EFFECTS OF SHELF LIFE OF EXTRACTS FROM *Moringa oleifera, Hibiscus sabdariffa* AND *Hibiscus esculentus* SEEDS ON REMOVAL OF WATER TURBIDITY

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Abstract: The study examined the effects of shelf life and efficiency of the extracts of *Moringa oleifera*, *Hibiscus sabdariffa* and *Hibiscus esculentus* seeds on removal of water turbidity. Two different methods of seeds storage were investigated. One part of each seed was placed in a clay pot and covered which was labelled as "N" while the other part was placed in polythene bags of 700 gauges and placed in a clay pot and covered which was labelled as "P". The seeds were subjected to ethanol extraction each month for six consecutive months based on soxhlet method using soxhlet solvent extractor. The coagulation activities of the seeds extracts were conducted using the jar test experiment. The extracts of the stored seeds at varying dosages of 30, 40, 50, 60, 70 and 80 mg/l were used on pond water having turbidity strengths ranging from 343-385 NTU. The results revealed that the efficiencies of turbidity removal of all the seeds extracts decreased as storage time increased. Higher values of turbidity removal were associated with storage method "P". The shelf life of the turbidity removal was insignificant for *Moringa oleifera* seeds extract and significant for *Hibiscus sabdariffa* and *Hibiscus esculentus* seeds extracts. The use of polythene bag and clay pot for seeds storage among rural dwellers especially when the seeds are being considered for water treatment and storage duration of up to six months should be encouraged.

Keywords: Turbidity, seeds, extracts, storage, clay, pot, polythene bag

Introduction

In developing countries, in which Nigeria belongs, water is mostly collected from surface sources by rural communities which rarely meet quality standard for consumption, warranting the need for treatment (Kihampa *et al*., 2011). The conventional water treatment process that basically involves the use of inorganic chemicals, synthetic organic polymers and chlorine as coagulants and disinfectants are associated with various health problems and environmental effects (Marina *et al*., 2005). The availability of these chemicals which depends on foreign exchange for importation and adequate supply is also a problem (Khodapanah *et al*., 2013). The use of natural coagulants is gaining attention and acceptability over chemical coagulants. Several authors have documented the successful use of plant extracts in coagulation. Naturally derived coagulation materials compete against propriety coagulants (aluminiumsulphate, ferric chloride, polyelectrolyte, etc.) on technical, economic and health terms (Awolola *et al*., 2010). Al-Samawi and Shokralla (1996) reported that when *Hibiscus esculentus* was used as primary coagulant or coagulant aid, 50-90% of alum requirement for same purpose could be saved. Nkhata (2009) reported that *Moringa oleifera* could achieve turbidity removal of between 92-95%. Yongabi *et al*. (2010) also reported that *Moringa oleifera* seed coagulated well above 90% of particles in a water sample leading to a clear supernatant. The water extract of *Hibiscus esculentus* fruits has been efficiently used as a lubricant, and to stabilized foams. It is traditionally used in culinary application as a thickener of soup such as gumbo soup (Carla *et al*., 2011). The use of the powders of the calyx of *Hibiscus sabdariffa* has shown both coagulative as well as disinfective effect (Yongabi *et al*., 2010).

Controlled storage of seeds is very essential especially in tropical and subtropical conditions to maintain high viability of seeds for longer periods (Nagaveni, 2005). Seeds deterioration during storage is due to the damage to membrane (Roberts, 1972). Enzyme, protein and nucleic acid accumulates with time, which are evidence of degenerative changes resulting in complete disorganization of membrane and cell organelles and ultimately cause the death of the seeds (Roberts, 1972). Seeds stored in ambient condition, loose their viability and vigor very fast due to changes in environmental condition such as temperature and relative humidity (Roberts, 1972). Nakagawa *et al.* (1991) reported that *Hibiscus esculentus* seeds quality was better after storage period of 24 months under ambient condition as compared to dry chamber storage.

The extent of storability is influenced by the type of packaging materials. In general, seeds stored in moisture impervious sealed containers provide suitable environment for storage, offer protection against contaminants and also act as barriers against the escape of seed moisture (Nagaveni, 2005). Sexana (1994) concluded that polythene bags of 700 gauges could be used for long term storage of various vegetable seeds like onion, tomato, okra and cabbage. Among different containers, polythene bag was promising since it is effective in preserving seed viability to about 81% (Doijode, 1988).

The foregoing discussion indicates that the use of *Moringa oleifera*, *Hibiscus esculentus* and *Hibiscus sabdariffa* seeds extracts in water treatment should be explored. The study examines the effects of shelf life on the turbidity removal of the crude extracts of these plant seeds under two different storage conditions. To our knowledge, there are no systematic published studies on the effects of the shelf life of these seeds extracts on their performances in turbidity removal of high turbid water.

Materials and Methods

Collection and storage of plant materials

The seeds of *Hibiscus esculentus*, *Hibiscus sabdariffa* and *Moringa oleifera* were collected from a vegetable garden in Kayamla village on the outskirt of Maiduguri, Borno State, Nigeria. The pods were allowed to dry on the plants before they were plugged. The pods were threshed manually to obtain the seeds. About 3250 g of each seed was used in the study. 250 g of each of the three seeds was used for the ethanol extraction in the first month. The remaining 3000 g of each seed was then divided into two equal parts, giving six separate seeds for storage. One part of each seed was placed in a clay pot and covered which was labelled as "N" while the other part was placed in a polythene bag of 700 gauge and covered inside a covered clay pot and labelled as "P". The contents of the clay pots were subjected to the ethanol extractions once in every month for six consecutive months.

Preparation of seeds extracts

The extraction process was conducted based on soxhlet method using soxhlet solvent extractor. About 3250 g of each seed was used for the extraction process. One litre of ethanol was added to the seeds in the solvent extractor to which was fitted a condenser and the heating mantle on the extractor was switched on and allowed to extract for 4 h. The solution was removed, cooled and filtered using filter paper to remove debris. The extracts were evaporated to dryness on rotary evaporator.

Source of raw water

The raw water samples having turbidity strengths ranging from 343-385 NTU were collected from a barrow pit in ModuSulumri village, Maiduguri, Borno State, Nigeria (Sa'ad, 2015). The water samples were collected in the middle of the borrow pit by immersing a plastic container completely until it was full. The samples were collected monthly for seven consecutive months and a laboratory test was carried out each month the sample was collected.

Coagulation tests

The coagulation activities of the plant seeds extracts on high turbid water (343-385 NTU) were evaluated using the jar test experiment of Phipps and Birds fitted with six (1000 ml) beakers. The jar test is a widely used method to evaluate coagulation – flocculation processes (Kawamura, 1991). The tests were carried out at varying dosages of 30, 40, 50, 60, 70 and 80 mg/l of the seeds extracts. The experiment was repeated for each of the stored three seeds.

Results and Discussions

Figure 1a shows the percentage of turbidity removal for the three seeds extractswith respect to time of six months for storage methods "N". From the figure, the turbidity removal of the seeds extracts for *Moringa oleifera* varied from 99.7% to 97.3% with model equation of y = 0.448x + 99.99 and a linear relationship ($R^2 = 0.938$) between the turbidity removal efficiency and storage period was obtained. This is in agreement with Katayon *et al*. (2006) which stated that efficiency of *Moringa oleifera* seeds extract decreased as storage duration increased. *Hibiscus sabdariffa* ability to remove turbidity dropped from 17.5% to 10.8% with R^2 of 0.902 while *Hibiscus esculentus* recorded a drop of turbidity removal of 38.6% to 31% over the same period with R^2 of 0.977.

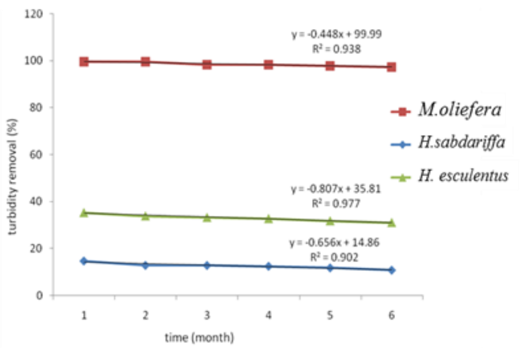

Fig. 1a: Percentage removal of turbidity for *Moringa oleifera*, *Hibiscus sabdariffa* and *Hibiscus esculentus* seeds extracts with respect to time for storage method "N"

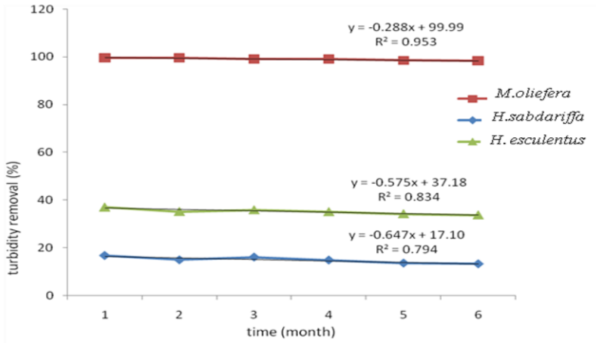

Fig. 1b: Percentage removal of turbidity for *Moringa oleifera*, *Hibiscus sabdariffa* and *Hibiscus esculentus* seeds extracts with respect to time for storage method "P"

Figure 1b shows the percentage of turbidity removal for the three seeds extractswith respect to time for storage methods "P" with *Moringa oleifera* showing a reduction from 99.7% to 98.3% over the six months storage period with R^2 of 0.953. *Hibiscus sabdariffa* and *Hibiscus esculentus* efficiencies of turbidity removal were reduced by 27.7% and 12.6% with R^2 of 0.794 and 0.834 respectively over the same period. Generally, higher values of turbidity removal efficiencies are associated with storage method "P". This can be attributed to the nature of the storage method "P" which is moisture impervious and is in agreement with Nagaveni (2005) who reported that seeds stored in moisture impervious sealed containers provides suitable environment for storage and offer protection against escape of seed moisture as earlier confirmed by Doijode (1988), that polythene bag preserve seed viability by 81%.

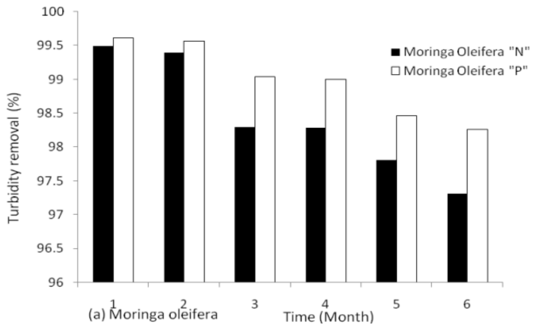

Fig. 2a: Percentage removal of turbidity for *Moringa oleifera* seeds extracts with respect to storage methods "N" and "P".

Figure 2a illustrates the effects of the two storage methods on turbidity removal by the *Moringa oleifera* seeds extracts. The differences in the turbidity removal efficiencies between the two storage methods in the first and the sixth months were 0.10% and 1%, respectively. The turbidity removal efficiency of *Hibiscus sabdariffa* is also affected by the storage methods (Fig. 2b). The turbidity removal is reduced by 18.05 between the two storage methods after six months. However, storage method "P" indicates a promising result as earlier confirmed by Doijode (1988), that polythene bag preserve seed viability by 81%.

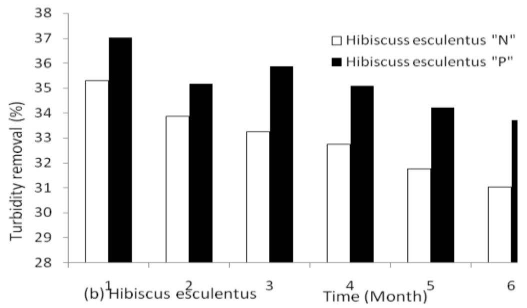

Fig. 2b: Percentage removal of turbidity for *Hibiscus sabdariffa* seeds extracts with respect to storage methods "N" and "P".

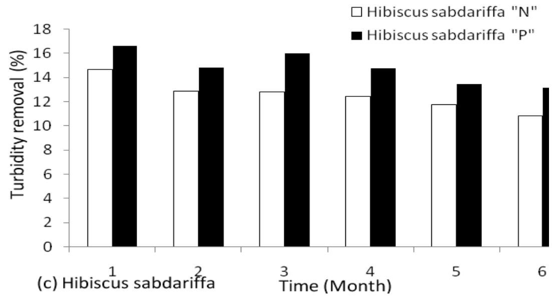

Fig. 2c: Percentage removal of turbidity for *Hibiscus esculentus* seeds extracts with respect to storage methods "N" and "P".

The turbidity removal of *Hibiscus esculentus* is also affected by the storage methods as indicated in Fig. 2c. The turbidity removal difference between 1 and 6 months increased from 1.7% to 2.7% respectively and indicates a loss of viability of the seeds as a result of storage method and duration. This is in agreement with Doijode (1987) that *Hibiscus esculentus* seeds maintained viability up to 2 years when stored in polythene bag under ambient temperature.

Table 1: One-way analysis of variance for turbidity removal of the seeds extracts and storage method

Source of variation	SS	DF	MS	Calculated F- value	Tabulated F-value	Remarks
			Moringa oleifera			
Storage method	0.9408	1	0.9408	1.780615	4.964603	Insignificant
Months	5.283567	10	0.528357			
Total	6.224367	11				
			Hibiscus sabdarifa			
Source of variation	SS	DF	MS	F_{value}	F_{crit}	Remarks
Storage method	15.43601	1	15.43601	8.784326	4.964663	Significant
Months	5.283567	10	0.528357			
Total	6.224367	11				
			Hibiscus esculentus			
Source of variation	SS	DF	MS	F_{value}	$F_{crit.}$	Remarks
Storage method	14.23541	1	14.23541	7.644233	4.964603	Significant
Months	18.62242	10	1.862242			
Total	32.85783	11				

The results of the one-way analysis of variance (ANOVA) for turbidity removal of the seeds extracts for the two storage methods are shown on Table 1. The calculated F-value of 1.78 for *Moringa oleifera* is less than the tabulated F-value of 4.96 at $P \leq 0.05$ level of significance. The implication is that the difference in the two methods of storage as regards to *Moringa oleifera* is insignificant. The calculated F-values of *Hibiscus sabdariffa* and *Hibiscus esculentus* seeds extracts were found to be 8.78 and 7.64 respectively which were both greater than the tabulated F-values. This means that the difference in the two methods of storage as regards to these seeds extracts were statistically significant.

Conclusion

The effect of shelf life on turbidity removal with respect to the two storage methods was insignificant for *Moringa oleifera* seeds extract while it was statistically significant for *Hibiscus sabdariffa* and *Hibiscus esculentus* seeds extract. *Moringa oleifera* has the best turbidity property. The efficiency of turbidity removal of the three seeds extracts decreased as storage duration increased. Storage method "P" tends to have preserved the initial properties of the seeds than those in clay pot without polythene bag, hence it was considered to be the best method of storage.Therefore, it is recommended that the use of polythene bag and clay pot for seeds storage be propagated among rural dwellers especially when the seeds are being considered for water treatment and storage duration of up to six months. It is also recommended that the use of indigenous plant material in water treatment should be explored by further diversifying their potentials towards treating some common chemical contaminants in surface water like potassium, phosphorus and other related compounds.

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