Australian Journal of Basic and Applied Sciences, 7(10): 127-136, 2013
ISSN 1991-8178

Use Of Ficus Trees Pruning Results For Wastewater Treatement

[1]El Nadi, M.H.; [2]Abdel Rahman, W.H.; [3]Radwan, A.; [4]And Ahmed, R.A.

[1]Professor of Sanitary Engineering, Faculty of Engineering, Ain Shams University.
[2]Assistant Professor of Sanitary Engineering, Faculty of Engineering, Mattaria Branch - Helwan University.
[3]Professor of Soil Mechanics, Faculty of Engineering – Mattaria Branch- Helwan University
[4]PhD. student, Faculty of Engineering, Mattaria Branch- Helwan University.

Abstract: Using agricultural wastes as media to remove wastewater contaminants and reduce agricultural wastes accumulation is environmentally very important to reduce agricultural wastes. In this study, Ficus pruning results were used as a media by dividing it into four forms (original, coarse, medium and fine). Column scale experiments were carried out to test the removal efficiency of the sewage parameters TSS, COD, BOD, N and P for each form. The results obtained indicated that the maximum removal efficiency (Re%) was achieved with medium size form. These results emphasized the environmentally effectiveness using of Ficus pruning results as a media for wastewater treatment. Steady state operational conditions (removal efficiency) was achieved after three weeks of continuous operation The average removal efficiencies after reaching steady state were: For the Biological Oxygen Demand (BOD) the removal efficiency was 80.31%. For the Total Suspended Solid (TSS), the average removal efficiency was 78.34%. For the Chemical Oxygen Demand COD, the average removal efficiency was 77.60%. While for the nitrogen (N), and Total Phosphorus (P), the average removal efficiencies were 93.30% and 93.33% respectively.

Key words: Raw agricultural wastes - Ficus trees pruning - Agricultural wastes as sorbent materials - Utilization of agricultural residues – Biological filtration media.

INTRODUCTION

In recent years, the searches for utilization of the agricultural wastes as rich sources for low cost materials in wastewater treatment have been widely intensified (Kumar, 2006). For an economically effective treatment of wastewater, various low cost kinds of agricultural wastes have been investigated such as rice husk activated carbon (Daifullah *et al*., 2003) as sorbent materials for the removal of complex six heavy metals (Fe, Mn, Zn, Cu, Cd, and Pb) from wastewater.

In Egypt, disposal of municipal solid waste accumulations, and utilization of these wastes as renewable sources of various products became important point as the different quantity of produced agricultural wastes was about 23 million annually on dry basis (EEAA, 2001). Most of these residues produced from rice (5.5 million ton), sugarcane (5.17 million ton), maize (4.71 million ton), and cotton (1.24 million ton) (EL-Hissewy and Tantawi, 2004).

Agricultural wastes are considered as a big problem facing farmers and officials in Egypt. Especially for rice straw that is burned as the primary method of disposal since long time because it is the cheapest, fastest and most effective method from farmers point of view (Tantawi, 2004).

Hashem, *et al*, (2009), in the same direction used cotton stalks filter media to test their removal efficiencies for all parameters. (El Nadi, 2009), worked using Almond shells as filter media to test the removal efficiency for BOD, COD & TSS.

El Nadi, *et al*, (2009) applied Sun Flowers Stalks as filter for raw wastewater to remove the BOD, COD & TSS.

El Sergany, (2009), in her study proved the success of applying the sugarcane waste stalks as filter media in removing the BOD, COD & TSS from raw sewage. Also, El Sergany, (2011) In her new study proved the suitability of rice husk to be used as biofilter media for wastewater treatment.

The objective of this study was to setting the best efficiency for wastewater treatment by defining the best form of Ficus trees pruning results according to the removal efficiency values.

MATERIALS AND METHODS

Materials:

Ficus Pruning Results were collected from available sources. These wastes were divided manually into four sizes (figure 1):

- The first size was used with its original shape without change (original).

Corresponding Author: El Nadi, M. H., Professor of Sanitary Engineering, Faculty of Engineering, Ain Shams University.

- The second size was cut as 5 cm pieces (Coarse)
- The third size was cut as 2 cm pieces (Medium).
- The fourth size was cut as 0.5 cm small particles (Fine)

The following figure illustrates the different sizes of the Ficus pruning results:

Fig. 1: The Cleaning Results From Ficus Trees (Different Sizes)

The pilot plant was erected in Elberka wastewater treatment plant in Cairo city, Egypt. It receives sewage from Ain shams district, Elsalam city and its subsidiaries at east of Cairo. The received sewage to Elberka wastewater treatment plant is mainly domestic with about 15% of industrial wastewater of food and chemical industry source, which could affect the results of the experiment.

The applied physical and chemical properties of the primary treated wastewater during the overall run are presented in table 1.

Table 1: The physical and chemical properties of the raw wastewater:

Measuring parameters	Description (Av. ± Standard Deviation)
Total suspended solids (mg/l)	135 ± 82
BOD (mg/l)	352 ± 239
COD (mg/l)	411 ± 298
N (mg/L)	25.26 ±6.06
P (mg/L)	12.3±2.1

Experimental methods:

The experiments were performed by using four column reactors as shown in Figure (2), erected nearby the carrier channel between the primary settling tanks and aeration tanks.

Fig. 2: The pilot unit

The individual Column reactor consists of tube with 10 Cm diameter and 2.00 m height with supportive gravel of 10 cm depth in the bottom of the column. The agricultural waste was put as media for treatment with 80 cm depth over the gravel.

The wastewater depth above the media was 100 cm.

Three samples were obtained from the influent, middle and effluent of the reactor and analyzed at the same time of day to avoid change in the characteristics of the wastewater (Figure 3). This procedure was performed for every form of agricultural wastes (Ficus pruning results). Percentage of each parameter removal (Re %) was calculated using the following formula:

$Re\% = (1-C/C_o) * 100$

Where:

C and C_o are the final and initial concentration of each parameter in the test.

To evaluate the performance of each media, the following physico-chemical characteristics were investigated:

- Biochemical oxygen demand (BOD) mg/l.
- Total suspended solids (TSS) mg/l.
- Chemical oxygen demand (COD) mg/l.
- Nitrogen (N) mg/l.
- Total phosphorus (P) mg/L.

All the measurements and parameters analyses were conducted in El Berka laboratory according to the American standards methods for water and wastewater examination. The following figure presents the samples locations.

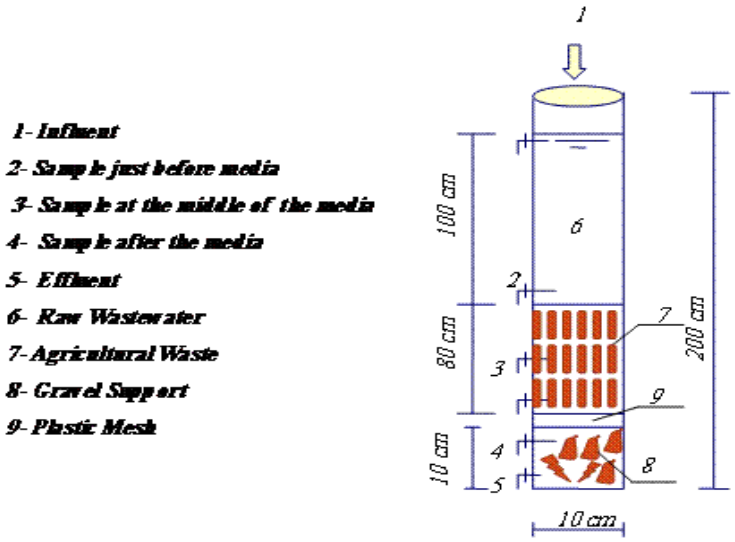

Fig. 3: Schematic Diagram of Column Reactor Showing Samples Different Locations

Removal efficiency Re% for BOD, TSS, COD, N and P are displayed in Figures (4), (5), (6), (7), (8), (9), (10), (11) and (12). Each of these figures presents the effect of Ficus pruning form on the removal efficiency per each parameter. These forms are (original, coarse, medium, and fine).

Results:

For the first week, the results indicated that the efficiency was oscillating between increase and decrease. For this reason, the pilot was operating during the second week without recording any results. For the third week, the removal efficiencies of the pilot plant were improved gradually and this assure that the system constancy needs a start up period up to two weeks as a minimum. For the first week, the removal efficiency was low for all the media sizes as the system was not still started up so, the complete micro biological growth has not been developed yet. During the third week, the removal efficiencies of the pilot plant were improved gradually and achieved good results for removal ratios. The pilot plant was operated for 3 weeks. The study was carried out at temperature (20 ± 3^oC). The pH value was ranged between 6.6 ± 0.34.

The results of Ficus pruning form on the overall removal efficiency for the analyzed parameters (BOD, TSS, COD, N, and P) will be presented and discused in the following subsections.

Results of BOD:

The removal ratios for the BOD parameter for the middle samples ranged between 6.86 % and 58.55 %.

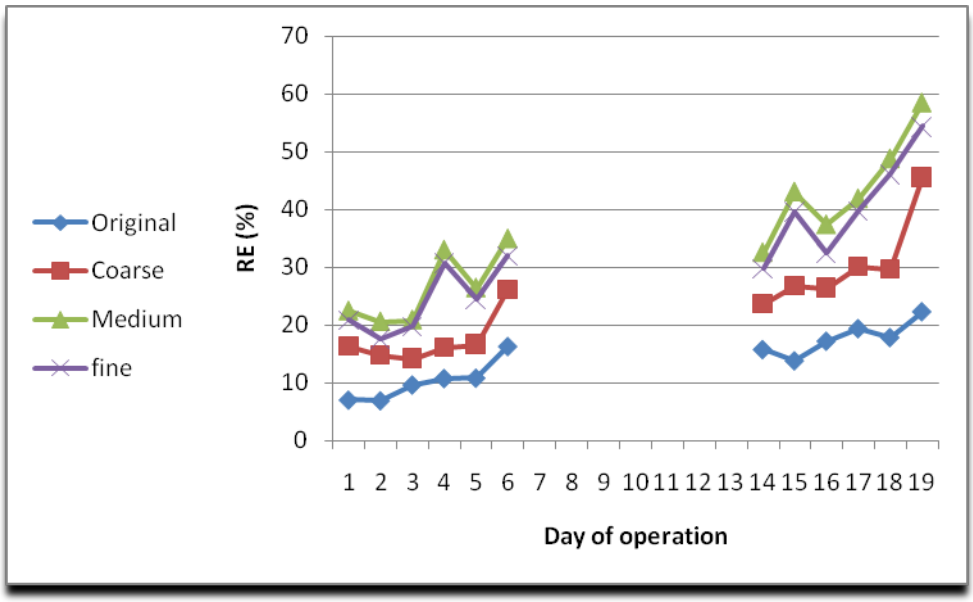

Fig. 4: BOD Removal efficiency at the middle samples for the applied forms

The removal ratios for the BOD parameter for the effluent samples ranged between 22.32% and 80.31%.

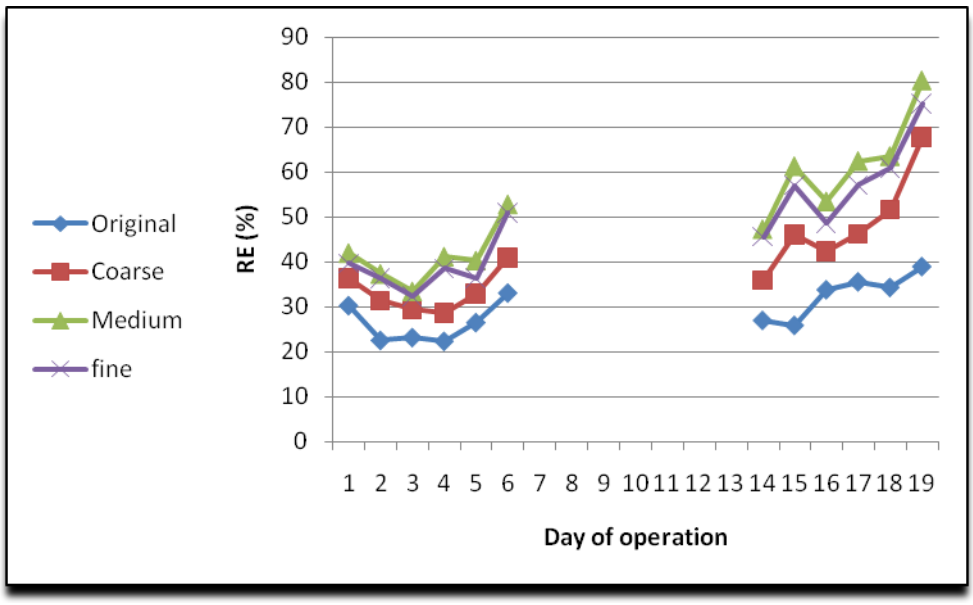

Fig. 5: BOD Removal efficiency at the effluent samples for the applied forms

The medium size was the best in the removing procedure as its surface area and voids ratio was the most suitable for the biological action to take place. The slime layer developed on the agricultural waste packing in the filter contained the microorganisms for biodegradation of the substrates. Organic material from the liquid flowing over the packing is adsorbed onto the biological film or slime layer. The media used balanced a high surface area. Since the voids spaces are filled with air rather than water, then the bacteria never become oxygen-starved.

For the fine size, the physical action covers the weakness in biological activity due to decrease in the voids ratio of this size so its efficiency was high but less than that one of the medium size due to the clogging effects.

For the original and coarse sizes, the percent between the surface area and the voids ratio was not balanced so the resulted high value of permeability in addition to the low surface area did not allow neither for the complete biological action nor for the physical action to take place.

Results of TSS:

The removal ratios for the TSS parameter for the middle samples ranged between 7.2% and 51.22 %.

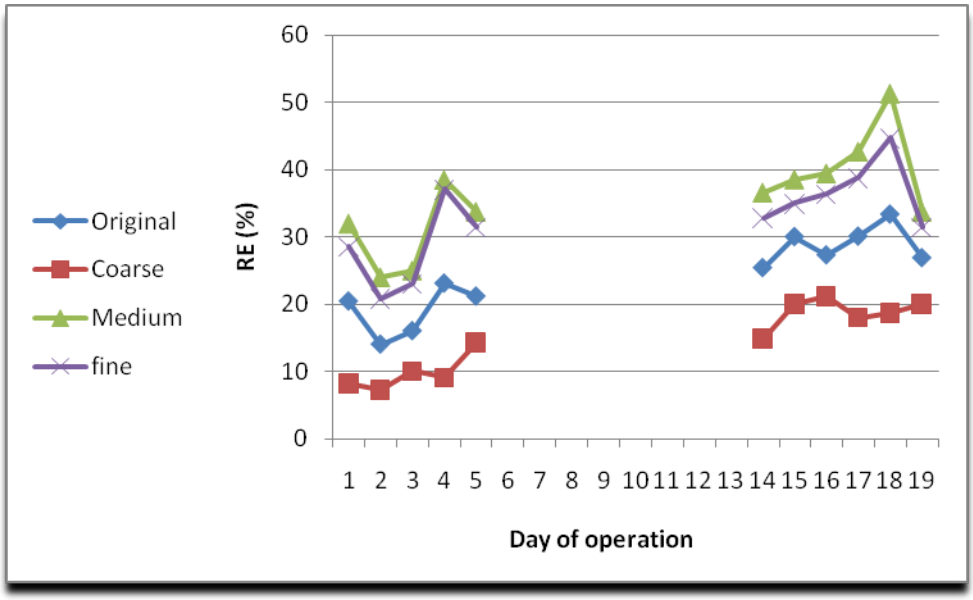

Fig. 6: TSS Removal efficiency at the middle samples for the applied forms

The removal ratios for the TSS parameter for the effluent samples ranged between 21.68 % and 78.34 %.

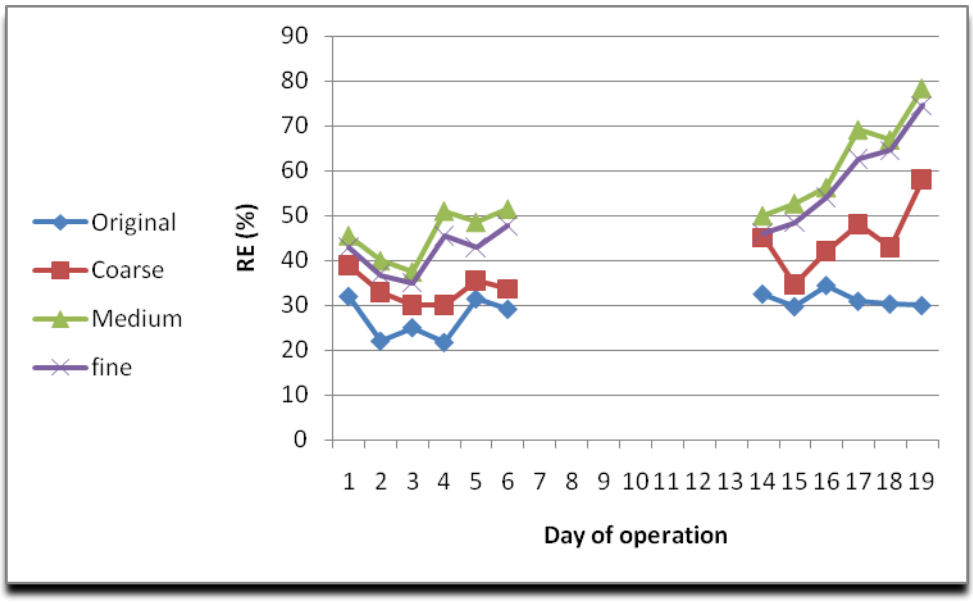

Fig. 7: TSS Removal efficiency at the effluent samples for the applied forms

The removal ratio efficiencies for the fourth and third sizes were close to each other. The medium and fine sizes beds presented a larger exposed surface area to the liquid being filtered which facilitates the removal of particulates and contaminants

There was a significant increase in the surface area available to the material to be filtered due to the fineness of the particles with appreciable void ratio for adequate hydraulic reaction performance of the system.

For the original and coarse sizes, the physical filtration action did not have a clear effect as the voids ratio was so high and the ratio between the surface area and the existing voids was not balanced so the natural retaining for the particles did not occur.

Results of COD:

The removal ratios for the COD parameter for the effluent samples ranged between 5.56 % and 77.6 %.

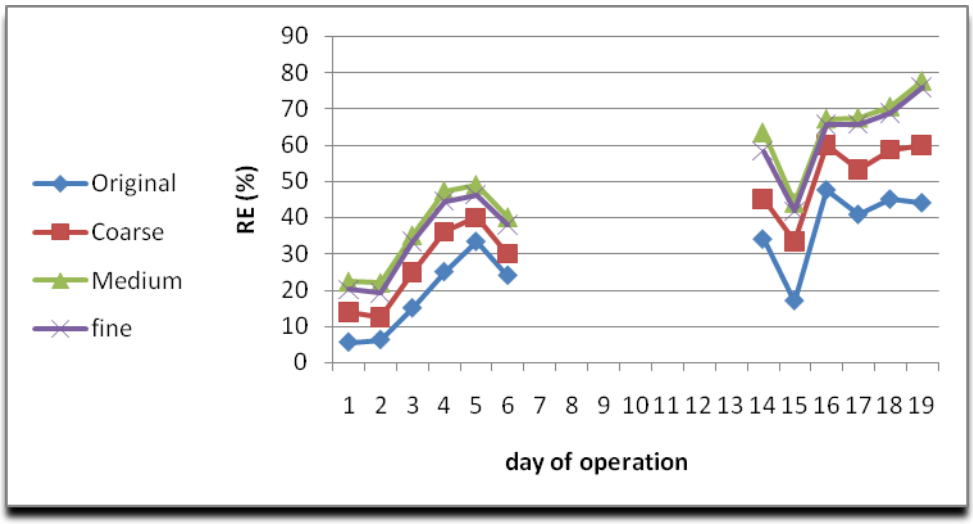

Fig. 8: COD Removal efficiency at the effluent samples for the applied forms

The medium and fine sizes media provided a large surface area per unit volume for growth of biota, and the interstitial spaces were not clogged as there is proportionality between the surface area and the voids ratio. The shape of these two media sizes allowed the aggregation of the bacteria cells.

Results of "N":

The removal ratios for the N parameter for the middle samples ranged between 9.03% and 88.85%.

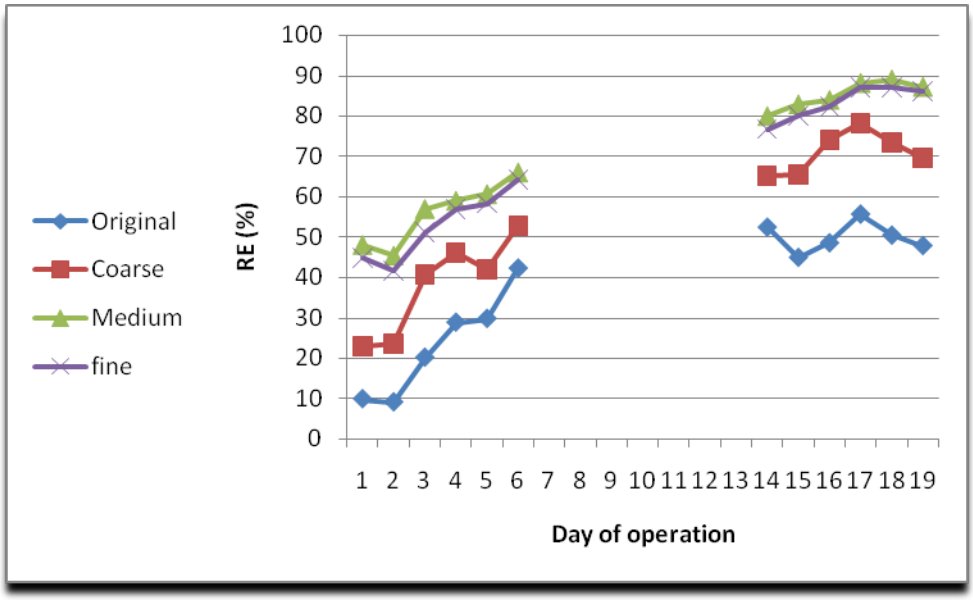

Fig. 9: N Removal efficiency at the middle samples for the applied forms

The removal ratios for the N parameter for the effluent samples ranged between 20.56 % and 93.30%.

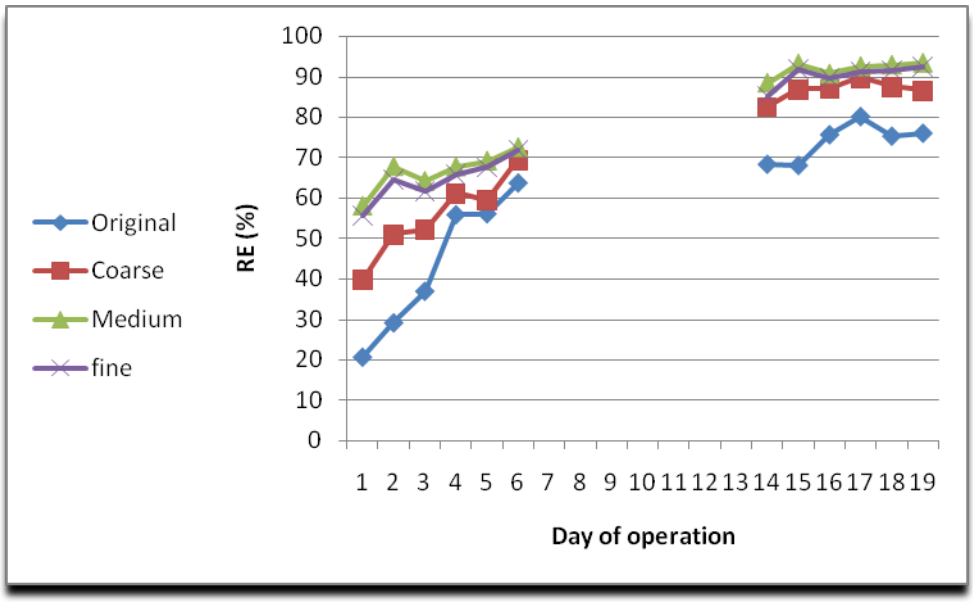

Fig. 10: N Removal efficiency at the effluent samples for the applied forms

The removal ratio is a function in the media size. The probable reason for improvement in the efficiency for the medium and fine sizes is the increase in the surface area.

Results of "P":

The removal ratios for the P parameter for the middle samples ranged between 11.76 % and 90.48%.

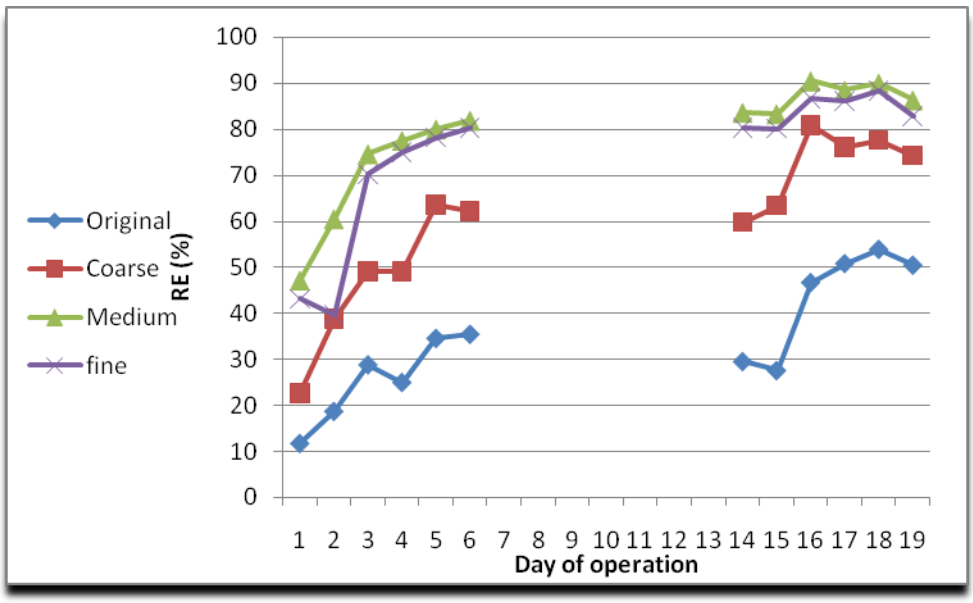

Fig. 11: P Removal efficiency at the middle samples for the applied forms

The removal ratios for the P parameter for the effluent samples ranged between 29.41% and 93.33%.

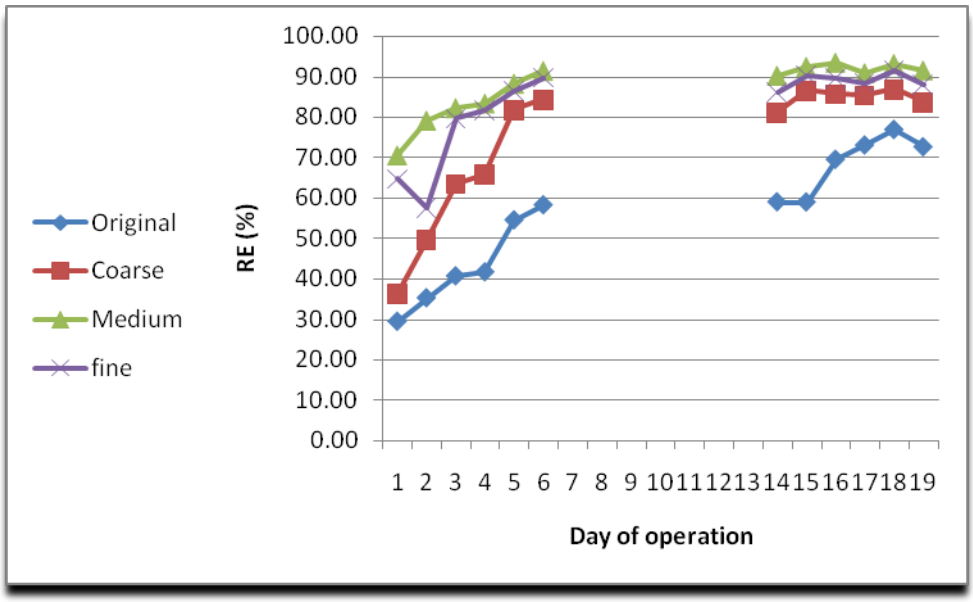

Fig. 12: P Removal efficiency at the effluent samples for the applied forms

The probable reason for improvement in the efficiency for the medium and fine sizes is the increase in the high porous surface area per unit volume that promotes contact between sewage and bio film and thus biofilm growth and development.

Discussion:

Using agricultural wastes as filtration media within the working days and by changing the form of media between (original, fine, medium and coarse), it was proved that the results for fine and medium sizes removal ratios were higher than coarse and original forms. This may be attributed to the form that increases the surface area of the sorbent and consequently, increases its efficiency. So it can be concluded that when the length of pieces of Ficus pruning results are around 2 cm, the removal efficiency Re% will be steady.

The middle samples were used as indicator that the whole media depth is working and the analyses of these samples revealed that the media, even it is organic material it did not increase the BOD and the COD values i.e, it does not have negative effect. No degradation has happened to the media along the study period. The media depth affected the removal efficiency as its results were lower than the effluent efficiencies. The difference in removal efficiencies between the middle and effluent samples were from 39% up to 96% for P, from 43% up to 95% for N, from 33% up to 65% for TSS and from 30 % up to 72% for BOD.

In Figure (10), high nitrogenous value Re% is noted which means that nutrient removal especially nitrogenous compounds may increase reaching Re%= 93.30%. TSS removal values varied between 21.67% and 78.34%. The media encouraged the nitrogenous bacteria to break down the nitrogenous components in a fast manner.

The result illustrated by Figure (8) showed that the maximum value of COD reached to Re% = 77.60 for medium form of media.

The individual small agricultural wastes grains for the medium and fine sizes seemed to provide a very high porous surface area per unit volume that promotes contact between sewage and bio film and thus biofilm growth and development. Bacteria on the effective surfaces characterizing the general structure of the bed provided a screening effect that traps considerable solids besides the pores volume comparable to those of the other sizes which gave easier access to the pores. These results coincide with the previous researches conducted by **El** Sergany, (2009) which mentioned that employing biomass wastes as media removes wastewater contaminants and reduces agricultural wastes accumulation.

Figure (13) illustrated the average results for the effluent during the overall run. The average removal ratios for BOD, TSS, COD, N and P for the medium size were 46, 54, 50, 79 & 87% respectively.

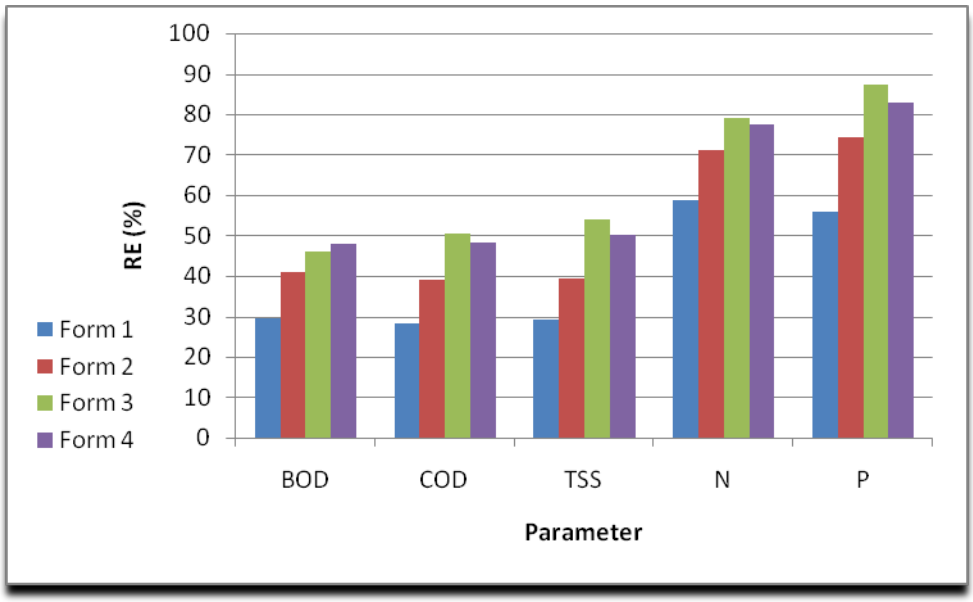

Fig. 13: The Average Results at the effluent samples for the applied forms

The following table illustrates the comparison between the removal ratios of Ficus pruning results and the other types of agricultural wastes applied by other researchers.

Table 2: Comparison between the removal efficiencies of Ficus pruning results and the other types of agricultural wastes

Type of agricultural waste	Removal ratios
Ficus Pruning Results	up to 80, 78, 77 % for BOD, TSS & COD
Cotton Stacks	up to 88% for all parameters
Almond Shells	BOD, COD & TSS are between 81& 85 %
Sun Flower Stacks	82, 83 & 82% removal efficiency for BOD, COD & TSS
Sugarcane waste stalks	up to 91% for all parameters
Rice Husk	Between 89, 92 % for all parameters

Conclusions:

The following points summarize the main conclusions of this study:

- The agricultural wastes media has a high potential application for wastewater treatment as natural backed media for biological filter.
- The system is very successful and promising to be applied in Egypt. The agricultural wastes media is reliable for application as a media for the biological filter from the economical point of view. Also, it could be applied at the raw wastewater disposal points as a low cost and efficient treatment that could decrease the agricultural drains pollution from such action.
- Start up period of the system took from 10 days to 2 weeks to start biological activities, and to get reasonable efficiencies.
- The results of this study revealed that changing the form of Ficus pruning results (original, coarse, medium or fine), has a measurable effect on the wastewater parameters (BOD, TSS, COD, N, and P).
- The removal efficiencies as indicated by these parameters were referring to highest values when medium form is used and followed by fine form. The original form has the least values compared with the other forms. This is mostly because the medium size fulfilled the required criteria for the voids ratio and the surface area factors needed to improve the necessary reaction for biodegradation and for the filtration screening action.
- The media reached high removal efficiency overall the working days without blockage.

Recommendations:

- Further research is recommended to investigate the long-term application of the natural media to determine its life time and the potential application of the expired natural fitter media in composting/co composting.
- The agricultural wastes media has a high potential application as a media for the biological filter from the economical point of view. A feasibly study of wide scale application of the proposed system for rural sanitation services in Egypt is highly recommended.

REFERENCES

Daifullah, A.A.M., B.S. Girgis, & H.M.H. Gad, 2003. "Utilization of Agro-Residues (Rice Husk) in Small Waste Water Treatment Plants." Materials Letters, pp: 1723-1731.

EEAA, 2001. Egyptian Environmental Affairs Agency, Solid waste management, pp: 116-126.

El Nadi, M.H., A.I. Hashem, M.A.K. EL-Deek & M.F. Darwish, 2009. "Use Of Sunflower Stalks For Wastewater Treatment.", Ain Shams Univ., Institute for Environmental Studies and Research, Journal of Environmental Science, 15: 2, Egypt,

El Nadi, M.H., A.I. Hashem, M.A.K. EL-Deek & M.F. Darwish, 2009. "Use Of Almond Shells For Wastewater Treatment.", Ain Shams Univ., Institute for Environmental Studies and Research, Journal of Environmental Science, 15: 2, Egypt.

El Sergany, F.A., R. GH., 2009. "Wastewater Treatment by Sugar Cane Waste Stalks.", Ain Shams Journal of Civil Engineering (ASJCE), 2: 253-258.

El Sergany, F.A., R. GH., 2012. "Application of Rice Husk as Low Cost Wastewater Treatment Technique.", 2nd International Conference & Exhibition Sustainable Water Supply & Sanitation (SWSSS 2012).

El-Hissewy, A.A. & B.A. Tantawi, 2004. "Agro-industrial waste management and by-products utilization.", FAO, pp: 119-130.

Hashem, A.I., M.H. El Nadi, M.A.K. EL-Deek & M.F. Darwish., 2009. "Use Of Cotton Stalks For Wastewater Treatment.", Ain Shams Univ., Institute for Environmental Studies and Research, Journal of Environmental Science, 15: 2, Egypt.

Kumar, U., 2006. "Agricultural products and by-products as a low cost adsorbent for heavy metals removal from water and wastewater.", A review. Scientific research and essay, 1: 033-037.

Tantawi, B.A., 2004. "Egypt strategies achievements in the utilization of agricultural residues." FAO, pp: 3-10.