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EXPERIMENTAL STUDIES ON FIBROUS MATERIALS AS AERATED BEDS FOR DOMESTIC WASTEWATER TREATMENT

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ABSTRACT: *Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. This paper discuss about natural fibers and its applications. Also, this paper concentrates on biomaterials progress in the field of orthopedics. An effort to utilize the advantages offered by renewable resources for the development of bio composite materials based on bio epoxy resin and natural fibers such as Agave sisalana, Areca husk fibres, Musa sepientum, Hibiscus sabdariffa and its application in bone grafting substitutes.*

In the present study efforts have been made to check the efficiency of two different fibrous materials, Agave sisalana fibers and Areca husk fibers used as filter media at different contact periods. To study the comparative removal efficiency of COD, BOD, sulphate, nitrate using Agave sisalana and Areca husk fibers on 15cm filter media and 30cm filter media.

1. INTRODUCTION

Water is considered as the most important and priceless commodity on planet Earth. Water on earth moves continually through the water cycle of evaporation and transpiration, condensation, precipitation and runoff, usually reaching the sea. It is one of the most essential thing that is required for every living being. In order to develop a healthy and hygienic environment, water quality should be monitored such that it lies within the respective standards.

Wastewater is liquid waste discharged by domestic residences, commercial properties, industry, agriculture, which often contains some contaminants that result from the mixing of wastewater from different sources. Wastewater obtained from various sources need to be treated very effectively in order to create a hygienic environment. If proper arrangements for collection, treatment and disposal of all the waste produce from city or town are not made, they will go on accumulating and create a foul condition that the safety of the structures such that building, roads will be damaged due to accumulation of wastewater in the foundations. In addition to this, disease causing bacteria will breed up in the stagnant water and the health of the public will be in danger.

The principal aim of wastewater treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. Therefore in the interest of the community of the town or city it is most essential to collect, treat and dispose of all the wastewater of the city in such a way that it may not cause harm to the people residing in the town. The extent and the type of treatment required, however depends on the character and quality of both sewage and sources of disposal available.

The sewage after treatment may be disposed either into a water body such as lakes, streams, river, estuary and ocean or into land. It may be used for several purposes such as conservation, industrial use or reclaimed sewage effluent in cooling systems, boiler feed, process water, reuse in agriculture, horticulture, sericulture, watering of lawns. Wastewater reuse is becoming increasingly popular, especially in geographies where potable water is in short supply.

OBJECTIVES

The main objective of the study aims at treating the domestic wastewater in a fixed film reactor filled with Agave sisalana fibres and Areca husk fibres.

The specific objectives are:

1. To study the performance of the Agave sisalana fibres and Areca husk fibres used as filter media at different contact periods.

2. To study the comparative removal efficiency of COD, BOD, sulphate, nitrate using Agave sisalana and Areca husk fibres.

2. LITERATURE REVIEW

Central Pollution Control Board (CPCB) studies depict that there are 269 sewage treatment plants (STPs) in India, of which only 231 are operational, thus, the existing treatment capacity is just 21 per cent of the present sewage generation. The remaining untreated sewage is the main cause of pollution of rivers and lakes. The large numbers of STPs created under Central Funding schemes such as the Ganga Action Plan and Yamuna Action Plan of National River Action Plan are not fully operated.

Kudaligama et al., did a study on " Effect of Bio-brush medium: a coir fibre based biomass retained on treatment efficiency of an anaerobic filter type reactor", which reveals that the efficiency of treatment increased with increase in SSA of the media and proper calibration of OLR in the reactor.

Kevin M. Sherman et al., did a study on "Introducing a new media for fixed film treatment in Decentralized Wastewater systems", which reveals that Quanics .Inc . has patented a product that combines advantages of both naturally and artificially occuring media. The product has successfully passed NSF Standard 40 certification.

Padmini et al., Surface modified Agava sisalana as an adsorbent for removal of nickel from aqueous solutions-Kinetics and Equilibrium studies. The studies reveals that the Sisal fibre can be considered to be a cheap and viable adsorbent for the removal of nickel from aqueous solution

Vinod et al. , did a study on "Studies on natural fibrous material as submerged aerated beds for wastewater treatment", which reveals that the maximum percentage reduction of COD(73%), BOD_5(80%), and Orthophosphate(82%) with increased retention time in both reactors. The used of natural fibrous materials as fixed bed in WWT shows promising removal efficiency of organic and nutrients.

3. MATERIALS AND METHODOLOGY

MATERIALS:

Agava sisalana as a filter media

Agava sisalana

Agave sisalana, is a species of Agave native to southern Mexico but widely cultivated and naturalized in many other countries. It yields a stiff fibre used in making various products.

Areca husk fibre as a filter media

Areca husk

Among all the natural fiber-reinforcing materials, areca appears to be a promising material because it is inexpensive, availability is abundant and a very high potential perennial crop. It belongs to the species Areca catechu L., under the family palmecea and originated in the Malaya peninsular, East India.

SAMPLE COLLECTION (Narsampet)

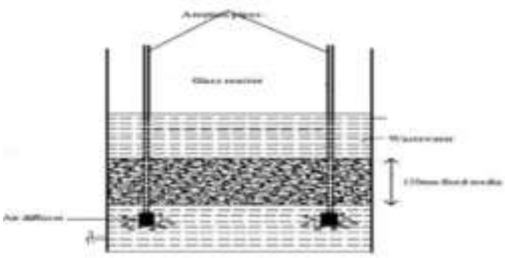
Narsampet is a Rural city in Warangal district of Telangana .According to 2011 census the Narsampet has a population of about 1,20,496 , its population growth rate over the decade 2001- 2011 was -0.28%. The quantity of wastewater being generated is 13.01MLD. The sewage is discharged from individual residential colonies directly into the open drain, since there is no under drainage system for the collection and disposal of sewage.

SAMPLING

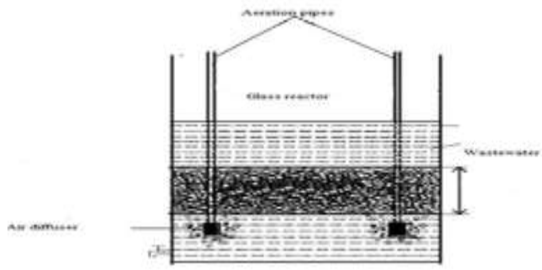
Sampling was conducted for every 72 hours for a period of 15 days between 5:30 pm to 6:30 pm. Grab samples were collected in plastic cans rinsed with distilled water. Sample was collected from the open drain channels and the treatment process was carried out.

Open drainage channel

METHODOLOGY



Cross-section of RC-1 Reactor (Agava sisalana)



Cross-section of RC-2 Reactor (Areca husk)

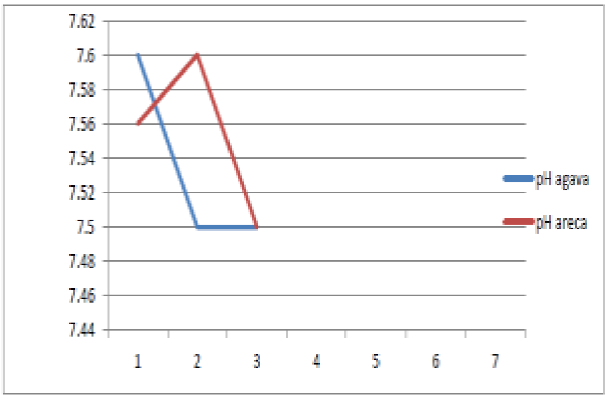
Two different fibrous packing materials used for the present study, Agave sisalana and Areca husk fibre Samples were analysed for the following parameters:

BOD, COD, Chloride, Sulphate, Nitrate, PH.

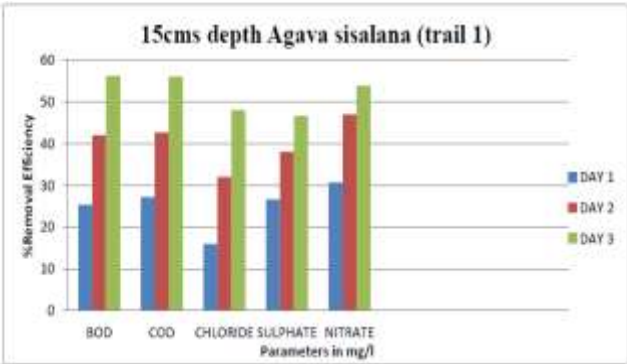
4. RESULTS AND DISCUSSIONS

4.1 Removal efficiency using 15cm Agava sisalana filter bed

PARAMETERS	INITIAL	15 cm depth AGAVA SISALANA (trial 1)					
		1st Day	Removal Efficiency (%)	2nd Day	Removal Efficiency(%)	3rd Day	Removal Efficiency(%)
BOD(mg/L)	240	179	25.4	139	42	105	56.2
COD(mg/L)	305	222	27.2	175	42.6	133	56
Chloride(mg/L)	25	21	16	17	32	13	48
Sulphate(mg/L)	1.5	1.1	26.6	0.93	38	0.8	46.6
Nitrate(mg/L)	1.3	0.9	30.7	0.69	46.92	0.6	53.8
pH	7.5	7.6		7.5		7.5	



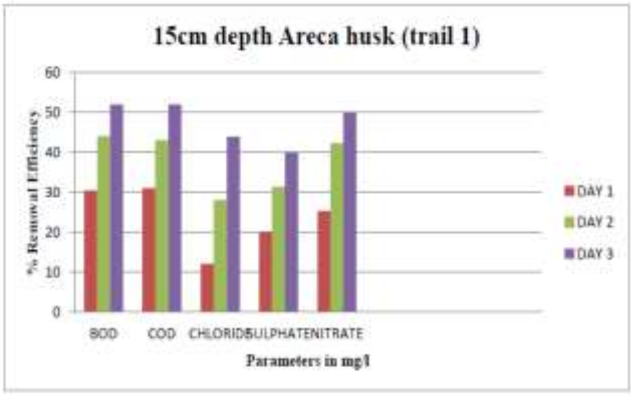
Represention of variation of pH in 15cm Agava sisalana and Areca husk filter beds.



Removal efficiency using 15cm Agava sisalana filter bed

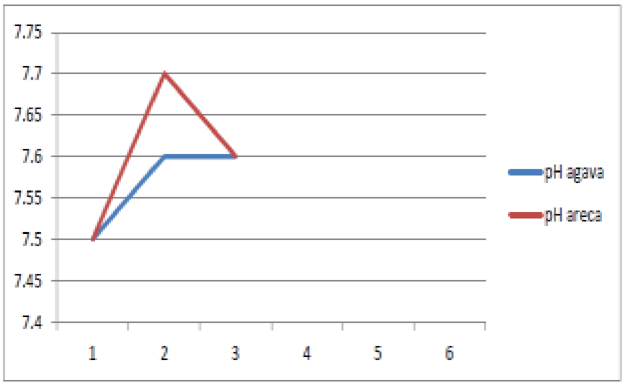
4.2 Removal efficiency using 15cm Areca husk filter bed

PARAMETERS	INITIAL	15 cm depth ARECA HUSK (trial 1)					
		1st Day	Removal Efficiency(%)	2nd Day	Removal Efficiency(%)	3rd Day	Removal Efficiency(%)
BOD(mg/L)	240	167	30.4	134	44.1	115	52.08
COD(mg/L)	305	209	31	169	43	146	52
Chloride(mg/L)	25	22	12	18	28	14	44
Sulphate(mg/L)	1.5	1.2	20	1.03	31.3	0.9	40
Nitrate(mg/L)	1.3	0.97	25.3	0.75	42.3	0.65	50
pH	7.5	7.56		7.6		7.5	

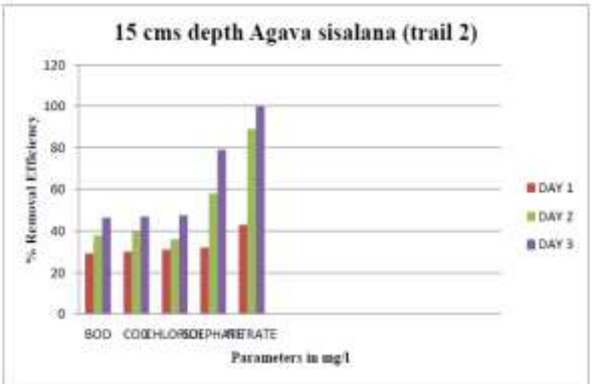


4.3 Removal efficiency using 15cm Areca husk filter bed

PARAMETERS	INITIAL	15 cm depth AGAVA SISALANA (trial 2)					
		1st Day	Removal Efficiency (%)	2nd Day	Removal Efficiency(%)	3rd Day	Removal Efficiency(%)
BOD(mg/L)	140	99	29.2	87	37.8	75	46.4
COD(mg/L)	179	124	30	107	40.2	95	46.9
Chloride(mg/L)	61.49	42	31.9	39	36.06	32	47.5
Sulphate(mg/L)	1	0.68	32	0.42	58	0.21	79
Nitrate(mg/L)	1	0.57	43	0.11	89	NIL	100



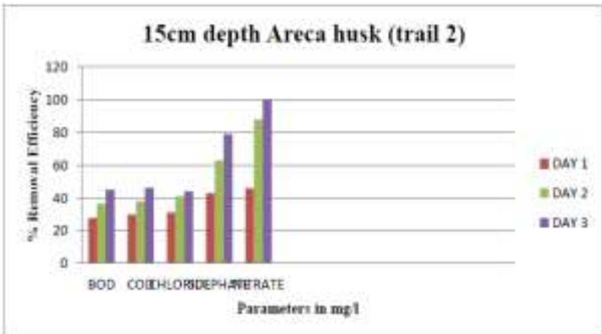
Representation of variation of pH in 15cm Agava sisalana and Areca husk filter beds.



Removal efficiency using 15cm Agava sisalana filter bed

4.4 Removal efficiency using 15cm Areca husk filter bed

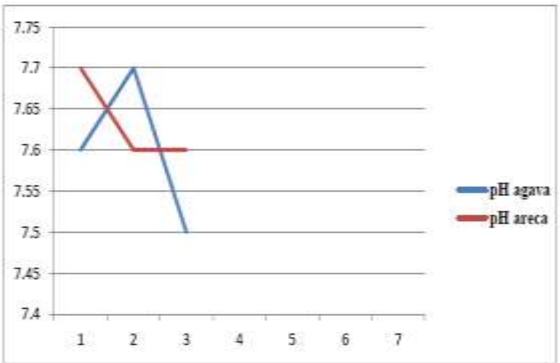
PARAMETERS	INITIAL	15 cm depth ARECA HUSK (trial 2)					
		1st Day	Removal Efficiency(%)	2nd Day	Removal Efficiency	3rd Day	Removal Efficiency(%)
BOD(mg/L)	140	101	27.8	89	36.4	77	45
COD(mg/L)	179	125.5	29.8	111	37.9	96.2	46.2
Chloride(mg/L)	61.49	42	31.1	36	40.9	34	44.2
Sulphate(mg/L)	1	0.57	43	0.37	63	0.21	79
Nitrate(mg/L)	1	0.54	46	0.12	88	NIL	100



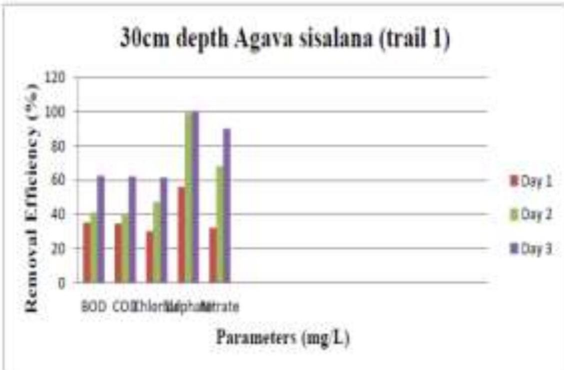
Removal efficiency using 15cm Areca husk filter bed

4.5 Removal efficiency using 30cm Agava sisalana filter bed

PARAMETERS	INITIAL	30 cm depth AGAVA SISAANA (trial 1)					
		1st Day	Removal Efficiency(%)	2nd Day	Removal Efficiency(%)	3rd Day	Removal Efficiency(%)
BOD(mg/L)	320	208	35	189	40.9	120	62.5
COD(mg/L)	398	260	34.6	237	40.4	151	62
Chloride(mg/L)	70	49	30	37	47.1	27	61.4
Sulphate(mg/L)	1	0.44	56	0.01	99	NIL	100
Nitrate(mg/L)	1	0.68	32	0.32	68	0.1	90
pH	7.7	7.6		7.7		7.5	



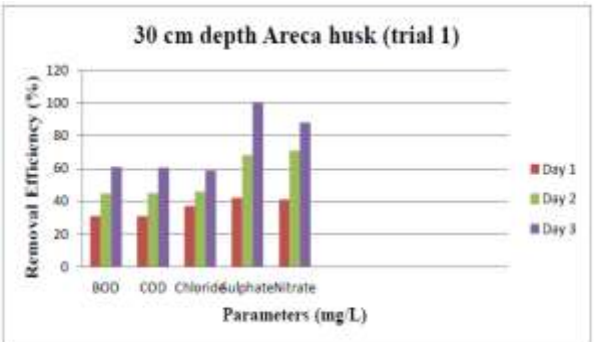
Representation of variation of pH in 30cm Agava sisalana and Areca husk filter beds



Removal efficiency using 30cm Agava sisalana filter bed

4.6 Removal efficiency using 30cm Areca husk filter bed

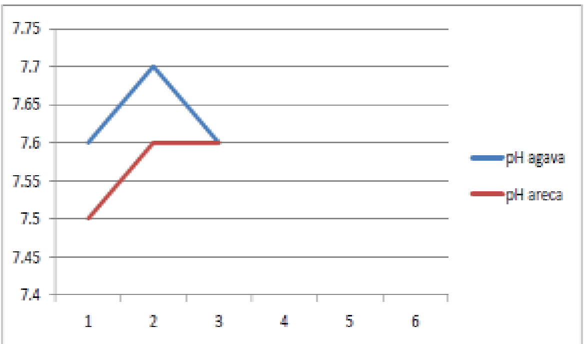
PARAMETERS	INITIAL	30cm depth ARECA HUSK (trial 1)					
		1st Day	Removal Efficiency(%)	2nd Day	Removal Efficiency(%)	3rd Day	Removal Efficiency(%)
BOD(mg/L)	320	221	30.9	177	44.68	125	61
COD(mg/L)	398	276	30.6	220	4407	157	60.5
Chloride(mg/L)	70	44	37.1	38	45.7	29	58.5
Sulphate(mg/L)	1	0.58	42	0.02	98	NIL	100
Nitrate(mg/L)	1	0.59	41	0.29	71	0.12	88
Ph	7.7	7.7		7.6		7.6	



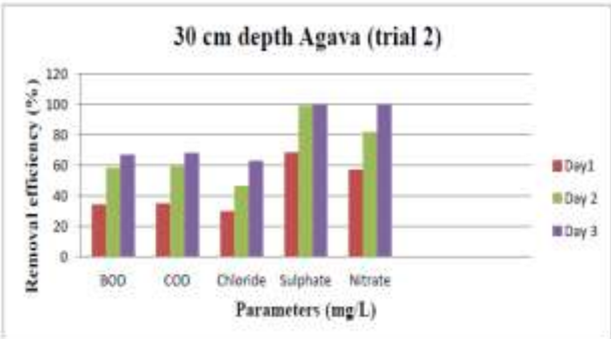
Removal efficiency using 30cm Areca husk filter bed

4.7 Removal efficiency using 30cm Agava sisalana filter bed

PARAMETERS	INITIAL	30cm depth AGAVA SISALANA (trial 2)					
		1st Day	Removal Efficiency(%)	2nd Day	Removal Efficiency (%)	3rd Day	Removal Efficiency(%)
BOD(mg/L)	335	219	34.6	139	58.5	110	67.1
COD(mg/L)	419	271	35.3	170	59.4	133	68.2
Chloride(mg/L)	73	51	30.1	39	46.5	27	63
Sulphate(mg/L)	1.02	0.32	68.6	0.01	99	NIL	100
Nitrate(mg/L)	1.1	0.47	57.2	0.2	81.8	NIL	100
Ph	7.6	7.6		7.7		7.6	



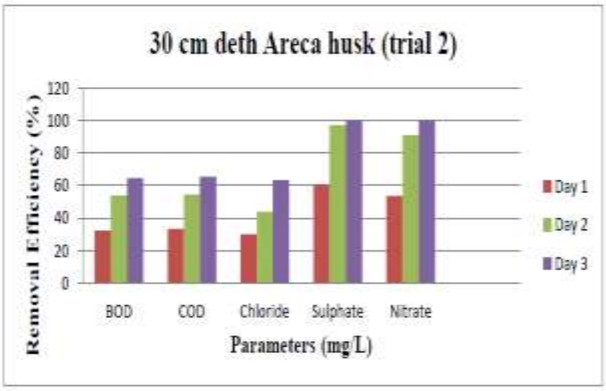
Represention of variation of pH in 30cm Agava sisalana and Areca husk filter beds.



Removal efficiency using 30cm Agava sisalana filter bed

4.8 Removal efficiency using 30cm Areca husk filter bed

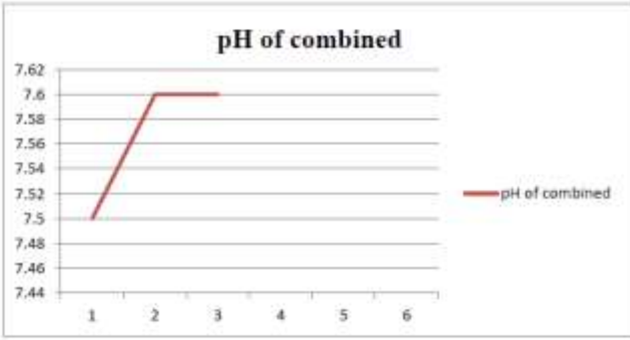
PARAMETERS	INITIAL	30 cm depth ARECA HUSK (trial 2)					
		1st Day	Removal Efficiency(%)	2nd Day	Removal Efficiecy(%)	3rd Day	Removal Efficiency(%)
BOD(mg/L)	335	227	32.2	155	53.7	119	64.4
COD(mg/L)	419	280	33.1	191	54.4	145	65.3
Chloride(mg/L)	73	50.5	30	41	43.8	27.5	62.3
Sulphate(mg/L)	1.02	0.4	60.7	0.03	97	NIL	100
Nitrate(mg/L)	1.1	0.51	53.6	0.1	90.9	NIL	100
pH	7.6	7.5		7.6		7.6	



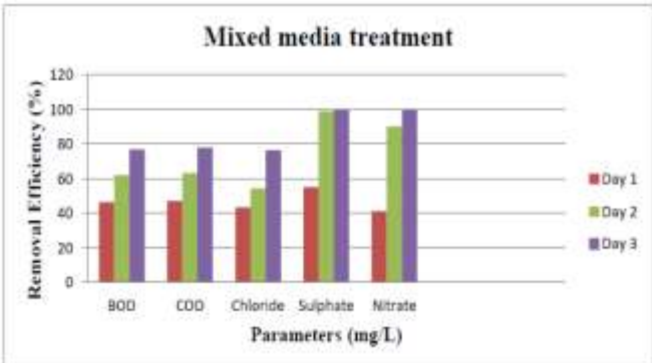
Removal efficiency using 30cm Areca husk filter bed

4.9 Removal efficiency using combined filter beds

PARAMETERS	INITIAL	COMBINED TREATMENT					
		1st Day	Removal Efficiency(%)	2nd Day	Removal Efficiency(%)	3rd Day	Removal Efficiency(%)
BOD(mg/L)	420	225	46.4	160	61.9	97	77
COD(mg/L)	529	280.2	47	195	63.1	120	78
Chloride(mg/L)	81	46	43.2	37	54.3	19	76.5
Sulphate(mg/L)	1	0.45	55	0.01	99	NIL	100
Nitrate(mg/L)	1.02	0.6	41.2	0.1	90.1	NIL	100
Ph	7.6	7.5		7.6		7.6	

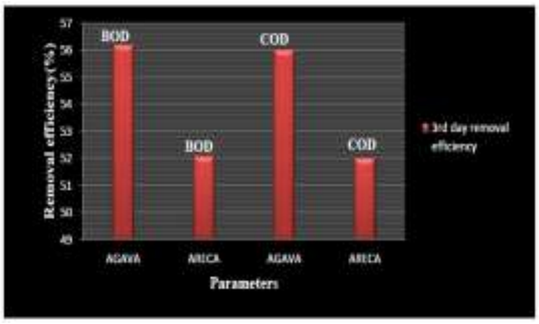


Representation of variation of pH in combined filter bed

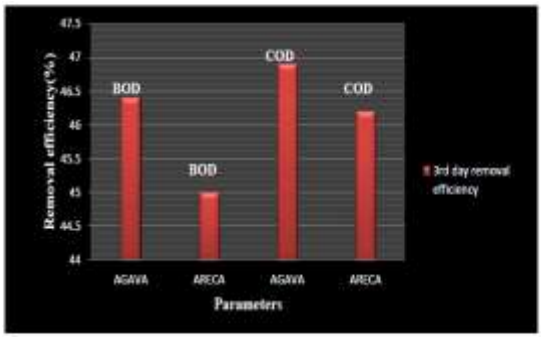


Removal efficiency using combined filter beds.

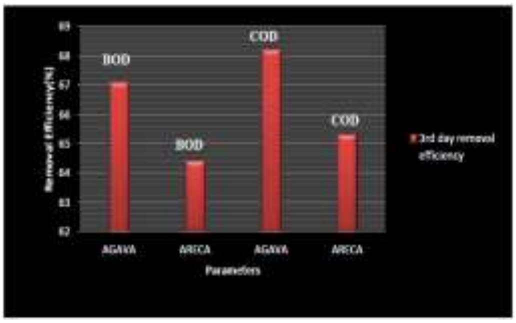
4.10 COMPARISON OF AGAVA SISALANA AND ARECA HUSKFIBRES



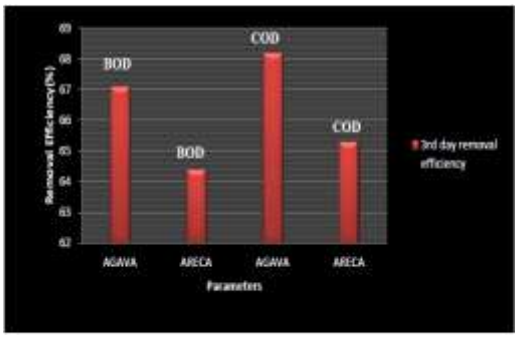
Comparison of BOD and COD Removal Efficiency (15cm depth)



Comparison of BOD and COD Removal Efficiency (15cm depth)



Comparison of BOD and COD Removal Efficiency (30 cm depth)



Comparison of BOD and COD Removal Efficiency (30 cm depth)

4.11 COST ANALYSIS

Characteristics	processing fees	labour fees	transportation charges	total cost
Agava sisalana(4kg)	20/-	50/-	50/-	120/-
Areca husk(4kg)	-	20/-	50/-	70/-

5. CONCLUSIONS

From this study the following conclusions are drawn:

1. Considerable reduction in BOD, COD, nutrients such as nitrates, sulphates, chlorides were achieved.

2. The removal efficiency of BOD and COD by using Agava as filter media was found to be 56.2% and 56% respectively, for 15 cm depth which was higher than that of Areca which was found to be 52.08% and 52% respectively.

3. The removal efficiency of BOD and COD by using Agava as filter media was found to be 67.1% and 68.3% respectively, for 30 cm depth which was higher than that of Areca which was found to be 61% and 61.5% respectively.

4. The removal efficiency for BOD and COD were found to be 77% and 78% respectively, when both the filter medias were combined.

5. The operation trouble faced during the study was foul odour emission due to the early decomposition of the fibers.

6. The cost of Areca fibers used for the treatment of 25liters of wastewater was about Rs.70, which is economical than compared to Agava fibres which costs about Rs.120. However the treatment efficiency of Agava was found to be higher than that of Areca fibres.

7. The treated wastewater can be used for gardening and other domestic purposes like washing and cleaning purposes.

8. The spent fibres were rich in nutrient values and can be used as a organic manure.

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