Research Journal of Recent Sciences _____ ISSN 2277-2502
Vol. **5(1),** 9-15, January **(2016)** *Res.J.Recent Sci.*

Evaluation of *Aloe vera* leaf gel as a Natural Flocculant: Phytochemical Screening and Turbidity removal Trials of water by Coagulation flocculation

Nougbode Yéwêgnon Alima Esther Irma[1,2], Sessou Philippe[2], Alassane Abdoukarim[1], Youssao Abdou Karim Alassane[2], Agbangnan Cokou Pascal [2], Mama Daouda[1] and Sohounhloue Koko Codjo Dominique[2]
[1]Laboratoire d'Hydrologie Appliquée (LHA), Faculté des Sciences et Techniques, Université d'Abomey Calavi, Cotonou, BENIN
[2]Laboratoire d'Etude et de Recherche en Chimie Appliquée (LERCA), Ecole Polytechnique d'Abomey Calavi(EPAC), Université d'Abomey-Calavi, Cotono, BENIN
ksohoun@bj.refer.org

Available online at: www.isca.in, www.isca.me
Received 25th June 2014, revised 30th December 2014, accepted 2nd May 2015

Abstract

This study focused on the evaluation as natural flocculant in water clarification and identification of major phytochemical groups of Aloe vera, a plant which belongs to Liliaceae family. Phytochemical groups such tannins, saponins, mucilage, flavonoids, anthracene derivatives, quinone derivatives and proteins were identified. However, they were devoid of alkaloids, reducing compounds, cardiotonic glycosides in this plant. The results obtained for determined Aloe vera constituent materials showed a high rate of organic matter in this plant (81.05% of dry matter) and low levels of dry matter and ash (respectively 4.2% of fresh matter and 12.04% of dry matter). The clarification tests using this plant for very turbid surface water (turbidity: 185-200 NTU, Suspended solids: 160-170, Obvious color: 275-285 Pt Co), showed a good elimination of turbidity and suspended solids. Removal efficiency was 72% for turbidity, 91% for suspended solids and 15% for the obvious color. Aloe vera can be promoted as a good natural floculant in surface water clarification.

Keywords: Phytochemical Screening, *Aloe vera*, natural flocculant, turbidity, suspended solids, ash content.

Introduction

Water is a precious and essential natural resource, unevenly distributed on our planet. Freshwater represents only 2.5% of global supplies of water. About 70% of this freshwater quantity are either trapped under ice caps, or disseminated in the form of humidity or steam. Less than 1% of the world's freshwater, about 0.007% of planet's waters, is easily accessible to the various uses for development[1].

In a century, the world population has tripled and is expected to increase by 50% over the next fifty years; irrigated areas were multiplied by six and the consumption of water by seven.

This high consumption resulted in a decrease to one-third in the amount of water available in the last twenty-five years[2]. Meanwhile the quality of available water deteriorates year by year. Pollution has increased alarmingly, in both developed countries (groundwater severely threatened by industrial and agricultural waste) and poor countries (domestic or agricultural waste in aqueous medium without treatment, poor waste management) [3]. This qualitative and quantitative degradation of water resources becomes a big problem in the water sector especially for developing countries. According to the 4th UN-UNESCO report on water, Africa remains the continent with limited access to quality water resources despite its vast potential [4].

In Benin, the population is estimated at more than eight millions with a daily increasing water demand, which is far from being satisfied. In 2010, 63.6% of the populations have access to improved source of drinking water; this shows that over a third of the population has no access to drinking water. So there are still many problems that prevent access to safe drinking water to the greatest number.

In the field of water, our country is faced with two mains and majors problems which are: quantity and quality of the drinking water and evacuation of sewage or waste water. Also, water treatment is very expensive for developing countries and requires the use of synthetic products which are not without impact on consumer health[5].

The use of natural resources in the process of water treatment, thus constitutes a potential promising ways to reduce on one hand, the high costs and environmental impacts due to the use of synthetic products used previously, and secondly allow as many people as possible access to drinking water. This will constitute therefore a major economic issue for developing countries. Many resources are already experienced, like Moringa seeds. The aqueous extracts of these seeds allow clarifying the water with a very good removal efficiency of turbidity and some metals[6-11].

The *Plantago ovota* can be used to improve the lowering of turbidity by the chemical coagulants, the peels of *Lablab*

purpureus may also be used in the treatment of water with a yield of 77% for turbidity[12,13]. Date's seeds are also used in water treatment with better removal efficiency of turbidity[14].

The use of an extract organic flocculant of Moroccan cactus has enabled significant reduction in turbidity and the removal of metals such as chromium (VI), chromium, copper in industrial discharges[15,16]. Opuntia dillenii is also natural coagulant and its successive addition and the lime, gave a better elimination of turbidity, suspended solids and color for highly turbid surface water treatment[17].

In view of what precedes and in order to expand the range of naturals floculants used in water clarification for the limitation of environmental and economic problems caused by use of synthetic products, we chose to test *Aloe vera* gel. This plant is a succulent plant in Liliacea family, consisting of 99% water and the remaining 1% representing more than 75 of other ingredients that gives to this plant many useful health properties : anti diabetic, anti-inflammatory, anti carcinogenic, anti microbial, dermatological, nutritional, cosmetic, digestive[18-22].

The objective of this study was therefore firstly, to identify initially large phytochemicals groups and some chemical parameters of this plant and to show that this plant can be used like a flocculant to reduce surface water turbidity.

Material and Methods

Aloe vera: *Aloe vera* was harvested in a private garden in Republic of Benin in the town of Calavi. The leaves are washed with distilled water; gel is recovered into a part of the fresh leaves. The other part was dried at the ambient temperature in the laboratory for two weeks and then reduced to powder for phytochemicals analyses.

Preparation of Aloe vera gel aqueous solution: 50 mL of gel were introduced into 500 mL of distilled water and stirred using a magnetic stirrer, then strained through a sieve of 25 mm mesh. The filtrate collected was stored in refrigerator until the use which not exceeding one week.

Material of laboratory: The pH, temperature, conductivity, were measured using a pH metre/conductimeter of mark WTW 340i.The measurement of turbidity was taken by a portable Turbidimeter TURBIQUANT 1100 IR. The color and the suspended solids were measured using a Colorimeter HACH DR/890. A drying oven BINDER and a furnace MEMMERT were used respectively for the desiccation and the mineralisation of the samples. The tests of coagulation and flocculation were carried out using a floculator LOVIBOND with six stations. Preliminary Phytochemical Screening The phytochamical screening was based on the colouring and/or precipitation reactions of the chemical compounds contained in the plants according to the standards methods described by several authors and summaries in the table-1 [22-24].

Other chemical characteristics The content of dry matters expressed in percentage (%) of fresh matters, was determined by desiccation of the samples in a drying oven with 105°C. 50g fresh matters were used for this analysis.

Total organic matter was determined by incineration method LOI. 5g samples of solids were placed at 375°C in an oven for 16 hours. The ash content, expressed as percentage (%) of dry matter, is obtained by digestion at 550°C for 5 hours with a plateau at 200 °C until disappearance of the smoke. 2 g of solids previously comminuted in this study[25,26].

Jar test Experiments (test of coagulation-flocculation): Raw water use for this test was drawn from the Nokoué Lake at the lagoon in Abomey Calavi town in Benin Republic. This water was a receptacle of all kinds of discharges due to intense human activity.

The coagulation-flocculation was performed according to the protocol of "Jar Test"[6,17]. Increasing doses of *Aloe vera* were introduced in 1000 mL of raw water. After settling time, 100 mL of the supernatant were collected in the average of 2 and 3cm from the surface using a pipette and subjected to the same physico-chemical analyzes of the raw water. The removal efficiency of the analyzed parameters was determined by the formula below:

Removal parameter in percentage = $100 * (C_i - C_f)/ C_i$

Where: C_i represents the concentration of the parameter in the raw water. C_f represents the concentration of the same parameter in the treated water.

Results and Discussion

Results of phytochemical analysis: The results for the phytochemical screening carried out on the powder obtained from dried *Aloe vera* leaves, are shown in Table-1. From these results, it appears that tannins, saponins, mucilage, flavonoids, quinone derivatives and proteins are identified in this plant. These results are similar to those obtained by Arunkumar and Muthuselvan in 2009 and Mariappan and Shanthi in 2012 for the same plant harvested in India, except the mucilage and proteins they have not defined[19,22]. However in our results, they were devoid of reducing compounds, alkaloids and cardiac glycosides. These results are comparable to those of Andima in 2014 who used *Aloe vera* harvested in Uganda and also those of Mariappan in 2012, but they have revealed the presence of glycosides in contrast to the absence of cardiac glycosides obtained during our work[22,27]. Our findings are also similar to those of Yebpella in 2011 and Andima in 2014 except that the alkaloids have been identified in their work in contrast to our results[27,28]. This may be as of result of the methods used. This hypothesis is confirmed by the work of Medha in 2011, in which three different reagents were used to determine the parameter in the same plant and this leads to different results: a

low presence of alkaloids with Mayer's reagent, an absence of alkaloids with Wagner's reagent and an average presence of alkaloids with Dragndroff's reagent[29]. It appears from the analysis of the results that the use of several methods is necessary for the phytochemical screening to compare different determined parameters.

Determined Aloe vera constituent materials: Test results of dry matter, organic matter and ash content performed on Aloe vera are shown in Table-2

These results showed that *Aloe vera* is rich in water (95.6%). The results obtained for organic matter are similar to those obtained for the acid casein extracted from coconut cream, but lower than those obtained for the *Moringua oleifera*, all of them are used as flocculent plants in water clarification[30]. The high rate of organic matter in *Aloe vera* can lead to the presence of dissolved organic matter in the treated water if compared to the use of acid casein, but this rate would be higher in the treated water by *Moringa oleifera*.

As regards the mineral materials, the results obtained for the *Aloe vera* showed that water treated with *Aloe vera* will be more mineralized than water treated by *Moringa oleifera* which has a lower content of mineral substances[30].

Physico-chemical parameters of raw surface water and water treated by the *Aloe vera* gel: The results of physicochemical analyze of surface water before and after treatment with *Aloe vera* gel are shown in Table-3. It is clear from this analysis that the water is turbid, highly mineralized and rich in suspended solids. The treatment of this water with *Aloe vera* reduce significantly turbidity and suspended solids, on the other hand there is a very small decrease in the apparent color. We can therefore conclude that *Aloe vera* does not eliminate organic matter responsible for the color of the water.

Table-1
Identification of the major phytochemical groups in *Aloe vera*

Large groups	methods and / or reagents used	*Aloe vera*
Alkaloids	Réactif de Meyer, Réactif de Bouchardat	(-)
Tannins	Ferric chloride test	(+)
Flavonoïds	soda test and ferric chloride test	(+)
saponins	Foam test	(+)
Mucilages	Test with absolute ether	(+)
reducing compounds	Fehling's test	(-)
quinone derivatives	Borntraeger's reagent	(+)
cardiac glycosides	Liebermann-Buchard's test	(-)
Proteins	Biuret's test	(+)

(-): No, (+): Presence

Table -2
Constituent materials of *Aloe vera*

Parameters analyzed	Results
Dry matter	4.2 % of fresh matter
Organic matter	81.05% of dry matter
Ash	12.04% of dry matter

Table -3
Results of physico-chemical analysis of water before and after treatment with *Aloe vera*

Parameters analyzed	raw water	Water treated with 5 ml Aloe vera 10%
pH	7.37	7.30
Temperature (°C)	26.7	27.2
Conductivity (µS/cm)	29000	28800
Turbidity (NTU)	186.8	52
suspended solids(mg/L)	163	15
apparent color (Pt/Co)	278	236

Results of essay of Jar Test:

pH and conductivity evolution depending on the quantity of *Aloe vera* added: Figures-1 and 2 show respectively the pH and the conductivity evolution of the treated water according to the quantity of *Aloe vera* added to raw water. There was a slight decrease in pH after water treatment with this natural flocculent. Indeed, the pH decreases from 7.4 to 7.1 to the raw water for the water treated with 30 mL of *Aloe vera*. This decrease shows that *Aloe vera* solution is acidic. The same observations are made with regard to the conductivity of the treated water. Indeed, the conductivity of the treated water decreases gradually according to the quantity of *Aloe vera* added to the raw water. The conductivity decreases as the volume of *Aloe vera* increases. This initial value 29000µ S/cm reached 28100 µ S/cm when the quantity of added *Aloe vera* is 30 mL. We can therefore deduce that *Aloe vera* solution can reduce water conductivity and, consequently remove other ions from water.

- Charts of pH depending on the amount of *Aloe vera* added

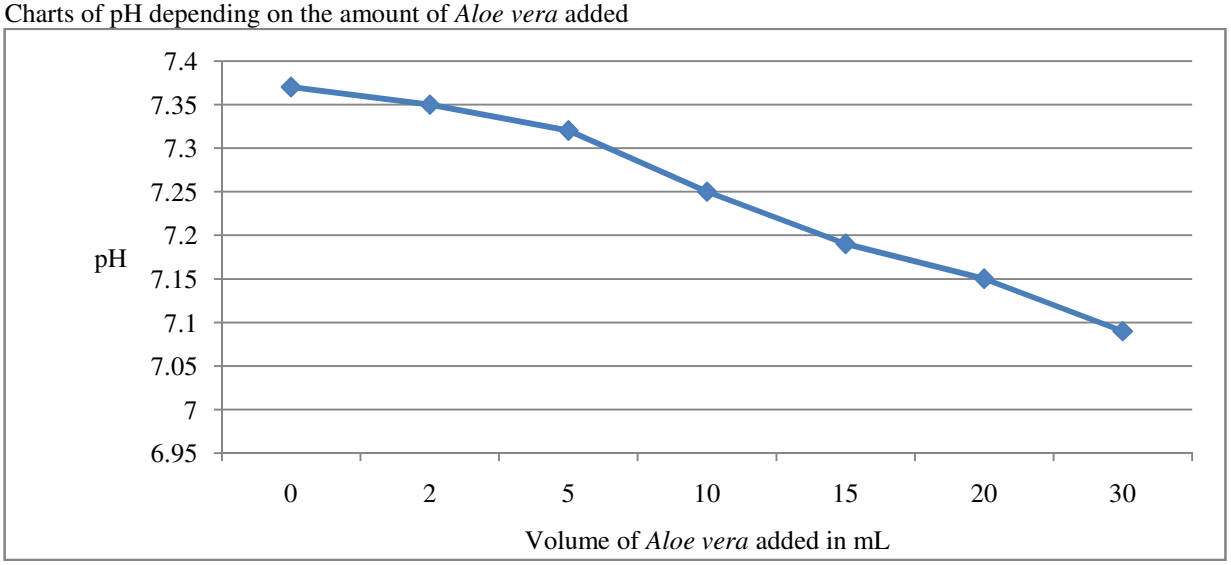

Figure -1
Evolution of the pH of the water treated according to the dose (ml) of flocculant added

- Evolution of conductivity depending on the amount of *Aloe vera* added

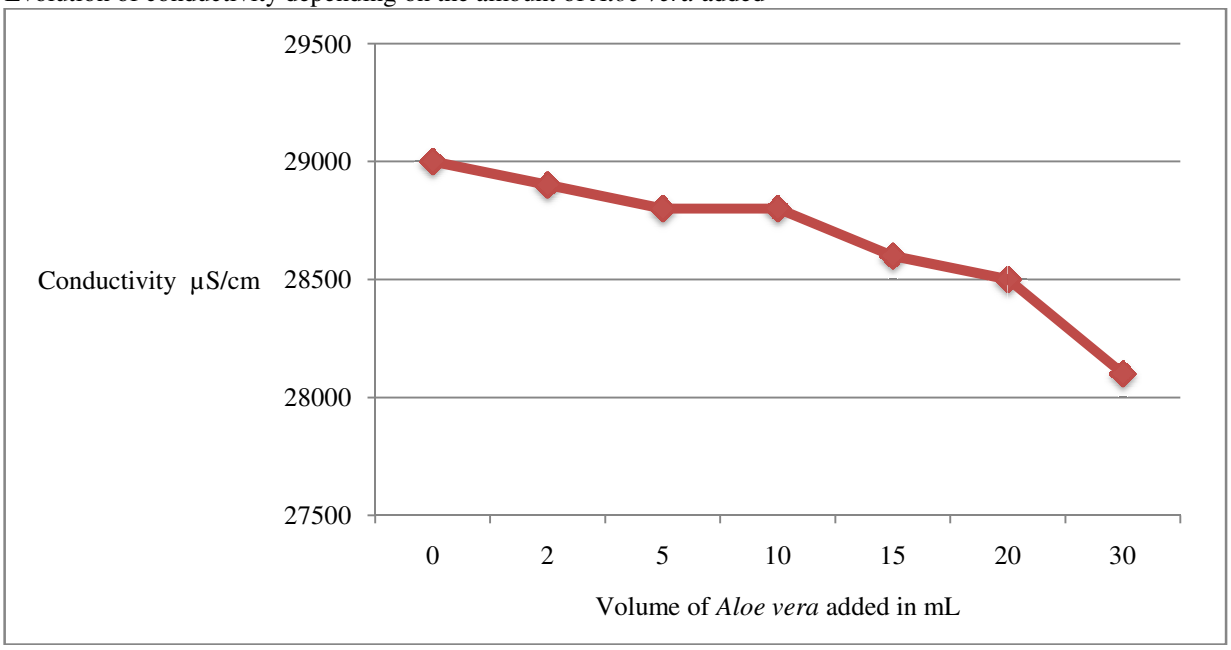

Figure -2
Evolution of the conductivity of the water depending on the volume (mL) of *Aloe vera* added

Figure-3 shows the relationship between the volumes of *Aloe vera* used and the removal of turbidity, suspended solids and the abvious color of the water. Throughout the results, it appears that for optimal doses, the percentage of removal of turbidity

was 72%, this percentage reaches 91% for the suspended solids, but is low for the abvious color (15%). Abvious color removal decreases when the *Aloe vera* dose increases. As the color removal output is very low compared to the turbidity removal output and suspended substances, we can deduce that *Aloe vera* can eliminate much more suspended particles than particles in colloidal state. *Aloe vera* can therefore be used as a natural flocculent in water treatment. The flocculating activity of this plant is similar to the one of *Plantago ovota* but less than that of *Moringa oleifera*[6, 12].

The results are similar to those of Shilpa and Al Sameraiy respectively using the peels of *Lablab purpureus* and seeds of dates in water clarification[13,14].

The implementation of this study, allowed demonstrating the positive effects of *Aloe vera* gel in the clarification treatment of the water highly loaded with suspended solids. We can therefore conclude that *Aloe vera* can be used as a natural flocculant in water treatment.

Conclusion

At the end of our study, *Aloe vera* can be used as natural flocculant for water treatment. It was also found that the use of this plant even in low doses can rid the highly charged water of their suspended materials therefore their turbidity. For optimal doses, the percentages of reduction are high, 72% for turbidity and 91% for suspended matter, but this reduction is low for the apparent color. The use of *Aloe vera*, whose pharmacological properties have already been demonstrated, would be a possible alternative to chemical flocculants for the same treatment of drinking water in rural areas, only that it could increase the organic matter in the water account given its high levels in this element (approximately 81.05% organic matter).

Prospects will therefore be considered regarding the extraction and identification of elements responsible for this flocculation.

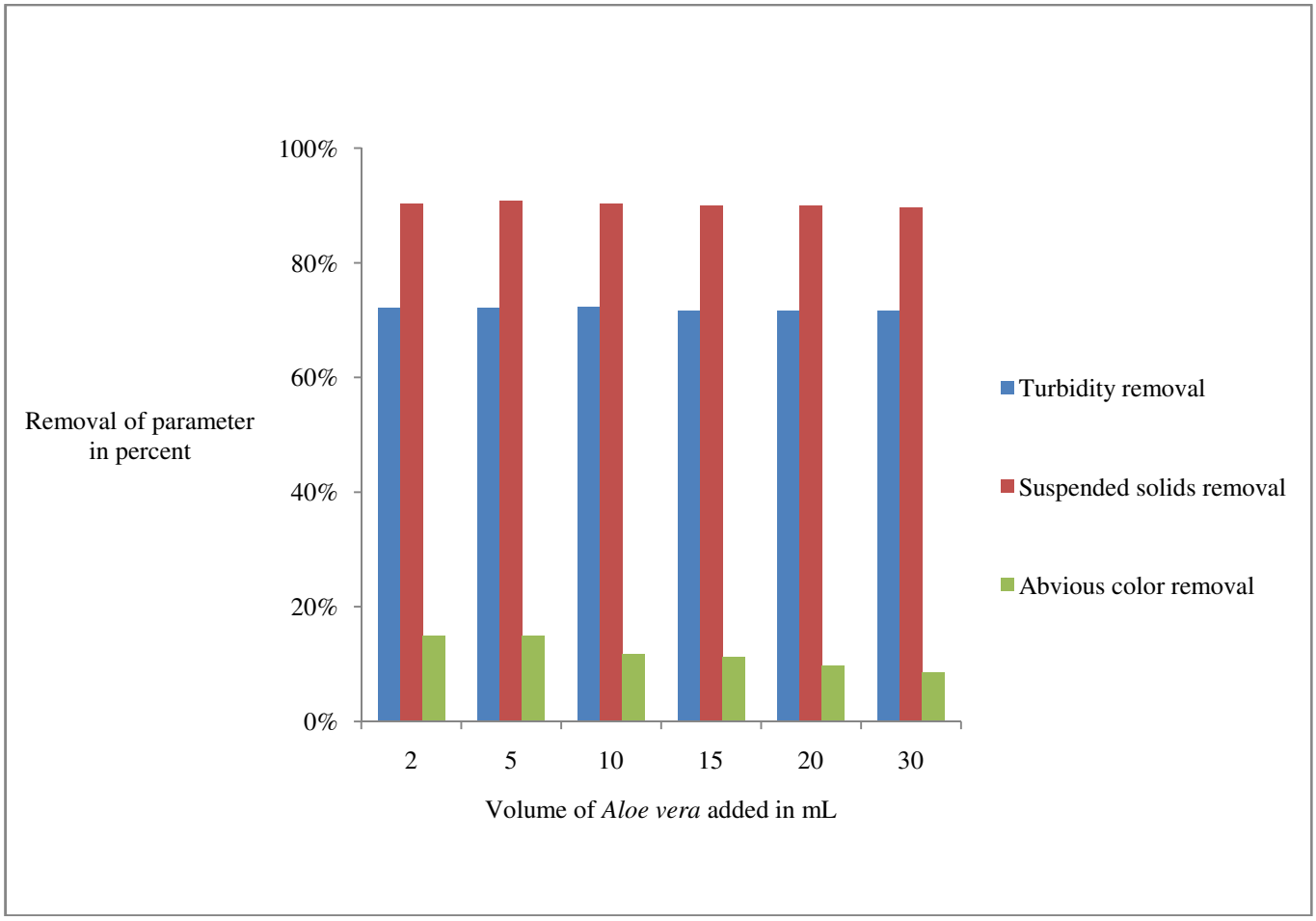

Figure-3
Reduction of turbidity, suspended solids and the apparent color of the treated water in the volume (mL) of the *Aloe vera* solution added

References

1. National Water Policy in Benin (2008). Branch water in Benin.

2. Young African Economy April (2003). 349.

3. Karima K., Khalid E., Wafae Belokda, Blaid B. and Mohammed L. (2012). Modélisation écologique des lacs, 1st International Colloquium REZAS12, Beni Mellal (Morocco), 14-16.

4. Kabbaj et Camdessus (2005). Article de Monsieur Camdessus pour le monde du 11 avril 2005, De l'eau potable pour les africains.

5. Altaher H. and Alghamdi A. (2011). Enhancement of Quality of Secondary Industrial Wastewater Effluent by coagulation Process: A Case Study, *Journal of Environmental Protection*, 2, 1250-1256.

6. Fatombi J.K., Josse M.G., Wotto V. and Aminou T. (2007). Paramètres physico-chimiques de l'Eau d'Okpara traitée par les graines de Moringa Oleifera, *Journal SOACHIM* 23, 75-79.

7. Bawa M.l., Djaneye-boundjou G., Soulémane A.G. and Kpékpassi I. (2008). Etude de la clarification d'une eau de surface par une substance naturelle (les extraits aqueux des graines de Moringa Oleifera LAM) : influence sur la demande en chlore, *Physical and Chemical news,* 42, 133-138.

8. Ali E.N., Muyibi S.A., Salleh H.M., Alam Md Z. and Salleh M.R.M. (2010). Production of Natural Coagulant from Moringa Oleifera Seed for Application in Treatment of Low Turbidity Water, *J. Water Resource and Protection*, 2, 259-266.

9. Raj K.R., Kardam A., Arora J.K., Srivastava M.M. and Srivastava S. (2010). Neural Network Modeling for Ni(II) Removal from Aqueous System Using Shelled *Moringa Oleifera* Seed Powder as an Agricultural Waste*, J. Water Resource and Protection*, 2, 331-338.

10. Menkiti M.C and Onukwuli O.D. (2010). Coag-Flocculation of Moringa Oleifera Coagulant (MOC) in Brewery Effluent: Nephelometric Approach, *Journal of American Science*, 6(12), 788-806.

11. M.C Menkiti, C.I. Nwoye, C.A. Onyechi and O.D. Onukwuli (2011). Factorial Optimization and Kinetics of Coal Washery Effluent Coag-Flocculation by Moringa Oleifera Seed Biomass, *Advances Chemical Engineering and Science*, (1), 125-132.

12. Bidhendi G.N., Shahriari T. and Shahriari Sh. (2009). Plantago Ovata Efficiency in Elimination of Water Turbidity, *J. Water Resource and Protection*, 2, 90-98.

13. Shilpa B.S., Akanksha Kavita and Girish P. (2012). Evaluation of Cactus and Hyacinth Bean Peels as Natural Coagulants, *International Journal of Chemical and Environmental Engineering*, 3(3), 187-191.

14. Mukheled AL-Sameraiy (2012). A Novel Water Pretreatment Approach for Turbidity Removal Using Date Seeds and Pollen Sheath, *J. Water Resource and Protection*, 4, 79-92.

15. Abid A., Zouhri A. and Ider A. et Kholtei S. (2009). Valorisation d'un nouveau bio- floculant extrait de cactus marocain dans le traitement physico-chimique des rejets liquides chargés en cuivre, en zinc et en matières en suspension, *Revue des Energies Renouvelables*, 12(2), 321-330.

16. Abid A., Zouhri A. and Ider A. (2009). Utilisation d'un nouveau bio- floculant extrait de cactus marocain dans le traitement des rejets chargés de chrome(VI) par le procédé de coagulation floculation, *Afrique. Sci.,* 05(3), 25-35.

17. Nougbode Y.A.E.I., Agbangan C.P., Koudoro A.Y., Dèdjiho C.A., Aïna M.P., Mama D. and Sohounhloue D.C. K. (2013). Evaluation of the Opuntia dillenii as natural Coagulant in water Clarification: Case of treatment of Highly Turbid Surface Water, *J. Water Resource and Protection*, 5, 1242-1246.

18. Hamman et Josias H. (2008). Composition and Applications of *Aloe vera* Leaf Gel, *Molecules*, 13(8), 1599-1616.

19. Arunkumar S. and Muthuselvam M. (2009). Analysis of phytochemical Constituents and Antimicrobial Activities of *Aloe vera* L. Against clinical Pathogens, *World Journal of Agricultural Sciences*, 5(5), 572-576.

20. Sathyaprabha G., Kumaravel S., Ruffina D. and Praveenkumar P. (2010). A comparative study on antioxidant, proximate analysis, antimicrobial activity and phytochemical analysis of Aloe vera and Cissus quadrangularis by GC-MS, *J. Pharm. Res*., 3, 2970-2973

21. Sergio Mazzulla, Settimio Sesti, Anita Schella, Ida Perrotta, Adelaide Anile and Saverio Drogo (2012). Protective Effect Of Aloe vera (Aloe Barbadensis Miller) on Erythrocytes Anion Transporter And Oxidative Change, *Food and Nutrition Sciences*, 3, 1697-1702.

22. Mariappan V. and Shanthi G. (2012). Antimicrobial and phytochemical analysis of Aloe vera L, *International Research Journal of Pharmacy*, 3(10), 158-161.

23. Bagre I., Bahi C., Gnahoue G., Djaman A J., Guede G.F. (2007). Composition phytochimique et evaluation in vitro de l'activité antifongique des extraits des feuilles de MORINDA Morindoides (BAKER) Milne-Redhead(Rubiaceae) sur aspergillus Fumigatus et Candida Albicans, *J. sci. Pharm. Biol*, 8(1), 15-23.

24. Bekro Y.A., Békro J.A M., Boua B.B., Fézan H. Tra Bi[2] et Ehouan E.E. (2007). Etude ethnobotanique et screening phytochimique de Caesalpinia benthamiana (Baill.) Herend. Et Zarucchi (Caesalpiniaceae), *Science et Nature*, 4(2), 217–225.

25. Centre de coopération internationale en recherche agronomique pour le développement (2004). Analyse de Végétau.

26. Centre D'experise En Analyse Environnementale Du Quebec (2012). Détermination des solides totaux et des solides totaux volatils: méthodes gravimétrique MA. 100-ST 1.1 Rév.2 Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs du Québec, 13.

27. Andima M., Ssegujja B., Owor R.O. and Andama E. (2014). Preliminary Qualitative Analysis of phytochemical constituents of the Endemic *Aloe tororoana* Raynolds in Tororo, Eastern Uganda, *Global Advanced Research Journal of Agricultural Science*, 3(3) 096–099.

28. Yebpella G.G., Hammuel C., Adeyemi H. M.M., Magomya A.M., Agbadji A.S. and SHallangwa G.A. (2011). Phytochemical screening and a comparative study of antibacterial activity of *Aloe vera* green rind, gel and leaf pupl extracts, *International Research Journal of Microbiology*, 2(10),382–386.

29. Medha P., Patel P.S. et. and Vyas P.J. (2011). Phytochemical Analysis of *Aloe vera* and Study of Mixing Antibiotic with *Aloe vera* and its Antibacterial Activity, *Asian Journal of Biochemical and Pharmaceutical Research*, 2(1), 473–479.

30. Fatombi K.J., Josse R.O., Mama D. et and Aminou T. (2009). Etude de l'activité floculante de la caséïne acide extraite de la crème de Cocos nucifera dans la clarification des eaux de surface, *Revue des Sciences de l'eau* 22(1), 93-101.