International Journal of harmTechResearch
CODEN (USA): IJPRIF, ISSN: 0974-4304
Vol.8, No.5, pp 836-842, 2015

Removal of Color from Textile Industry Wastewater using Microorganism

D. Sivakumar

Department of Civil Engineering, Vel Tech High Tech Dr.RangarajanDr.Sakunthala Engineering College, Chennai 600 062, Tamil Nadu, INDIA

Abstract: The present study is focused to isolate the *Aspergillus niger* from textile industry wastewater contaminated soil from Kanchipuram and the same is used for removal of colour in a textile industry wastewater. The experiments were conducted against the effect of pH, fungus biomass and different concentration (different dilution ratio) to know the effectiveness of *Aspergillus niger* for removing colour from textile industry wastewater. The results showed that maximum removal of colour by *Aspergillus niger* at an optimum pH of 5, an optimum fungus biomass of 10 g and an optimum dilution ratio of 5 was 96.72%. Also, the experimental data on removal of colour in a textile industry wastewater is validated with the aqueous solutions and the results of validated experiments showed that the experimental investigation done in this study may be reproduced for removing any coloured wastewater from any industrial wastewater environment.

Keywords : *Aspergillusniger*, Process Parameters, Textile Industry Wastewater.

Introduction

Textile industries consume a large volume of water and chemicals for making various textile goods and as a result, large volume of wastewater discharged on land with partially or without treatments [1]. These wastewater contaminate the soil while flowing through it and contaminate the water body when these wastewater reach it [2]. The quantities and characteristics of wastewater discharged vary from mill to mill, which depends on the water consumption and the average daily product. The wastewater generated from the various processing units in a textile industries are desizing, scouring, bleaching, mercerizing, dyeing, printing, and packing required huge amount of organic chemicals of complex structure [3]. The main parameters identified in the textile industry are pH, electrical conductivity, chloride, sulphate, phenols, total dissolved solids, biochemical oxygen demand and chemical oxygen demand and other solution substances [4]. Therefore, wastewaters from the textile industry have to be treated before being discharged to the environment.

Various methods like coagulation, oxidation, catalytic oxidation [5], reduction, precipitation, coagulation [6], filtration, flotation, absorption [7], adsorption [8,9,10,11], activated carbon [12], electrochemical treatment [13], reverse osmosis [14], membrane separation [15] and ozonation techniques [16] etc. can be employed to remove various pollutant forms the textile industry wastewater. However their costs are high and most of them are difficult to use under field conditions, hence such a condition there is an urgent need to study the simplest and cost-effective techniques for controlling pollution from industrial wastewaters and treating such wastewater, such as bioremediation [17].

Bacteria, fungi, yeast and algae are abundantly available in nature are a potential alternative to conventional methods that are used to decontaminate liquid wastes [18]. The greater advantages of using fungi species is that the fungi species have wall material, which shows excellent metal-binding properties [19]. Similarly, it can adapt and grow under various extreme conditions of pH, temperature, nutrient availability and high metal concentrations [20]. Thus, the present study focused to isolate the *Aspergillus niger* from textile

industry wastewater contaminated site, located in Kanchipuram District and the same isolated *Aspergillus niger* from textile industry wastewater contaminated soil were used to remove the colour in a textile industry wastewater. Also, the experimental data on removal of colour in a textile industry wastewater by *Aspergillus niger* was validated with the experimental data on removal of colour and other parameters in an aqueous solution.

Materials and Methods

Collection of Textile Industry Wastewater

For the present study, textile industry effluent samples were collected from the final clarifier of textile industrial effluent treatment plant of Kanchipuram, Tamil Nadu, India with the help of airtight sterilized bottles. Then, took the effluent samples to the Environmental Laboratory and then they were stored in the refrigerator at a temperature of 278 K for analyzing colour in later stages along with other parameters. The main characteristics of raw wastewater from textile industry wastewater are given in Table 1.

Table 1 The characteristics of raw wastewater in Textile industry wastewater

Sl. No.	Parameters	Concentration
1	Total Dissolved Solids, mg/L	5432
2	Chemical Oxygen Demand, mg/L	4126
3	Colour, mg/L	45

Soil Sample Collection

Soil samples were collected by randomly at 5 places around the textile industrial wastewater contaminated site and composite soil sample was prepared from mixing of soil samples from 5 sites and it was taken for laboratory and stored at 4 °C to ensure minimal biological activity. The isolation of *Aspergillus niger* was carried out within 24 hours of sample collection for further investigation.

Sterilization of Materials

Petri plates, media bottles, distilled water, McCartney bottles and syringes were sterilized in an autoclave for 60 min. at 120 °C. After autoclaving all sterilized were dried in oven at 100 °C.

Media Preparation

Potato Dextrose Agar (PDA) media were used for the isolation of fungi. For the preparation of PDA, potatoes (200 g) were peeled, sliced and boiled, and then sieved through a clean muslin cloth to get a broth in which agar (10 g) and dextrose sugar (10 g) was added. The media was then autoclaved for 30 min. at 120 °C.

Isolation of Fungi

Fungi were isolated on Potato Dextrose Agar (PDA) by the soil dilution method. Poured the media in Petri-dishes and allowed to solidify for 48 hours. To suppress the bacterial growth, 25 mg/L of streptomycin was added to the medium. After solidification, the plates were filled with diluted soil solution (different proportion). The plates were incubated at 28 °C for 72 hours. After incubating at 28 °C for 72 hours, the prominent colonies were picked and inoculated individually in other PDA plates for further purification.

Identification of Fungi

After incubation, the distinct colonies were counted and identified. The fungal cultures were identified on the basis of macroscopic (colonial morphology, colour, texture, shape, diameter and appearance of the colony) and microscopic (septation in mycelium, presence of specific reproductive structures, shape and structure of conidia, and presence of sterile mycelium) characteristics (Table 2). Though the identified fungi species *Aspergillusniger*and*Aspergillusflavus*, this study concentrated on removal of colour in a textile industry wastewater by *Aspergillusniger* only.

Table 2 Isolated fungi from textile industry wastewater contaminated soil samples

Fungus Code	Isolated Fungi	Sample Code
F1	*Aspergillus niger*	S1, S2, S3, S5, S8, S10
F2	*Aspergillus flavus*	S4, S6, S7, S9

Absorption Experiments

This method consists of batch experiments involving effect of pH, fungi biomass and different initial concentration (different dilution ratio) to know the effectiveness of *Aspergillusniger* for removing colour from textile industry wastewater. The colour of textile industry wastewater is due the presence of Acid Orange 10 dye, whose initial concentration in a textile industry wastewater is 45 mg/L (Table 1). The concentrations of colour in a textile industry wastewater before and after equilibrium were determined as per standard procedure given by APHA [21]. Triplicate of each experimental setup was maintained. In order to reduce colour in a textile industry effluent, the experimental setup were examined for different pH (2, 3, 4, 5, 6, and 7), different fungi biomass (2, 4, 6, 8, 10, and 12 g) and different dilution ratio (0, 1, 2, 3, 4, and 5). The absorption removal percentage of colour by *Aspergillusniger*was calculated by using the following formula:

$$\text{Percentage Removal} = \frac{(C_1 - C_2)}{C_1} \times 100 \qquad (1)$$

in which C_1 is the concentration of colour (mg/L) before treatment with *Aspergillusniger*and C_2 is the concentration of colour (mg/L) after treatment with *Aspergillusniger*.

Results and Discussion

In this study, isolated the *Aspergillusniger* fungus species from textile industry wastewater contaminated soil were used to remove the colour of Acid Orange 10 dye from the textile industry wastewater collected from Kanchipuram. The reduction of colour in a textile industry wastewater using isolated fungus species *Aspergillusniger*was done against different pH, fungi biomass and dilution ratio.

Effect of pH

Fig. 1 shows the maximum removal percentage of colour for the incubation period of 5 days, 2 g of fungus biomass, initial concentration of Acid Orange 10 dye 45 mg/L (dilution ratio 1 part of wastewater : 0 part of deionized water) against pH of 2, 3, 4, 5, 6 and 7. It can be observed from Fig.1 that the reduction of colour increases upto the pH of 5 and decreases with increase pH values of 6 and 7. Thus, the optimum pH for which maximum removal of colour in a textile industry wastewater by *Aspergillus niger* is found to be 5. The decrease in sorption capacity for the higher pH is due to the changes in other metal speciation and the dissociation of functional groups on the *Aspergillus niger*.

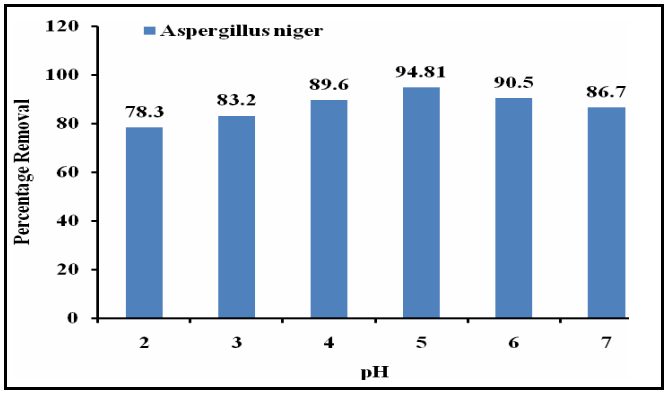

Fig.1 The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by an Isolated *Aspergillus niger* for different Ph

The maximum removal percentage of colour in a textile industry wastewater by the group of an isolated *Aspergillus niger* with an optimum incubation time of 5 days, *Aspergillus niger* biomass of 2 g, and an initial colour concentration of 45 mg/L against different pH was presented in Table 3. From Table 3, it may be noted that the order of removal of colour by the *Aspergillus niger* at an optimum pH of 5 was S1 > S2 > S4 > S3 > S5 > S8 > S10. From Table 3, it may be observed that the maximum removal of colour by the group of an isolated fungi species was found to be 94.81 % at an optimum pH of 5.

Table 3 The maximum removal percentage colour in a textile industry wastewater by group of an isolated *Aspergillus niger* with an optimum pH of 5, optimum incubation time of 5 days, *Aspergillus niger* biomass of 2 g, and an initial colour concentration of 45 mg/L

Sample Code	Isolated Fungi	Percentage Removal
S1	*Aspergillus niger*	94.81
S2	*Aspergillus niger*	93.17
S3	*Aspergillus niger*	89.48
S5	*Aspergillus niger*	86.51
S8	*Aspergillus niger*	83.25
S10	*Aspergillus niger*	80.77

Effect of Fungi Biomass

Fig.2 shows the maximum removal percentage of colour for the incubation period of 5 days, initial concentration of Acid Orange 10 dye 45 mg/L (dilution ratio 1part of wastewater : 0 part of deionized water), optimum pH of 5 against the fungus biomass of 2, 4, 6, 8, 10, and 12 g. It can be observed from Fig.2 that the reduction of colour increases upto the biomass of 10 g and decreases with increase biomass values of 12 g. The optimum biomass for which, maximum removal of colour occurred is found to be 10 g. Higher the removal at an optimum biomass 10 g is due to more binding sites available by the fungi biomass. The colour removal *Aspergillus niger* has shown similar trend as that of effect of pH.

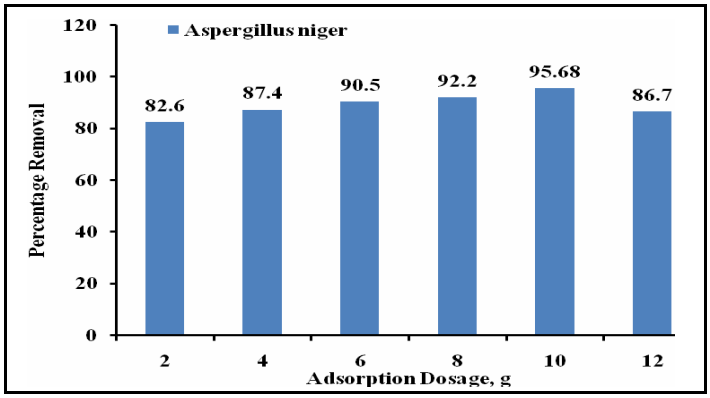

Fig.2 The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by an Isolated *Aspergillus niger* for different Fungus Biomass

The maximum removal percentage of colour in a textile industry wastewater by the group ofan isolated *Aspergillus niger* with an optimum incubation time of 5 days, an initial colour concentration of 45 mg/L, optimum pH of 5 against different *Aspergillus niger* biomass was presented in Table 4. From Table 4, it may be observed that the order of removal of colour by the fungus at an optimum biomass of 10 g was S1 > S2 > S4 > S3 > S5 > S8 > S10. From Table 4, it may be observed that the maximum removal of colour by the group of an isolated fungi species was found to be 95.68 % at the optimum *Aspergillus niger* biomass of 10 g.

Table 4 The maximum removal percentage colour in a textile industry wastewater by the group of *Aspergillus niger* with an optimum pH of 5, optimum incubation time of 5 days, optimum *Aspergillus niger* biomass of 10 g, and an initial colour concentration of 45 mg/L

Sample Code	Isolated Fungi	Percentage Removal
S1	*Aspergillus niger*	95.68
S2	*Aspergillus niger*	93.23
S3	*Aspergillus niger*	90.21
S5	*Aspergillus niger*	87.37
S8	*Aspergillus niger*	84.46
S10	*Aspergillus niger*	81.43

Effectof Initial Concentration

Fig.3 shows the maximum removal percentage of colour for the incubation period of 5 days, optimum pH of 5, optimum fungus biomass of 10 g against the dilution ratio of 0, 1, 2, 3, 4 and 5. It can be observed from Fig.3 that the reduction of colour increases upto the dilution ratio of 5. Higher the removal for the dilution ratio of 5 is due to there is less intermolecular attraction between the metal ions, leading to more adsorption by the *Aspergillus niger*, results, colour intensity in a textile industry wastewater was reduced. The colour removal by *Aspergillus niger* for the effect of initial concentration has shown similar trend as that of effect of pH and effect of fungi biomass and the optimum dilution ratio found from this study is 5.

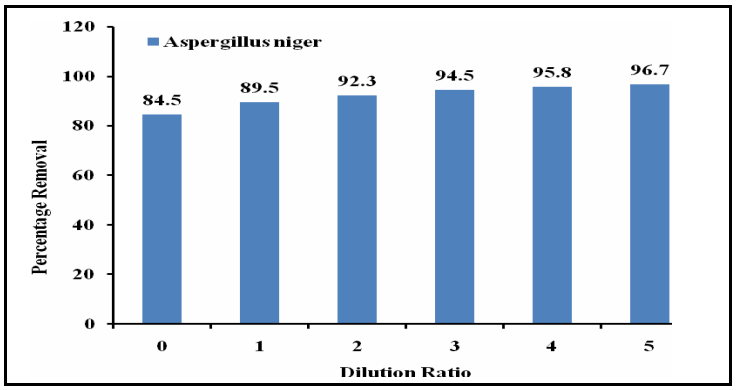

Fig.3 The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by an Isolated *Aspergillus niger* for different dilution ratio

The maximum removal percentage of colour in a textile industry wastewater by the group of an isolated Aspergillus niger with an optimum incubation time of 5 days, optimum pH of 5, optimum Aspergillus niger biomass 10 g against the different dilution ratio was presented in Table 5. From Table 5, it may be observed that the order of removal of colour by the fungi at an optimum dilution ratio of 5 was S1 > S2 > S4 > S3 > S5 > S8 > S10. From Table 5, it may be observed that the maximum removal of colour by the group of an isolated fungi species was found to be 96.72 % at the optimum dilution ratio of 5.

Table 5 The maximum removal percentage of colour in a textile industry wastewater by the group of*Aspergillus niger* with an optimum pH of 5, optimum incubation time of 5 days, optimum *Aspergillus niger* biomass of 10 g, and optimum initial colour concentration of 1.41 mg/L

Sample Code	Isolated Fungi	Percentage Removal
S1	*Aspergillus niger*	96.72
S2	*Aspergillus niger*	95.86
S3	*Aspergillus niger*	91.94
S5	*Aspergillus niger*	89.23
S8	*Aspergillus niger*	86.49
S10	*Aspergillus niger*	82.52

Validation of Experiment

Validation of experiment is required to verify the finding of similarities against the observed values of an experimental investigation. This study is used to check the degree of similarity exits between the experiments at optimum values of pH, biomass and concentration on removal of colour in a textile industry wastewater using *Aspergillusniger*with the new experiments (separate experiments) conducted against the optimum values of pH, biomass and concentration on removal of colour in an aqueous solution. The maximum removal of colour in a textile industry wastewater and an aqueous solution by an isolated *Aspergillusniger*at the optimum values of selected parameters is shown in Fig.4.

The results (Fig.4) showed that the maximum removal percentage of colour in an aqueous solution by an isolated *Aspergillusniger*at the optimum conditions is greater than the results of colour removal in a textile industry wastewater by an isolated *Aspergillusniger*. From Fig.4, it may be noted that the colour removal from aqueous solution is higher than the colour removal from textile industry wastewater, is due to there are no competitive ions present in aqueous solution than in a textile industry wastewater, where the competitive ions and impurities are presented. The order of maximum removal of colour in an aqueous solution by the group of an isolated *Aspergillusniger*is similar to the observation made for maximum removal of colour in a textile industry wastewater.

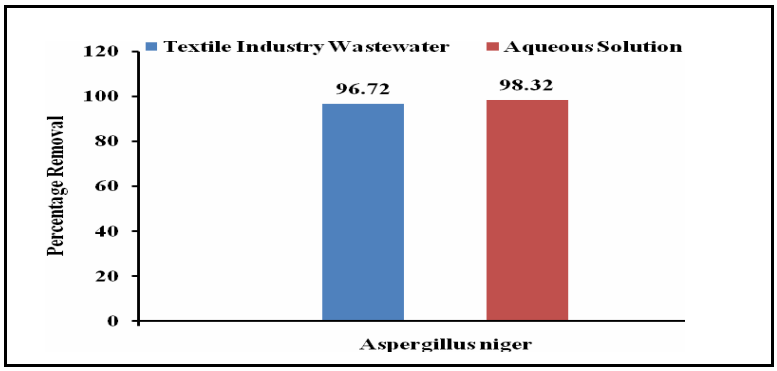

Fig.4 The Maximum Removal Percentage of Colour in a Textile Industry Wastewater and in a Aqueous Solutions by an Isolated Fungus *Aspergillus niger* with an Optimum pH of 5, Optimum Incubation Time of 5 days, Optimum Fungus Biomass of 10 g, and Optimum Initial Colour Concentration of 1.41 mg/L

Further, the obtained maximum removal percentage of colour in a textile industry wastewater using *Aspergillus niger*with an at optimum values of pH, biomass and concentration was verified with the other physico-chemical parameters like TDS and COD in a textile industry wastewater. The results of maximum reduction of TDS and COD in a textile industry wastewater are presented in Table 6. From Table 6, it may be noted that the maximum removal of TDS and COD in a textile industry wastewater was obtained at the same optimum values of pH (5), fungus biomass (10 g) and concentration (5), which was observed for the removal of colour in a textile industry wastewater. Thus, the validation results (Fig. 4 and Table 6) indicated that the optimum values of different process parameters using *Aspergillus niger* were reproducing capability for removing not only the colour but also various parameters in a textile industry wastewater and in aqueous solutions.

Table 6 The maximum removal percentage of TDS and COD in a textile industry waster by an Isolated Fungus *Aspergillus niger* with an Optimum pH of 5, Optimum Incubation Time of 5 days, Optimum Fungus Biomass of 10 g, and Optimum Initial Colour Concentration of 1.41 mg/L

Parameters	Initial	Final	Percentage Removal
TDS	5432	771.3	85.8
COD	4126	717.9	82.6

Conclusion

The isolated fungus species *Aspergillus niger* from textile industry wastewater contaminated soil were used to remove the colour from tannery industry wastewater of Kanchipuram. The maximum removal percentage of colour in textile industry wastewater by isolated *Apergillus niger* was found at an optimum pH of 5, optimum incubation time of 5 days, optimum fungus biomass of 10 g, and an optimum initial colour

concentration of 1.41 mg/L. The maximum removal efficiency of colour from textile industry wastewater was achieved by *Aspergillus niger* (S1) is 96.72 %. Further, the findings of observed values of colour removalby an isolated *Aspergillus niger* in a tannery industry wastewater with the observed values of removal of colour in an aqueous solution were validated. The results of regular and validate studies concluded that the isolated fungus species *Aspergillusniger*from textile industry wastewater contaminated soil are very viable and useful for bioremediation of not only tannery industry wastewater but also any contaminated water and wastewater.

References

1. Sivakumar D. and Shankar D., Effect of aeration on colour removal from textile industry wastewater, International Journal of Environmental Sciences, 2012a, 2(3), 1386-1397.
2. Sivakumar D., A study on contaminant migration of sugarcane effluent through porous soil medium. Int. J. Environ. Sci. Tech., 2011, 8(3), 593-604.
3. Smita V., Pandey N.D. and Quoff A.R., Decolorization of Synthetic Dye Solution Containing Congo Red By Advanced Oxidation Process (AOP), International Journal of Advanced Research in Civil, Structural, Environmental and Infrastructure Engineering and Developing, 2014, 2(1), 49-55.
4. Irina I.S. and Romen B., Wastewater characteristics in textile finishing Mills, Environmental Engineering and Management Journal, 2008, 7(6), 859-864.
5. Hussein F.H. and Abass T.A., Photocatalytic treatment of textile industrial wastewater. Int. J. Chem. Sci., 2010, 8(3), 1353-1364
6. Guendy H.R., Treatment and reuse of wastewater in the textile industry by means of coagulation and adsorption techniques, Journal of App. Sci. Res., 2010, 6(8), 964-972.
7. Sivakumar D., Shankar D., Dhivya P. and Balasubramanian K., Bioaccumulation study by *Lemna Gibba lin*, Pollution Research, 2014b, 33(3), 531-536.
8. D. Sivakumar (2014). Hexavalent chromium removal in a tannery industry wastewater using rice husk silica. Global Journal of Environmental Science and Management, 1 (1), pp.27-40.
9. D. Sivakumar, N. Murugan, R. Rajeshwaran, T. Shobana, C. Soundarya, V.S. Vanitha (2014). Role of Rice Husk Silica Powder for removing Cr(VI) in a Tannery Industry Wastewater. International Journal of ChemTech Research. 6 (9), pp.4373-4378.
10. Sivakumar Durairaj, Adsorption Study on Municipal Solid Waste Leachate using Moringa oleifera Seed. Int. J. Environ. Sci. Technol., 2013c, 10, 113-124**.**
11. Shankar D., Sivakumar D., Thiruvengadam M. and Manojkumar M., Colour removal in a textile industry wastewater using coconut coir pith, Pollution Research, 2014, 33(3), 449-503.
12. Syafalni S., Ismail A., Irvan D., Chan K.W., and Genius U., Treatment of dye wastewater using granular activated carbon and zeolite filter, Modern Applied Science, 2012, 6(2), 37-51.
13. Dogan D. and Haluk T., Electrochemical Treatment of Actual Textile Indigo Dye Effluent, Pol. J. Environ. Stud., 2012, 22(5), 1185-1190.
14. Ramesh Kumar M., Koushik C.V. and Saravanan K., Textile wastewater treatment using reverse osmosis and SDI, Elixir Chem. Engg., 2013, 54A, 12713-12717.
15. Fersi C., Gzara L. and Dhahbi M., Treatment of textile effluents by membrane technologies, Desalination, 2005, 185(1-3), 399-409.
16. Guendy H.R., Ozone treatment of textile wastewater relevant to toxic effect elimination in marine environment, Egyptian Journal of Aquatic Research, 2007, 33(1), 98-115.
17. D. Sivakumar, A.N. Kandaswamy, V. Gomathi, R. Rajeshwaran andN. Murugan, (2014e). Bioremediation studies On Reduction Of Heavy Metals Toxicity, Pollution Research EM International, 33 (3) : 553-558.
18. D. Shankar, D. Sivakumar and R. Yuvashree, (2014b). Chromium(VI) Removal From Tannery Industry Wastewater Using Fungi Species, Pollution Research, 33 (3) : 505-510.
19. D. Sivakumar, G. Gayathri, R. Nishanthi, V.Vijayabharathi, Sudeshna Das, R. Kavitha (2014d). Role of Fungi Species in Colour Removal from Textile Industry Wastewater. International Journal of ChemTech Research. 6 (9), pp.4366-4372.
20. Kapoora T.V. and Cullimoreb D.R., Removal of heavy metals using the fungus Aspergillus niger, Bioresour. Technol., 1999, 70(1), 95-104.
21. APPA AWWA and WEF. (2005). "Standard methods for the examination of water and wastewater". 20th edition, APHA Publication, Washington D.C.

*****