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A Comparative Study on Treatment of Domestic Kitchen Wastewater by Using Vermiculture Technology

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Abstract

The vermifiltration is a low-cost, sustainable technology has been applied to treat Domestic Kitchen wastewater using earthworms (Eisenia Foetida). The earthworm with microorganisms is responsible for the treatment of Domestic Kitchen wastewater as it passes through the gut and intestine of earthworms. A vermifilter (VF) was set up using Gravel, Sand and Garden soil as filter media.VF was inoculated with Earthworm Eisenia foetida at 5,000 worms. The Average percentage removal of Physical and Chemical Parameters (pH ,Turbidity ,Biochemical Oxygen Demand (BOD) , Chemical Oxygen Demand (COD), Total Solids (TS),Total Dissolved Solids (TDS) ,Total Suspended Solids (TSS),Alkalinity,Hardness,Chlorides) of Untreated and Treated Domestic Kitchen waste water is given in Table 4.1 & 4.2 and Shown in Fig.4.9. The total cost for this project is Rs.3050 %.The Treated Nutrient Valued water is discharged to Gardening and Agricultural purpose and collected vermicompost used as fertilizer. Vermifiltration is an economically feasible, sustainable to environment and socially acceptable technology giving monstrous benefits.

Keywords - Earthworms; Domestic wastewater treatment; pH; Turbidity; Total Solids;BOD; COD; Alkalinity; Hardness; Chlorides ; Vermifilter.

Introduction

Vermiculture Technology

Vermiculture technologies based on earthworms are self-promoted, self-regulated, self-improved & self-enhanced, low or no-energy requiring zero-waste technologies, easy to construct, operate and maintain. They excel all “bio-conversion”, “bio degradation” & “bio-production” technologies by the fact that they can utilize organics that otherwise cannot be utilized by others. They excel all “bio-treatment” technologies because they achieve greater utilization than the rate of destruction achieved by other technologies.

The use of earthworms to breakdown and stabilize human, animal and vegetable waste is called vermicomposting or vermistabilisation. It has the following advantages:

- Increasing the surface area for drying and microbial decomposition by fragmenting the sludge.
- Increasing the moisture holding capacity by decreasing particle size.
- The tunnelling action of earthworms improves aeration.
- The malodours produced by putrescible nitrogen and sulphur compounds are removed, with reduced forms of nitrogen and sulphur being oxidized by microbial composting.

The action of earthworms is mechanical, physical and biological. It involves substrate aeration, mixing, grinding as well as microbial decomposition of the substrate in the intestine of the earthworm.

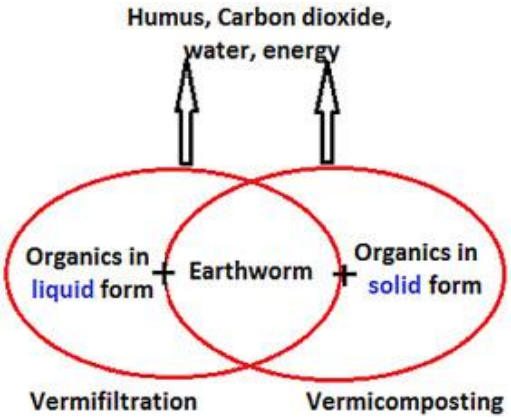

Fig 1.1 Biological degradation process

Materials and Methodology

Collection of sample wastewater

The kitchen waste (organic waste) and papers were collected from house located in Patlur Goundampalayam, Tiruchengode. The Coconut fibre (in powder form) is collected from Coir Industry, Thottikarapalayan.

The sample is stored in plastic cane which is tightly closed .Then immediately which is transported to laboratory for testing in which is kept in freezer at 4ºC.

The gravel, sand and top soil also collected for preparation of filter bed

The red wiggler is collected as biofilter.

Fig 1.2 Red Wiggler (Earth worm)

The cow manure was used as feed for earthworm

And another combination mixture of cow manure leaves and vegetable organic waste is used as feed.

Fig 1.3 Cow manure, Leaves and Organic Vegetable waste

VERMIFILTERATION SYSTEM

A vermifiltration bed which was made up of gravel of different sizes, sand, garden soil, a sprinkler, a fibrous plastic filter was used. 5000 Eisenia fetida earthworms were used on the earthworm type based on a 5000-10000 worms/m^2 calculation.

PREPARATION OF BEDDING

PVC plastic drum is used for vermi reactor in which first layer is placed with aggregates of sizes 10-20 mm and filled up to the depth of 0.2 m and second layer is placed with aggregates 6-8 mm and filled up to another depth of 0.15 m, on top it sand is placed then garden soil, organic waste, coconut peat, shredded paper is placed.

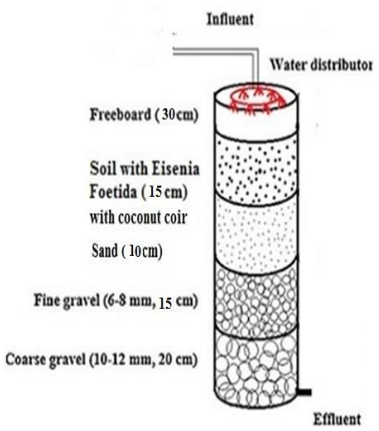

Fig 1.4 Cross section of Vermifilter

FEEDING OF DOMESTIC KITCHEN WASTEWATER

The collected domestic wastewater is discharged to the vermifiltration bed; the detention time is maintained for 2 hours. During the filtration process in vermifilter, the worm acts as a biofilter Worms takes organic matter present in kitchen waste it digests and growth process is taking place in bed. Feeding food waste twice or thrice in a week is essential for metabolism pathway of worms.

Fig 1.5 Vermifilter with Domestic Kitchen waste water with Cow Manure

Fig 1.6 Vermifilter with Domestic Kitchen waste water with mixture of Cow Manure, Leaves and organic vegetable waste

Results and discussion

General

The experimental work on the Vermiculture technology was planned to determine the physico-chemical parameters present in it and to removal percentage of parameters by vermifiltration process.

The physico-chemical parameter determined are pH,Turbidity,TS,TSS,TDS,COD,BOD,Alkalinity,Hardness, Chlorides are compared with the raw effluent.

The vermicompost process is combined with in this to collect vermicompost as fertilizer which contains highly nutritional value.

Comparison of Parameters of Raw Water with Treated Water

S.No	Parameters	Percentage removal of Sample 1 and Sample 2				
		Raw Sewage	Vermifilter with Cow Manure	Vermifilter with Mixture of of Leaves, cow manure and Cow Manure	Non Vermifilter	Vermifilter
		Avg	%	%	%	%
1	pH	6.28	**19.5**	**23.93**	**15.99**	**16.87**
2	Turbidity	383.38	**90.43**	**74.26**	**84.75**	**87.54**
3	TS	694.33	**75.72**	**70.68**	**70.64**	**73.72**
4	TSS	325.11	**66.18**	**66.53**	**74.54**	**74.56**
5	TDS	369.21	**71.6**	**72.78**	**66.57**	**73.21**
6	BOD	334.44	**92.41**	**75.71**	**87.08**	**91.75**
7	COD	667.75	**93.48**	**73.98**	**81.86**	**83.17**
8	Alkalinity	261.38	**24.85**	**77.42**	**86.0**	**88.675**
9	Hardness	251.75	**31.99**	**80.7**	**93.4**	**96.48**
10	Chlorides	106.13	**29.21**	**75.45**	**70.28**	**87**

Table 4.1Percentage removal of Sample 1 and Sample 2

Table 4.2 Average parameter of Sample 1 and Sample 2

S.No	Parameters	Average Parameter Value of Sample 1 and Sample 2,mg/l (or) ppm				
		Raw Sewage	Vermifilter with Cow Manure	Vermifilter with Mixture of of Leaves, cow manure and Cow Manure	Non Vermifilter	Vermifilter
		Avg	Avg	Avg	Avg	Avg
1	pH	6.28	7.5	8.35	7.7	7.55
2	Turbidity	383.38	28.5	127	52	46.5
3	TS	694.33	241	200.75	215.5	96.5
4	TSS	325.11	190	71.05	95.25	35.5
5	TDS	369.21	111	129.7	120.25	61
6	BOD	334.44	28	80.5	39	27.345
7	COD	667.75	57.5	188	126	64
8	Alkalinity	261.38	123.5	115	25.05	22.1
9	Hardness	251.75	229.5	44.5	10	10.25
10	Chlorides	106.13	59	23.41	46.9	18.26

From our investigation Non Vermifilter is worked completely as rapid sand filter concept, we get 85-95% of purified water but colour remains. We cannot use it for drinking purpose. For irrigation purpose, water is passed.

Vermifilter technology removes turbidity well enough.

Treated water from vermifilter tank using layers as cow manure and mixture of cow manure,Leaves,Organic Vegetable waste gives Nutrient valued treated water which is passed to gardening and Agricultural purpose which is sustainable to soil and environment**.**

REMOVAL OF pH

The average pH value of the raw waste water was neutralized by the earthworms in the vermifilter bed to a pH of around 7.0.

There was an average reduction in the Domestic kitchen waste water pH by earthworms in the vermifilter and Non Vermifilter by 16.87 % and % 15.99

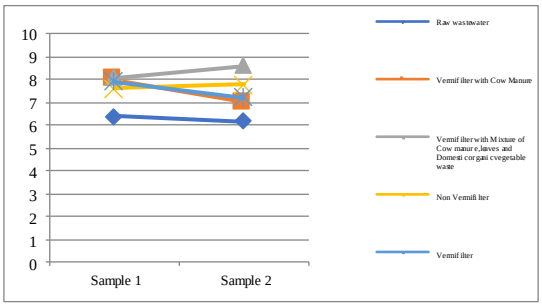

Fig 4.1

Parameter value for indication of pH

There was an average reduction of pH by vermifilter with cow manure layer and mixture of Cow manure, Leaves and organic vegetable waste by 19.5% and 23.93 %

The graph indicates average parameters value. The pH values obtained in the vermifiltration and control bed were acceptable for irrigation purposes i.e. pH range of 6.5-8.5. Furthermore, this pH is ideal for optimum earthworm activity.

REMOVAL OF TURBIDITY

There was a reduction in the Domestic kitchen waste water turbidity by earthworms in the vermifilter and Non vermifilter by 87.54 % and 84.75 %.

The 90.43 % was removed by using cow manure as feed for 1 feet and 74.26 % was removed by using mixture of cow manure, Leaves and Organic vegetable waste. The successful reduction of BOD_5, COD and TDSS has a direct link to turbidity reduction as well such that the water can be successfully used for irrigational purposes.

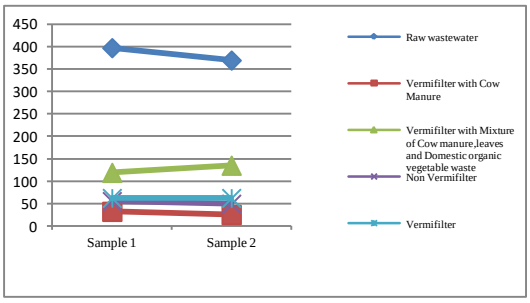

Fig 4.2 Parameter values for indication of Turbidity

REMOVAL OF TS

In the vermifilter bed bio-solids were consistently ingested by the earthworms and expelled as vermicompost. Therefore, there was reduction of total solids are 70.64% and 73.72 % by the vermifiltration process and Non vermifiltration process.

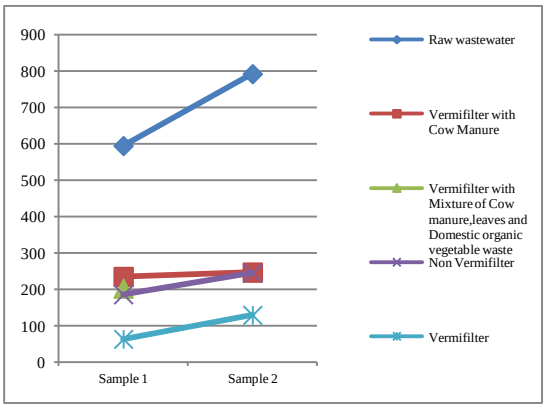

Fig 4.3

Parameter values for indication of Total Solids

The average removal of total solids was 75.72 by vermifiltration with 1 feet cow manure layer and vermifilter process with mixture of cow manure, Leaves and Organic vegetable waste was 70.68%

REMOVAL OF BOD AND COD

There was reduction of BOD are 97.75 % and 87.08 % for Sample 1 and Sample 2 by the vermifiltration treatment process and Non vermifiltration treatment process.

There was reduction of COD reductions are 83.17 % and 81.86 % by the vermifiltration treatment process and Non vermifiltration treatment process..

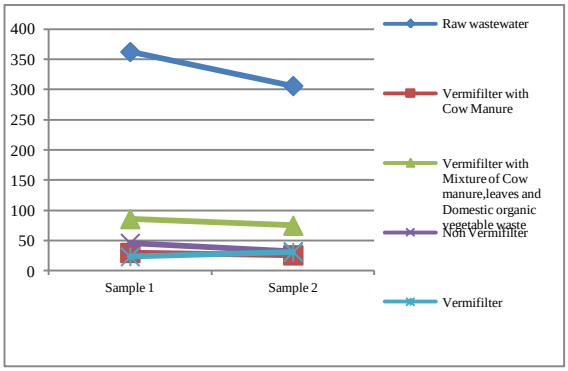

Fig 4.4 Parameter values for indication of BOD

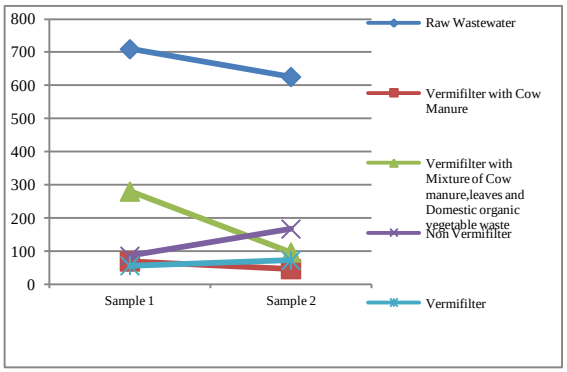

Fig 4.5 Parameter values for indication of COD

The BOD and COD value of treated wastewater by vermifilter with cow manure layer and vermifilter process with mixture of cow manure, Leaves and Organic vegetable waste was 93.48 % and 73.98 %.Similarly, 92.41 % and 75.71%.The obtained value is within permissible limit. Hence it will be suitable for irrigation purpose.

REMOVAL OF HARDNESS

The Removal Efficiency of Hardness is 96.48 % and 93.4 % by the vermifiltration treatment process and Non vermifiltration treatment process.

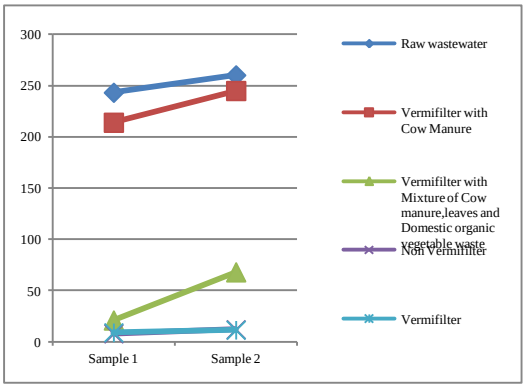

Fig 4.6 Parameter values for indication of Hardness

The Hardness value of treated wastewater by vermifilter with cow manure layer and vermifilter with cow manure, Leaves and organic vegetable waste layer was 31.99 % and 80.7 %.

The Hardness value of treated wastewater by vermifilter with cow manure layer is 214 mg/l and 245 mg/l for sample

1and Sample 2.It exceeds permissible value. It may be possible to reduce by increasing hydraulic retention time and increasing number of earthworms.

REMOVAL OF ALKALINITY

There was a reduction of alkalinity by earthworms in the vermifilter and Non vermifilter by 88.67 % and 86.0 %.

From our experiment the value of Alkalinity brought by vermifiltration with cow manure and vermifiltration with mixture of cow manure, Leaves and organic vegetable waste was 24.85 % and 77.42%.

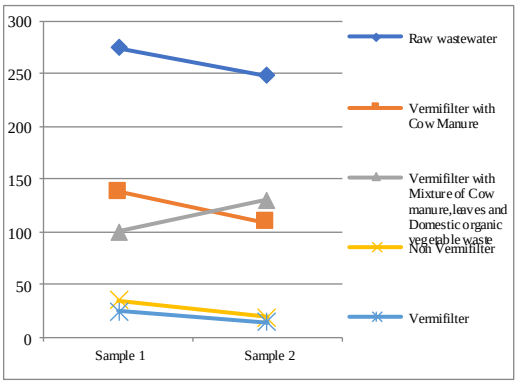

Fig 4.7 Parameter values for indication of Alkalinity

REMOVAL OF CHLORIDE

There was a reduction in the Domestic kitchen waste water chlorides by earthworms in the vermifilter and Non vermifilter by 87 % and 70.28 %.Chloride may impact freshwater organisms and plants by altering reproduction rates, increasing species mortality, and changing the characteristics of the entire local ecosystem.

The 29.21 % and 75.45 % of chlorides was removed by filling cow manure for one foot as feed and filling mixture of cow manure, leaves and organic vegetable waste for one foot as layer. The acceptable value for chlorides is 250 mg/l.

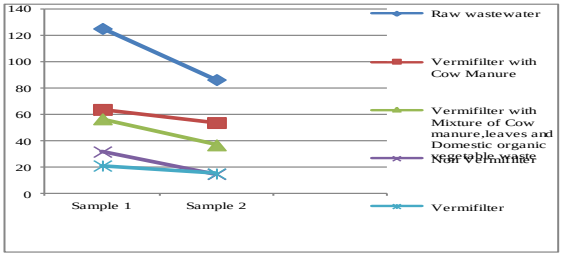

Fig 4.8 Parameter values for indication of Chloride

The chloride values for samples are within permissible limit. Hence it is suitable for irrigational purposes

The graph 4.1, Fig 4.2, Fig 4.3, Fig 4.4, Fig 4.5, Fig 4.6, Fig 4.7, Fig 4.8 and Fig 4.9 showed that physical and chemical parameter value of Samples I and Samples II.These parameters are within permissible limits. Hence suitable for agricultural purpose.

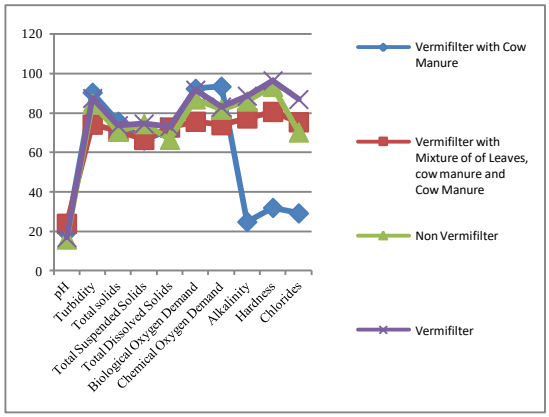

Fig 4.9 Average percentage removal of physical and chemical parameters of Domestic kitchen wastewater

Table 5.1 Impact of composting on loss of weight of organic substrate

S.No	Type of Wastes	Initial weight of Substrates (gm)	Final weight of Vermicompost (gm)	% loss
1.	Cow manure	4000 gm	3525 gm	**11.8**
2.	Mixture of Cow manure, leaves and vegetable waste	4000 gm	2450 gm	**38.7**

From this Vermiculture field treatment, vermicompost is produced in which cow manure and mixture of cow manure, leaves and vegetable waste is used as feed for earthworm.

Finally it reduces amount of organic waste which is beneficial in reduction municipal solid waste. The total weight loss in the organic substrates found to be 11.88 % and 38.73%.

ADOPTING TECHNOLOGY IN HOUSEHOLD FOR REDUCING SOURCE WASTE AND TO FILTER DOMESTIC KITCHEN WASTEWATER

Vermifiltration and vermicomposting are natural organic waste management processes which concept was experimented in our thesis on the use of earthworms to convert organic wastes to stable soil enriching compounds. As material balance concept vermicompost produced as fertilizer for agricultural uses and home gardening.

Fig 4.10 Domestic treatment unit for treating kitchen waste water

In our phase-I cow manure used as feed which is eaten by earthworm and produces vermicompost periodically. In thesis mixture of cow manure, leaves and vegetable organic waste from household used as feed, through this domestic waste water is passed for 1 hour detention time, after the treatment nutrient valued treated wastewater is collected, vermicompost in the tank is collected periodically.

Fig 5.5 Cocoon

Fig 5.6 Vermicompost

Domestic wastewater management can be accommodated through these processes in sustainable concept.

By adopting this technology in every house that we can reduce the load of municipal wastewater.

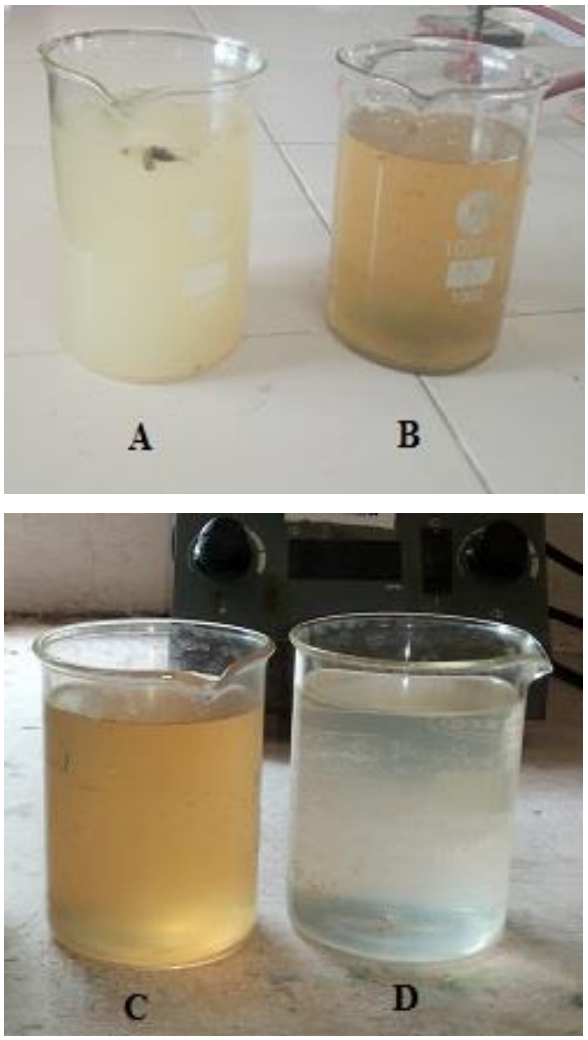

Fig 5.7 A. Untreated Wastewater B.Treated Water by cow manure as layer C.Treated Water by mixture of cow manure, Leaves and organic vegetable waste as layer D.Treated Water by Vermifiltration Process

As material balance concept,

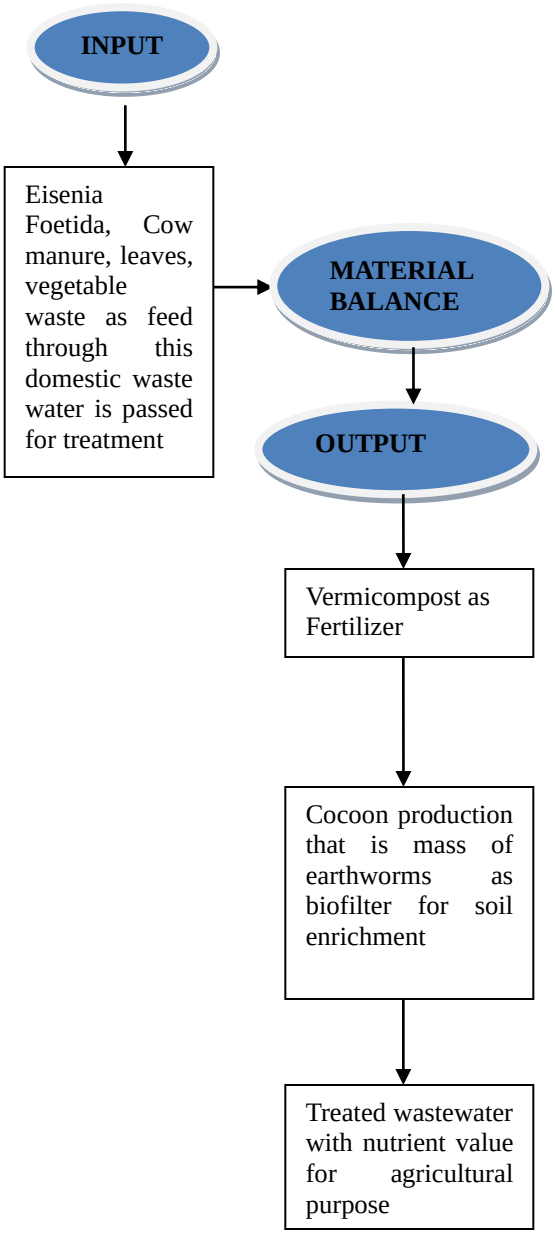

Fig 6.0 Flowchart for material balance of treatment

5.1 TOTAL COST FOR THIS PROJECT

The total amount utilized for this project is Rs.3050 /-.The treatment unit for treating domestic wastewater is placed in open field for this PVC drum is used for unit operation.

Table 4.3 Total cost for this project

S.No	Materials	Cost in rupees
1.	PVC Drum (Gate Valve, fittings, etc.)	1000
2.	Gravel ,Sand, Garden soil	850
3.	Eisenia Foetida (Per kg-Rs.600)	1200
Total cost		**Rs.3050 /-**

Output and profit from this project:

1 kg of earthworm is produces the same quantity of earthworm within 30 – 45 days and periodically vermicompost is collected .1 kg of vermicompost manure is 20-50.Rs and 1 kg of Eisenia Foetida is Rs.600.Our project fulfills the material balance concept and sustainable to environment.

CONCLUSION

Vermifiltration is a logical extension of soil filtration and can be a most cost-effective and odour free process for Domestic kitchen wastewater treatment with efficiency. The total Cost for this project is discussed and given. Installing this treatment unit in every house reduces the municipal load and I suggest that adopting this technology to make sustainable environment.

In vermifilter the sample colour was removed in the same percentage. Hence further increasing detention time, it will be used for drinking purpose. This treated water contains nutrient in high percentage which is used for agricultural purpose.

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