International Journal of
Environmental Sciences & Natural Resources
ISSN: 2572-1119

Research Article
Volume 9 Issue 4 - April 2018
DOI: 10.19080/IJESNR.2018.09.555769

Int J Environ Sci Nat Res

A Low Cost Natural Process of Waste Treatment: Phyto-Treatment of High Bio-Degradable Wastewater of Poultry Processing Industry in Developing Country

Seraj Ahmad[1] and Inamul Haq[2]*

[1]*Environmental Science & Engineering, Department of Civil Engineering, India*

[2]*Department of Biotechnology, Jamia Millia Islamia (JMI), Central University, India*

Submission: March 13, 2018; **Published:** April 04, 2018

***Corresponding author:** Inamul Haq, Department of Biotechnology, Jamia Millia Islamia (JMI), Central University, New Delhi, India, Email: drihaq@yahoo.com

Abstract

Water hyacinth (Eichhorniacrassipes) is a fast growing and worst kind of aquatic plant which has caused adverse socio-economic and environmental impacts. In spite of these problems, it has several benefits in resources conservation and clean-up of contaminated environmental media. Several studies reviewed suggesting that Water Hyacinth (WH) can effectively remove pollutants. Nowadays, particularly in the developing countries, the wastewater including sewage posing serious problems of treatment In the present study water hyacinth is used to treat wastewater containing high biodegradable organics of Poultry Processing Industry (PPI) mostly located in rural areas of India where availability of electricity is a major problem. The treated wastewater quality showed high pollutant removal rate in terms of Biochemical Oxygen Demand (BOD), and other parameters in a defined time. The treated wastewater meets the norms prescribed under Indian Water Pollution Control Act. The BOD removal efficiency was found at 85.5% and 92% in case of WH-1(50% wastewater surface coverage area by WH) and WH-11 (75% wastewater surface coverage area by WH) as compared to control condition without WH. A significant reduction in all the parameters achieved in 4 to 5 days of retention time. The high biodegradation rate of organics is derived by the bacterial actions in two phases - suspended culture (liquid phase) and attached culture-a bio-film on plant roots. The efficacy of the natural process using water hyacinth for treatment of PPI wastewater is discussed in this paper.

Keywords : Water Hyacinth; Phyto-Treatment; Poultry Processing Industry; Biodegradable Organics

Abbreviations : WH: Water Hyacinth; PPI: Poultry Processing Industry; BOD: Biochemical Oxygen Demand; SS: Suspended Solid; TDS: Total Dissolve Solid; RT: Retention Time; TSS: Total Suspended Solid; TS: Total Solid; BOD: Biochemical Oxygen Demand; WW: Waste Water

Introduction

Water hyacinth (WH) has been identified as the world's worst and fast growing water weed, known as "Blue Devil". It reached India in 1902 and spread in other countries in different phases. In India, its massive growth has destroyed many lakes, canals, ponds, and river water bodies. The invasiveness of macrophyte is mainly due to the disposal of excessive nutrients - enriched waters and wastewater from point and non- point sources, such as industrial, massive flow of municipal wastewater, and occasional surface run off from urban, agricultural, deforestation lands into aquatic resources. These sources are responsible to promote growth of aquatic plants species [1-26]. A review on the current status of aquatic weeds in South Africa, their socio-economic and environmental impact has been documented [27]. Water hyacinth as reported adversely impact, the biodiversity of aquatic system, socio-economic conditions due to changes in physic-chemical parameters of water bodies [28-42] and water supply system.

In spite of environmental degradation associated with growth of water hyacinth, this plant has played tremendous positive role as resource conservation like in production of compost, bio-fuel, and environmental management. It has wide acceptance in phyto remediation for clean-up of pollutant's contaminated sites, industrial & municipal wastewater, and groundwater as successful techno-economically feasible option [19, 29]. Treatment of contaminated environmental media by conventional engineering processes is prohibitively expensive. A less expensive and effective waste treatment systems, particularly in developing countries for continuous operation are required as regular supply of electricity in rural areas disrupts frequently. The idea of natural means of waste treatment by using plants, in the presence of sunlight, was developed earlier [43-50] and being practiced now. The concept of phyto–treatment or phyto-remediation is a new emerging cost effective alternative and efficient in-situ non- polluting environmental friendly, solar-driven process adopted to treat wastes for the protection of soil, lake, river ecosystems. Several plant species have been reported which were used to clean- up or treat contaminated environmental media [51-57]. The most commonly used species such as hemp dogbane (*Apocynumcannabinum*), common ragweed (*Ambrosia artemmisiiflia*), Asiatic dayflower (*Commelinacimmunis*), maize (*Zeamays*), Indian mustard (*Brassica juncea*), and Thlasicaerulescens, were shown to have pollutant accumulating and removal potentials. Several reviews have been published dealing with such aspects of pollution control [58,59].

The method of phyto- treatment has been defined by Cunningham and Brite [11] as the use of vascular plants to remove pollutants from the environment or to render them harmless. It was stated that plants can be divided into two types:

a) Sensitive species with varying degree of sensitivities to the detrimental effects of pollution and ultimately succumbing to pollution.

b) Tolerant species which remain viable in their native habitat. The selection of phyto- treating or phyto-remediating species is possibly the single most important factor affecting the extent of pollutant removal. As a general rule, native species preferred to exotic plants which can be invasive and endanger the harmony of the ecosystem.

Despite of several advantages of phyto-treatment, there are some specific draw back also other than those in case of toxic pollutants, for the applicability of such natural methods of treatment. These are: lack of plants species for effective waste treatment, risk to food chain, disposal of contaminated plants wastes, and plant based biological limitation etc. The phyto remediation technology has been applied by various consulting engineering services as a most techno-economic method for treating contaminated wastewater, ground-water, soil, and lakes water etc. [60,61]. Cost estimates of such process for many types of pollutants were reported. The estimates made by USEPA were fraction of the exorbitant cost for treatment of pollutant contaminated areas using engineering methods [62]. In addition to the cost components, natural plant treatment system avoids landscape disruption and pressure on ecosystem.

The one most important concern in the application of phyto remediation is the handling &disposal of plant residue contaminated particularly with toxic pollutants as it falls under the hazardous waste category. This entails an added cost and represents drawback of phyto-treatment. However, to overcome such problems, one option to reduce land filling disposal cost is to reduce its volume by thermal, microbial, or chemical means. The volume of plant residue after incineration is reduced as concentrate (a bio-ore) for recovery metals. These authors showed that the cost of metal recovered from such plant biomass was found to offset the cost of phyto treatment. Such associated costs of treatment, however, may not arise in case of industrial or municipal wastewater containing only biodegradable substrates. In another study, it is reported that plant loaded after absorption of heavy metals provide an opportunity for their extraction, reused, and the left over extracted biomass can be safely disposed in landfill [63].

The beneficial use of water hyacinth for waste treatment has been recently documented. Large quantity of wastes generation and its inadequate treatment and disposal affects adversely human health. This requires protection by suitable treatment to meet the stipulated discharge standards notified by Indian Ministry of Environment and US-EPA. A number of physical chemical and conventional engineering processes were used for the treatment of contaminated media. However, these methods considered expensive, not environment friendly and suitable to eliminate and achieve the discharge standards for pollutants set by environmental regulatory agency. A low cost, efficient natural system has been demonstrated by using aquatic plants specie water hyacinth to achieve desired limit of pollutants. Many research studies were undertaken which suggest the usefulness of water hyacinth as a means of phyto remediation for clean-up of contaminated sites, water quality management, and wastewater. It has been an accepted practice that waste water, after treatment by activated sludge process, is subjected for further treatment through a polishing pond using aquatic plants to achieve stringent wastewater discharged standards.

The water hyacinth over other plants species for treatment of wastewater containing heavy metals and organic substances has shown several advantages. Removal capacity of water hyacinth for heavy metals was carried out and protein profile of the plant was examined for the purpose to assess the metal tolerance level in plant which can be a good idea to use the data as bio-indicator form pollution regulation view point [64]. Using naturally or genetically engineered plant species, removal of small level of pollutants in field and laboratory conditions were successfully carried out [65]. A laboratory and pilot study demonstrated to treat organic matter from wastewater using water hyacinth [66]. Many aquatic plants including Eichhornia have the potential to uptake and absorb heavy metal and other pollutants by their root, stem or leave from soil [16, 56]. Application of water hyacinth in a continuous flow system, studied to develop a kinetic model incorporating the activities of bacteria suspended in wastewater phase and attached on plant roots [48].The findings suggest that organic carbon degradation efficiency is dependent on the biomass of film bacteria, which is determined by the available root surfaces of the water hyacinth. It was found necessary to periodically harvest water hyacinth for proper bacterial [67] for increased removal efficiency BOD, COD and SS. Natural systems are therefore needed to be evolved and commercialized on a large scale. The harvested biomass in such cases will be a potential source of energy recovery, fodder, and compost products which will not pose any adverse impacts on food chain and also if it is land filled. This is true only in case of pollutants highly biodegradable one. This is a potential for of resource recovery & conservation and such system being encouraged in India.

How to cite this article: Seraj A, Inamul H. A Low Cost Natural Process of Waste Treatment: Phyto-Treatment of High Bio-Degradable Wastewater of Poultry Processing Industry in Developing Country. Int J Environ Sci Nat Res. 2018; 9(4): 555769. DOI: 10.19080/IJESNR.2018.09.555769

The treatment of wastewater from most of the industries is based on activated sludge process which requires regular power supply. Considering the local conditions in rural areas, there is a need to study a suitable method of waste treatment based on natural processes. The present study is carried out to treat a high biodegradable organic wastewater from Indian Poultry Processing Industry (PPI) by using Eichhornic Crassipes, a native species of water hyacinth. Poultry Processing Industry (PPI): The poultry processing industry is engaged in slaughtering, dressing & freezing, and packing of broilers and mature chickens. Wastewater from PPI is potential source of nuisance like odour, contains high organic matter, solids, and oil & grease which warrants sustainable management of wastewater.

Methodology

Experimental Set-up and parameter selection

A study was conducted using Eichhornic Crassipes (local name water hyacinth) which has high mineral absorption capacity with rapid growth and can easily be harvested. The liquid waste was collected from a poultry processing industrial (PPI) unit. Water hyacinth was placed in a mixture of 9 liters tap water and 0.6 liter poultry wastewater for acclimatization. After acclimatization period of 10 day, the water hyacinth was used for wastewater treatment. Three glass containers (experimental tanks) were taken and 50 liters of wastewater of PPI was poured in each container. First container was kept as control i.e. without WH. In second container WH was introduced and the leaves of WH covered half of the wastewater surface area (container marked as WH-I). In third container, two third of wastewater surface area was covered by plants leaves (container marked as WH-II). All the containers were kept in full diffused light. The detention time for experiments was kept for 10 days. Triplicate samples of 500 ml from each of the three containers were taken daily for ten days on a fixed time at 11 a.m. The samples were analyzed for pH, Suspended Solid (SS), dissolved solid, Total Dissolve Solid (TDS), BOD, and oil & grease by using the standards. These parameters selected, are the critical one for the industrial wastewater discharge requirements notified under the Water Pollution control Acts in US and Indian water [68]. The experimental setup is shown in (Figure 1).

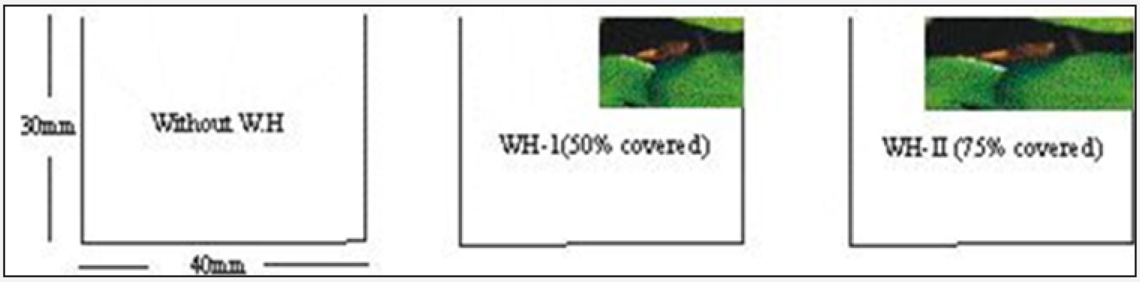

Figure 1: Experimental setup-container's wastewater surface area covered with WH.

Result and Discussion

Characteristics of Waste Water

Analysis results for wastewater collected from PPI showed BOD at 1783 mg/l, TSS 1400 mg/l, TDS 2350 mg/l, and Oil & Grease at 203 mg/l indicating that the wastewater from PPI is a strong organic waste.

Treated Wastewater Quality

Performance results of phyto treated wastewater quality are briefly presented below:

pH and Total Suspended Solid: pH of PPI wastewater showed increase from 7.3 to 9.0 with time and deceases after about 7days of retention time in control condition i.e. without water hyacinth. The fluctuation of pH in this case was relatively higher due to high rate of biodegradation of nitrogenous compounds and release of ammonium ion during the Retention Time (RT). A similar pattern in pH variation was observed in the presence of plant in experimental tanks (container) WH-1 and WH-11 showing pH value with time found to be lowered up to 8.0 after 6-7 of RT and marginally decreased further (Figure 2). It was found relatively more reduction in case of WH-II. The pH reduction follows as: pH of WH-II < WH-I <Control condition. This may be due to the uptake of released NH_4 +/NO_3- by plants from wastewater (in the process of organic decomposition) in two ways, one by bacterial release of NH4+ and its absorption by WH and secondly the bacterial conversion of NH4+ to NO3- (nitrification) by the presence of bacteria in suspension and attached on plant roots.

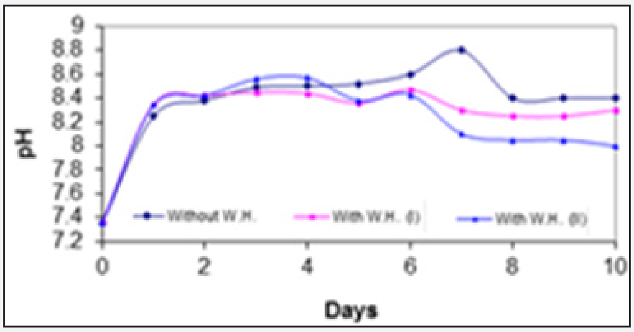

Figure 2: Variation in pH with time.

pH variation relatively exhibited low at normal range in high coverage of wastewater surface area by water hyacinth in the experimental tanks. Such observations were reported by other

How to cite this article: Seraj A, Inamul H. A Low Cost Natural Process of Waste Treatment: Phyto-Treatment of High Bio-Degradable Wastewater of Poultry Processing Industry in Developing Country. Int J Environ Sci Nat Res. 2018; 9(4): 555769. DOI: 10.19080/IJESNR.2018.09.555769

authors in lake system with high WH area density. Therefore on the basis of the pH results of the treated wastewater it can be stated that the WH is found to be a good water and wastewater pH stabilizer as also reported by others. The decrease in water pH by the growth of WH may also be attributed as the resultant of intensive respiration of WH roots releasing CO_2 into the water and relatively low CO_2 uptake in photosynthesis due poor light penetration caused by high SS resulting increased turbidity in the experimental tank's waste water. Both the above factors, i.e., the NH_4+ reductions and CO_2 availability in wastewater resulting stabilization of pH to normal level of liquid discharge standards, are related to WH biological process.

Total Suspended Solid (TSS): In case of Total Suspended Solid (TSS) of initial conc. of raw wastewater at 1440 mg/l, a maximum reduction up to 50% (700 mg/l) and 61% (560 mg/l) were found in wastewater of experimental tank WH 1 and WH I1 after 10 days of RT in comparison with control condition (without plant) having TSS reduction only up to 36 % (920 mg/l) from the initial conc. of 1440 mg/l. However, maximum reduction in TSS was observed in 4 days, of RT i.e. 25%, 44%, and 46% in waste water for control, WH-1, and WH-11 experimental tanks. A variation trend with time in TSS concentration showed a significant statistical coefficient of correlation. The result suggest that in case of 75 % of wastewater surface area coverage by water hyacinth, the TSS concentration was found to less than the wastewater discharge standards (600 mg/l) prescribed for disposal to public sewer. The reduction in TSS may be due the bacterial degradation of organic substances attached with suspended colloidal mass.

Total Solid (TS) and Oil & Grease: The wastewater treatment result using WH showed that after 10 days of RT, the reduction in Total Solid (TS) were 18%, 44.5%, and 50% respectively in case of control, WH-1, and WH-11 conditions. However, a significant reduction in TS occurred after 4-5 days. Variation in TS with time as in other parameters also showed a high degree of coefficient of correlation. Based on TSS and TS value, the total dissolve solid (TDS) found at 2200 mg/l, 1400 mg/l, and 1350 mg/l respectively under control, WH-1, and WH-11 conditions suggesting significant reduction in less than 10 days of RT. The wastewater treatment by natural process showed that the discharge standards for TDS (i.e. 2100 mg/l) is achievable in a short hydraulic RT.The reduction of TS during the growth period of water hyacinth attributed due to the crop root mats which were fully developed and the absorption or filtration capacity of the roots increased for suspended solids along with other nutrients and organics. The oil & grease (o/g) concentration in case of control, was reduced only up-to 35 % after 5 days of RT. However, the same was observed at 55% i.e. 80 mg/l from initial value of 200 mg/l of o/g in both the WH-1 and WH-11 cases. The o/g value is found less than the stipulated standards (100 mg/l) for discharge to public sewer system.

Biochemical Oxygen Demand (BOD): BOD is an important parameter to assess the performance of Waste Water (WW) treatment scheme. In the present study of natural process of wastewater treatment using water hyacinth (WH) showed maximum removal of BOD at 85.5 % and 92 % in case of WH-1(50% surface area coverage of WW by WH) and WH-11(75% surface area coverage of WW by WH) while, in comparison, it was 65% in control condition after 10 day of RT from the initial value of BOD (1800 mg/l of PI- WW). Similar finding was reported in other study which showed high removal efficiency of organic matter by water hyacinth. The high removal efficiency of BOD found in this case is comparable with the activated sludge process of wastewater treatment. A significant reduction in BOD was observed at 60 % in 4 days of RT. The BOD variation with time showed a significant coefficient of correlation (Figure 3).

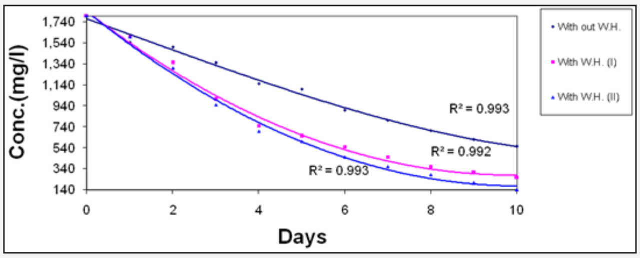

Figure 3 : Reduction in BOD with time.

The BOD remaining in case of WH-11, after 10 days of retention time was found to be 140 mg/l. This value of BOD after PPI WW treatment is much less than the effluents discharge limitation i.e., 500 mg/l, as applicable for land and sewer disposal. It expected in case of municipal wastewater whose BOD value range 150-200 mg/l, the present natural process of treatment can be used to achieve the BOD at 15-20 mg/l which is as per the US-EPA discharge limitation and Indian E(P) Act for treated wastewater .The high BOD removal efficiency is due to symbiotic relationship between bacteria and plant growth which creates aerobic conditions. The biodegradation of organic matter occurs by bacteria in suspension phase as well as attached biomass (bio film) on plant roots. Oxygen produced by the plant is utilized aerobically for the biodegradation of organic matter. Biochemical processes, in aerobic condition created by plant, produce CO_2, and nutrients which are utilized for plant for its growth. The oxygen produce is transferred to the surface of the plant's root mat having bacterial growth that serves as one of the sites for biochemical transformations of organics and thus reduces BOD of wastewater. The natural process of waste treatment is, therefore, a two way combination of organic degradation by bacteria in suspended and attached (bio film) on plant root's mat (Figure 4).This relates to enhanced increase of substrate removal efficiency. The BOD decreased significantly during the growth period of water hyacinth because the crop root mats were fully developed for degradation of organic substances by microbes and absorption of nutrients etc.

How to cite this article: Seraj A, Inamul H. A Low Cost Natural Process of Waste Treatment: Phyto-Treatment of High Bio-Degradable Wastewater of Poultry Processing Industry in Developing Country. Int J Environ Sci Nat Res. 2018; 9(4): 555769. DOI: 10.19080/IJESNR.2018.09.555769

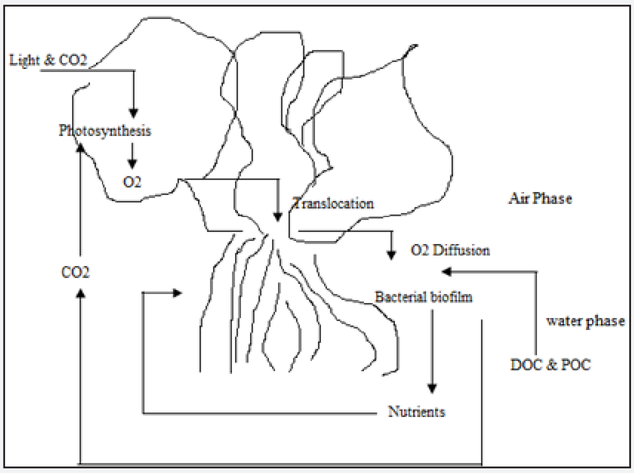

Figure 4 : Wastewater Treatment System: a symbiotic function of water hyacinth and bio film bacteria. (DOC: Dissolved organic carbon; POC: Particulate organic carbon).

The BOD is expected to increase after certain interval due to decomposition of dead plant's organic matter in the experimental tanks (WH-I &WH-II) and release nutrients for growth of water hyacinth. Such step would complicate the treatment process and so water hyacinth should be harvested periodically in order to avoid such situation in treatment efficiency. A similar observation reported that water hyacinth is very efficient to treat wastewater for removal of COD, BOD, and suspended solids. The advantage of natural process for treating waste water containing mainly biodegradable nature of organic matters is that the harvested biomass (used plants) in such case will be free from toxic contaminants and can better be utilized as a good source of energy recovery as CH_4, digested residue as compost, and other useful products by means of biotechnological processes. Such material in case disposed for land filling, will also not pose any adverse effect on food chain and environment. The technology which serves both the above purposes, i.e. waste treatment & resource recovery, is encouraged by the Government of India.

Conclusion

The plant species (*E. Crassipes*) used in the present study has proved to be effective for treatment of wastewater containing high biodegradable organics. The study results showed that about more than 90% removal of organic matter can be achieved in less than 10 days of retention time and meets the regulatory requirements for waste disposal. The natural process of waste treatment is gaining momentum in India like in Indian Tobacco Company where such treatment technology has been adopted and, being operated successfully for treatment of waste water. Successful phyto treatment for water and wastewater relies on water hyacinth mat size i.e. the WH surface coverage area of wastewater, gap between WH patches or mat (in case of large water bodies like pond or lake), sunlight , and periodic harvesting strategy of WH .biomass This will reduce the management cost and ensure better treatment efficiency. The laboratory results can be utilized for evaluating the biology of WH and designing the continuous flow based ecological engineering system for water quality improvement as a practicable natural process of bio remediation. The harvested biomass can be used for energy recovery, compost as fertilizer, soil conditioner etc and will not have any adverse impact on environment in case it requires disposal by land filling as it is free from toxic substances.

References

1. Arora A, Saxena S, Sharma DK (2006) Tolerance and phyto remediation of chromium by three Azolla species: World J Microbiol Biotechnol 22(2)**:** 97-100.
2. Amasek (1986) Assessment and operation of Water hyacinth removal process pilot plant, Florida Department of Environmental Regulation, Kissimmee.
3. APHA (2005) Standard Methods for the Examination of Water and Wastewater, APHA, AWWA and WEF, (21st Edn.); American Public Health Association, Washington, USA
4. Berti WR, Cunningham SD (1993) Remediating contaminated soil with green plants: Presented ininten Conf Soc Environ Geochem Health, New Orleans, USA, p. 25-27.
5. Blaylock MJ, Salt DE, Dushenkov VS , Zakharova O , Gussman C (1997) Enhanced accumulation of Pb in Indian mustard using chelating agents: Environmental Science and Technology 31(3): 860-865.
6. Brown SL, Chaney RL, Angle JS, Baker AJM (1994) Phyto remediation potential of Thlaspicaerulesens and blabber champion for Zn and Pb contaminated soil. J Environmental Quality 23: 1151-1157.
7. Casabianca ML, Laugier T, Posada F (1995) Petroliferous wastewater treatment with water hyacinths (Ra_nerie de Provence, France). Experimental statement: Waste Management 15(8): 651-655.
8. CBD (2005) Invasive Alien Species, Convention on biological diversity.
9. Coetzee A, Hill MP (2012) The role of eutrophication in the biological control of water hyacinth (*E. casspies*) in south Africa. Biological Control 57(2)**:** 27-261.
10. Chaney RL (1983) Plant uptake of inorganic waste: In Land Treatment of Hazardous Waste, Data Corp, Park Ridge II, p. 50-76.
11. Cunningham SD, Berti WR (1993) Remediation of contaminated soil and water with green plants: An overview. In Vitro Cellular and Developmental Biology 29(4): 207-212.
12. Cunningham SD, Ow DW (1996) Promises of phytorem ediation: Plant Physiology 110: 715-719.
13. Chaney RL, Li YM, Angle JS, Baker AJM, Reeves RD, et al. (1999) Improving metal hyper accumulators wild plants to develop commercial phyto-extraction system: Approaches and Progress. In phyto remediation of Contaminated Soil and Water. CRC Press, Boca Raton, Florida, USA.
14. CPCB (2002) Municipal Sewage Pollution along Indian Coastal Waters (COPOCS). Central Pollution Control Board, Ministry of Environment, New Delhi, India.
15. Coleman MS (1974) Aquaculture as a means to achieve effluent standards: In: Proceeding on wastewater use in production of food and fiber. US Environmental Protection Agency, Washington, USA 199-214.
16. Dar SH, Kumawat DM, Singh N, Wani KA (2011) Sewage treatment Potential of water *(Eichhorniacrassipes)***:** Research Journal of Environmental Sciences 5(4): 377-385.
17. Dinges R (1982) Natural System for Water Pollution Control: Van No strand Reinhold, New York, UK.

How to cite this article: Seraj A, Inamul H. A Low Cost Natural Process of Waste Treatment: Phyto-Treatment of High Bio-Degradable Wastewater of Poultry Processing Industry in Developing Country. Int J Environ Sci Nat Res. 2018; 9(4): 555769. DOI: 10.19080/IJESNR.2018.09.555769

18. Doersam J (1987) Use of water hyacinth for the polishing of secondary effluent of Austin city hyacinth green house facility: In Proceedings of Conference on Aquatic Plants for Treatment and Resource Recovery, University of Florida, Orlando, Florida.

19. Gunnarsson CC, Petersen CM (2007) Water hyacinths as a resource in agriculture and energy production. A literature review: Waste Management 27(1): 117-129.

20. Gao Y, Yi N, Zhang Z, Liu H, Zou L (2012) Effect of water hyacinth on N_2O emission through nitrification and denitrification reactions in eutrophic water. Acta Scientiae Circumstantiate 32(2): 349-359.

21. Giraldo E, Garzon A (2002) The Potential for water hyacinth to improve the quality of Bogota river stabilization ponds. Water Science and Tech 45(1): 103-110.

22. Glass D J (1999) Economic potential of phyto remediation: In Phyto remediation using plants to Clean up the Environment. Editors Raskin I, Ensley, BD publication John Wiley and Sons Inc. New York, UK p. 15-31.

23. Glass D J (2000) US and International Markets for phyto remediation, Assoc Inc, MA Needham.

24. Gazette notification-Water Pollution Control Act (1974) and notified under E (P) Act 1986, Ministry of Environment, New Delhi, India.

25. Ghaly AE, Kamal M, Mahmoud NS (2005) Phyto remediation of aqua culture waste water for recycling and production of fish feed. Environ Int 31(1): 1-13.

26. Guo BH, Tang HC, Song ZW, Xi JX (2003) Theory of wastewater treatment by constructed wetlands and removal of nitrogen and phosphorus. Pollution Control Technology 16(4): 119-121.

27. HillMP, Coetzee J (2017) The biological Control of aquatic weed in South Africa**:** Current Status and future challenges. Bothalia 47(2): 2152-2164.

28. HWMR (2008) Hazardous Waste (management, handling and trans-boundary movement) Rules: Gazettes notification, Environment Ministry.

29. Jebanesan A (1997) Biological treatment of dairy waste by *Eichhorniacrassipes* Solms: Environ Ecol 15(3): 521-523.

30. Ledue DL, Terry N (2005) Field trial of transgenic Indian mustard plants show enhanced phyto remediation of selenium contaminated sediment. Environ Sci Technol 39(6): 1771-1777.

31. Lasat MM, Pence NS, Garrin DF, Ebbs SD, Kochian L (2000) Molecular Physiology off Zn transport in plant (*Thlaspicaerulescens)* J Experimental Bot 51(342): 71-79.

32. Lee CI, Mc kim T (1981) Water Hyacinth and Wastewater Treatment System: Reedy Creek Utilities Co. Buena Vista, Florida.

33. Lee JH (2013) An overview of phyto remediation as a potentially promising technology for environmental pollution control. Biotechnology and Bioprocess Engineering 18(3): 431-439.

34. Mahamadi C (2011) Water Hyacinth as a bio-sorbent: Afr J Environ Sci Technol 5(5): 1137-1145.

35. Malik A (2007) Environmental challenge *vis a vis* Opportunity. The case of water hyacinth 33(1): 122-138.

36. Miretzky P, Saralegui A, Cirelli F (2004) Aquatic macrophytes potential for the simultaneous removal of heavy metals (Buenos Aires, Argentina). Chemosphere 57(8): 997-1005.

37. Maine M, Duarte M, Sune N (2001) Zinc uptake by floating macrophytes. Water Res 35: 2629-2634.

38. Metcalf, Eddy (2002) Wastewater Engineering, Treatment, Disposal, Reuse (4^{th} edn.) Tata Mc Graw- Hill, New Delhi, India.

39. Mohapatra PK, Mohanty RC (2002) Feasibility study of water hyacinth for water purification of Vani Lake, Bhubaneswar: Udaipur, India, p. 307-310.

40. Mitsch WJ, Home AJ, Naim RW (2000) Nitrogen and phosphorous retention in Wetlands- Ecological approaches to solving excess nutrient problems. Ecological Engineering 14(1-2): 1-7.

41. Ndimele A, Jenyo Oni, Ayodele A (2010) The phyto-remediation of crude oil-polluted aquatic environment by water hyacinth. Afr J Livest Extension 8: 48-52.

42. Ndimele P, Kumolu Jonson C, Anetekhai M (2011) The invasive aquatic macrophyte, Water hyacinth - Problem and Prospects. Res J Environ Sci 5(6): 509-520.

43. Ndimele P, Jimoh A (2011) Water Hyacinth (*Eichhorniacrassipes* [Mart] Solms.) in Phyto remediation of heavy Metal Polluted Water of Ologe lagoon, Lagos, Nigeria. Research journal of Environmental Sciences 5(5): 424-433.

44. Preetha SS, Kaladevi V (2014) Phyto remediation of heavy metals using aquatic macrophytes. World J Environ Bio Sci 3(1): 34-41.

45. Patel S (2012) Threats, management and envisaged utilizations of aquatic weed Eichhorniacrassipes. An overview: Reviews in Environmental Science and Bio/Technology 11(3): 249-259.

46. Phetsombat S, Kruatrachue M, Pokethitiyook P, Upatham S (2006) Toxicity and Bioaccumulation of Cd and Pb in Salviniacucullta**.** J environ Biology 27(4): 645-652.

47. Prasad MNV, FrentasH (2003) Metal hyper-accumulation in plants biodiversity prospecting for phytoremediation technology. Electron J biotechnol 6(3): 285-321.

48. Polyprasert C, Khatiwada NR **(**1998) An integrated kinetic model for water hyacinth ponds used for wastewater treatment. Water Res 32(1): 179-185.

49. Rezania S, Ponraj M, Talaiekhozani A, Mohamad SE (2015) Perspectives of phyto remediation using waterhyacinth for removal of heavy metals, organic pollutants in wastewater. Journal of Environmental Management 163(1): 125-133.

50. Rommens WJ, Maes N, Dekeza P, Inghelbrecht T, Nhiwatiwa E (2003) The impact of water hyacinth in eutrophic subtropical impoundment (Lake Chivero, Zimbabwe)-water quality. Archivfür Hydrobiology 158(3): 373-388.

51. Reeves RD, Baker AJM (1999) Metal accumulating plants-Phyto remediation of toxic metals, using plants to clean up the environment. Editor Raskin I, Ensly BD Publication John Willy & Sons Inc, New York, UK, p. 193-229.

52. Reddy K R, D Angelo E M (1997) Bio geochemical indicators to evaluate pollutant removal efficiency in constructed wetlands. Water Science and Technology 35(5): 1-10.

53. Singh B, Prasad G, Rupainwar DC (1996) Adsorption technique for the treatment of As^{+5} rich effluents: Colloids Surf 111(1-2): 49-56.

54. Suresh B, Ravishanker GA (2004) Pyhto remediation. A novel and promising approach for environment clean up. Crit Rev Biotechnol 24(2-3): 97-124.

55. Suryandri MK, Hariate AH, Mahnudi M (2017) Removal of Lead by water hyacinth (*Eichhorniacrassipes)* Solms: Imperial J Interdisciplinary Research 3(1): 2387-2392.

56. Shahabaldin R, Fadhil M, Ponraj M, Sairan FM (2013) Nutrient uptake and waste water purification with water hyacinth and its effect on plant growth in batch system. Journal of Environmental Treatment Techniques 1(2): 81-85.

57. Saleh HM (2016) Biological remediation of hazardous pollutants using water hyacinth-A Review. Journal of biotechnology Research 2(11): 80-91.

How to cite this article: Seraj A, Inamul H. A Low Cost Natural Process of Waste Treatment: Phyto-Treatment of High Bio-Degradable Wastewater of Poultry Processing Industry in Developing Country. Int J Environ Sci Nat Res. 2018; 9(4): 555769. DOI: 10.19080/IJESNR.2018.09.555769

58. Salt DE, Blaylock MK, Kumar PBAN, Dushenkov V, Ensly BD, et al. (1995) Phyto remediation: A novel strategy for the removal of toxic metals from the environment using plants Biotechnology 3(5): 468-475.

59. Sandhu SS, Deserres FJ, Gopalan HNB, Grant W (1991) Status report of the International program on chemical safety. Collaborative study on plants test system. Mutation Research 257(1): 19-28.

60. UNEP (2004) Invasive aliens threaten biodiversity and increased vulnerability in Africa-Action. United Nations Environment Programme, Nairobi 1(1).

61. Utsunamyia T (1980) Japanese Patent Application 55: 72959.

62. US-EPA (1993) Cleaning up the Nations contaminated sites. Markets and Technology Trends: Office of Solid Waste and Emergency Response, Technology Innovation Office, Washington, USA.

63. US-EPA Federal Register (1988) Secondary Treatment Regulation 40 CFR Part-133.

64. Villamagna A, B Murphy (2010) Ecological and Socio economic impact of invasive water hyacinth: A review. Fresh water Biol 55(2): 282-298.

65. Vithanage M, Dabrowska BB, Mukharjee B, Sandhi A, Bhattachaya P (2012) Arsenic uptake by plants and possible phyto-remediation application a brief overview. Environ Chem Lett 10(3): 217-224.

66. Zhang Y, Zhang D, Barrett S (2010) Genetic uniformity characterises, the invasive spread of water hyacinth (*Eichhorniacrassipes*) a clonal aquatic plant. Molecular Ecology 19(9): 1774-1786.

67. Zhang Z, Gao Y, Guo J, Yan S (2014) Practice and reflections of remediation of eutrophicated waters. J of Ecology & Rural Environment 30(1): 15-21.

68. Zhu J, Li H, Wang P (2009) The impact on Environmental factors- COD, TN, TP release from sediment Technol. water treatment 35(8): 44-49.

DOI: 10.19080/IJESNR.2018.09.555769

How to cite this article: Seraj A, Inamul H. A Low Cost Natural Process of Waste Treatment: Phyto-Treatment of High Bio-Degradable Wastewater of Poultry Processing Industry in Developing Country. Int J Environ Sci Nat Res. 2018; 9(4): 555769. DOI: 10.19080/IJESNR.2018.09.555769