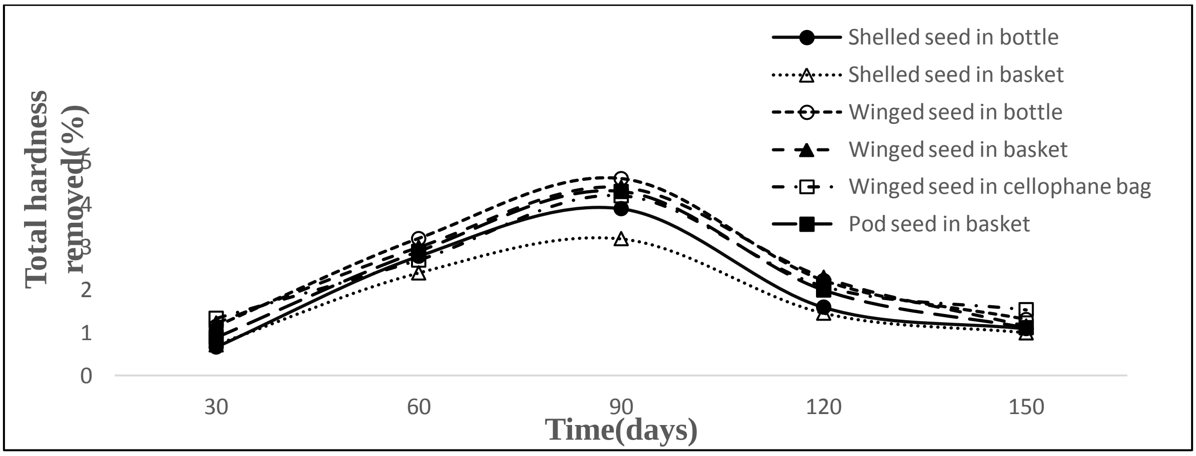

Figure 4. Percentage reduction in total hardness versus storage time

(iv) pH

The values of pH in the raw water was generally within the Nigerian Drinking Water Quality Standards acceptable range of 6.5 to 8.5. They were essentially unaffected by treatment of the water with *Moringa oleifera* seed protein. Hence Figure 5 shows the values of percentage ph reductions clustered closely above and below the horizontal line. Values which plot below the horizontal line are cases where the observed ph were higher than the raw water value, though not significantly. These plotted as negative percentage reductions.

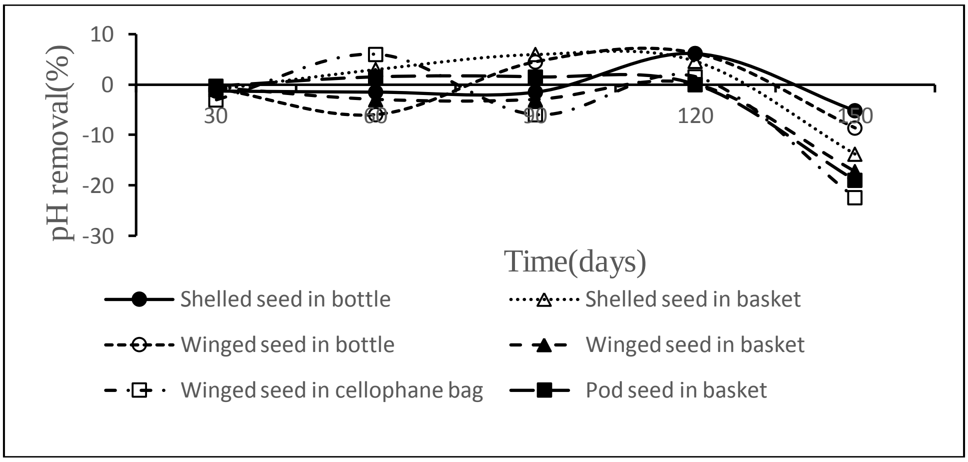

Figure 5. Percentage pH reduction versus storage time

(v) Conductivity

Figure 6 is a plot of percentage increase in conductivity against storage time for each mode of storage. The values of conductivity in the raw water were well within acceptable limits of Nigerian Drinking Water Quality Standards (NDWQS). Although the values of conductivity increased considerably after treatment with the extract, they remained far lower than maximum acceptable limits. Abaliwano et al (2008) also observed a significant increase in the conductivity of water after treatment with MO extract and attributed it to the presence of NaCl ions used during the purification stage for the process of elution. However, increase in conductivity of water treated with the use of MO seed protein precipitate suggest that the increase in conductivity may be due to the seed protein itself. This is corroborated by the recent report that protein has been found to conduct electricity (Zhang et al, 2017; Goval, 2017; Lindsay, 2019 and Sawyer 2019).

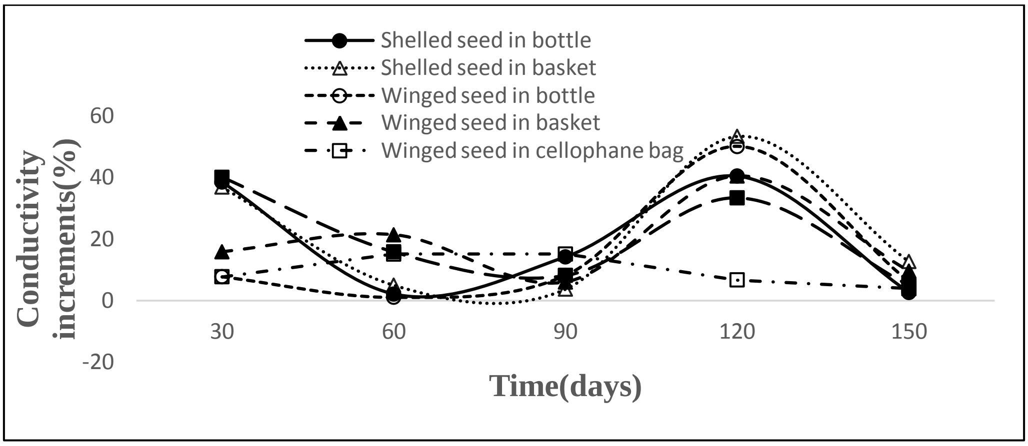

Figure 6. Percentage increase in Conductivity versus storage time

(vi) Turbidity

Figure 7 shows percentage turbidity removals at each 30day experimental intervals. Turbidity was significantly reduced in all the modes of storage throughout the storage period. Percentage turbidity removals ranged between 48 and 98%. This shows that MO seed protein significantly reduces the turbidity of water. Other researchers have observed turbidity reductions between 80 and 98% (Golestanbagh *et al*, 2011 ; Muyibi and Okuofu, 1995)

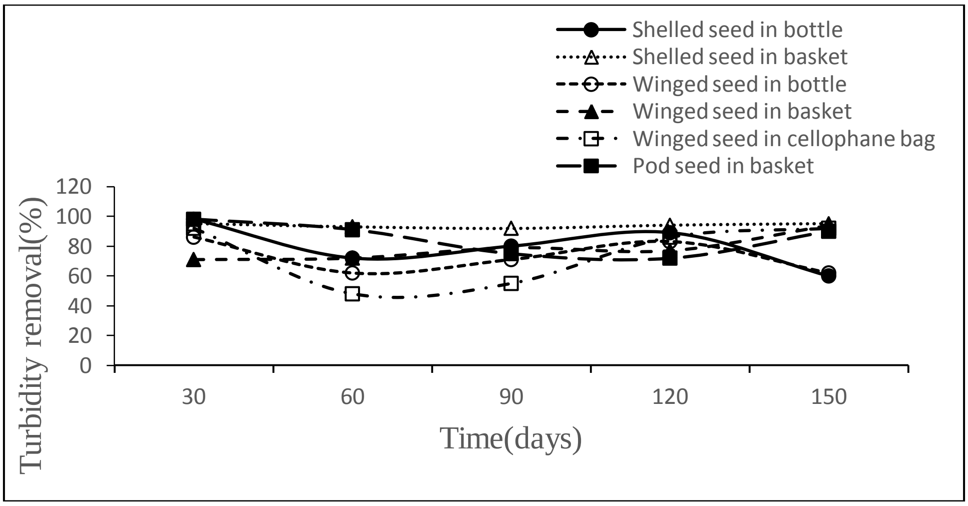

Figure 7. Percentage Turbidity removal versus storage time

IV. CONCLUSION

Protein extracts from stored *Moringa oleifera* seed were used to purify turbid water collected from Ezu river in Amansea, located at Longitude 6° 15′ and Latitude 7° 08′, in Awka North Local Government Area, Anambra State. The results showed that stored seeds effectively modified the physicochemical properties of the purified water. The protein extracts were effective in reducing turbidity, total suspended solids and total hardness. On the other hand, total dissolved solids and conductivity were significantly increased while the pH of the water was essentially unaffected.

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