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CHARACTERIZATION AND MICROBIAL TREATMENT OF TANNARY WASTEWATER

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ABSTRACT:

Present study deals with characterization and treatment of tannary wastewater samples collected from 4 different stages of tannary processing unit from Ashta, Dist. Sangli of Maharashtra State. The characterization of selected wastewater was studied in each stage as well as in mixed effluent form for determination of various parameters like P^H , Total acidity, Total alkalinity, Total solids(TS), Total dissolved solids(TDS), Total volatile solids(TVS), Total suspended solids(TSS), Biological oxygen demand (BOD), Chemical oxygen demand (COD), Total Kjeldahl's nitrogen and Total organic carbon. Out of all effluent samples collected, effluent 01(E1) was highly alkaline with total alkalinity 3200 mg/lit, COD 8600mg/lit, total solids 21800mg/lit while remaining all 03 effluent samples (E2, E3 and E4) were acidic in nature with variations in all parameters. As compared to other, Effluent 3(E3) and mixed effluent(E5) shows more or less similar parameters. However, E3 shows COD 24400 mg/lit, BOD 3640 mg/lit, total solids 19260 mg/lit while mixed effluent (E5) shows COD 21200 mg/lit, BOD 3780 mg/lit and total solids 20560 mg/lit respectively. Along with other parameters, values of COD and total solids present in wastewater is relatively higher. So, environmental point of view it is essential to treat it properly to reduce pollution load. Hence, present study was carried out for treatment of mixed tannary wastewater using potent identified organism isolated from feather dumping site and named as *Stenotrophomonas maltophilia* YArck with accession no. KY941138 deposited in Gen Bank. The study reveals that, use of such organism along with physical, chemical treatment i.e. using aeration and treatment of optimized dose of alum coagulant is helpful and more effective indicated by maximum reduction in the respective tannary wastewater parameters significantly. After treatment, study reveals major reduction as 51.88% in COD, 46.03% in BOD and 55.44% in TS than initial parameters along with reduction in other parameters successfully.

KEYWORDS: Tannary wastewater, Physicochemical Parameters, *Stenotrophomonas maltophilia* YArck, Pollution, Microbial Treatment.

INTRODUCTION:

Tanning is the one of the process by which animal skin and hides are converted into leather and other related products using tanning agents and through this process it generates highly turbid, colored and bad foul smelling wastewater [1]. The process of tanning is to performed to maintain the skin's natural properties, to stabilize its structure and at the same time to chemically process to avoid putrefaction for longer period. Conversion of animal skin into leather is carried out by performing

eight step processes such as Unhairing, Liming, Deliming and Bateing, Pickling, Tanning, Neutralising, Dyeing and Fat Liquoring, Drying, Finishing [2,3,4]. The wastewater generated in Soaking, liming and Deliming process includes high amount of sulphides, lime and ammonium salts, chlorides, sulphates and proteins in the effluent with high amount of BOD and COD [5]. Lime liquor is highly alkaline which contains suspended solids, sodium sulphide, dissolved lime, high ammonical nitrogen and organic matter [6]. Total 30-35 m³ of wastewater produced per ton of raw hide. Thus, tannary effluent parameters shows high values. Simultaneously it also creates severe problems in collection, treatments and disposal of waste effluents [7]. This situation also creates serious public health problems. The various components present in the effluent affects agriculture, human beings, live stock besides causing severe problems in the tannary workers.

These tannary waste not only represent a threat to the environmental quality but also needs adequate treatment to reduce their pollution potential. Various physicochemical treatment techniques can also be applied to tannary wastewater but these methods are expensive. So that, most commonly biological treatments are applied which are reliable and cost effective [8]. Various micro-organisms have ability to reduce contents of pollutants significantly by using them as nutrient and energy source under aerobic or anaerobic conditions. Present investigation mainly deals with characterization of collected tannary wastewater and its biodegradation treatment using specific organism.

MATERIAL AND METHODS:

Collection Of Tannary Effluent Samples:

Effluent samples of various stages were collected from a tannary unit at Ashta, Dist. Sangli. The effluents were collected in plastic containers and brought to the research laboratory with proper care and stored at R.T. till further analysis. The different chemicals used during analysis of tannary effluents were analytical grade reagents.

Characterization Of Tannary Effluent Samples:

The various physiochemical parameters of respective effluents were analysed as per standard procedures. The parameters include P^H, Total Acidity, Total Alkalinity, Chemical oxygen demand (COD), Biological oxygen demand (BOD), Total solids (TS), Total suspended solids (TSS), Total volatile solids (TVS), Total dissolved solids (TDS), Total organic carbon, and Total Nitrogen content.

Determination Of P^H

P^H of the respective effluent samples were determined by strip method and confirmed by electrode method in which it is determined by measurement of electromotive force (emf).

Determination Of Total Acidity:

Total acidity of 50 ml effluent sample was determined by P^H probe method using 0.1 N NaOH until the P^H of sample reached at 8.3 [9]. The NaOH volume added was noted and total acidity

of sample was calculated by using following formula-

$$\text{Acidity as mg/l of CaCO}_3 = \frac{(5000) \times N \text{ of NaOH} \times \text{ml of NaOH required for titration}}{\text{Volume of sample taken}}$$

Determination Of Total Alkalinity:

Determination of alkalinity of tannary effluent sample was carried out by P^H probe method using 0.1 N HCl until the P^H of sample reached to 3.7 [9]. The volume of acid added was noted and total alkalinity of sample was calculated by following formula-

$$\text{Total Alkalinity mg/l of CaCO}_3 = \frac{(5000 \times N \text{ of HCl} \times \text{ml of titrated value})}{\text{Volume of sample taken}}$$

Determination Of Chemical Oxygen Demand (COD):

The quantity of oxygen (in mg) required to oxidise the chemicals present in the 1 lit of effluent sample under specific condition is called as chemical oxygen demand of sample. Chemical oxygen demand of respective samples was determined by using K₂Cr₂O₇ method [10] and then calculated by using following formula-

$$\text{COD (mg/lit)} = \frac{(\text{Sample reading} - \text{blank reading}) \times 8 \times 1000 \times 0.1}{\text{Amount of sample taken}}$$

Determination Of Biological Oxygen Demand (BOD):

The milligram of oxygen required to degrade organic compounds present in sample with help of micro-organisms in 5 days at 20 °C is consider as biological oxygen demand. To determine BOD of effluent sample, Wrinkler Azide method was used [10] and BOD of sample was calculated by following formula-

$$\text{BOD mg/lit} = \frac{R \times 0.1 \times 1000 \times \text{Dilution factor}}{\text{Amount of sample used for titration}}$$

Determination Of Total Solids:

The filterable or non-filterable matter remains as residue upon evaporation and subsequent drying at a particular temperature is called 'solids'. Total solids are residue after evaporation and subsequent drying in oven at 103-105⁰ C of a known volume of sample. Total solids was determined by standard method [10]. Then total solids were determined by using following formula-

$$\text{Total solids (mg/ lit)} = \frac{(\text{Final weight} - \text{initial weight}) \times 1000 \times 1000}{\text{Amount of sample taken}}$$

Determination Of Total Volatile Solids:

For this, above procedure of determination of total solids was used and then same dish was kept for ignition until all the content in dish converts into ash form. Total volatile solids were then calculated by using following formula-

$$\text{Total volatile solids(mg/lit)} = \frac{\text{Loss of weight after ignition} \times 1000 \times 1000}{\text{Amount of sample taken}}$$

Determination Of Total Dissolved Solids:

For determination of Total dissolved solids, standard method used[10]. Then total dissolved solids were determined by using following formula-

$$\text{Total dissolved solids (mg/lit)} = \frac{(\text{Final weight}-\text{initial weight}) \times 1000 \times 1000}{\text{Amount of sample taken}}$$

Determination Of Total Suspended Solids:

For determination of total suspended solids, effluent was filtered through previously weighed Whatmann filter paper and after drying filter paper total suspended solids were calculated by following formula-

$$\text{Total suspended solids (mg/lit)} = \frac{(\text{Final weight}- \text{initial weight}) \times 1000 \times 1000}{\text{Amount of sample taken}}$$

Theoretically, the difference between Total solids and Total dissolved solids is suspended solids

$$\text{Total suspended solids (mg/lit)} = \text{Total solids} - \text{Total dissolved solids.}$$

Determination Of Total Organic Carbon:

Total organic carbon present in tannary wastewater was determined by using Walkley-Black chromic acid wet oxidation method and finally organic carbon content was determined by using following formula-

$$\text{Total organic carbon (\%)} = \frac{(\text{B.R.}-\text{S.R.}) \times N \times 0.003 \times 100}{\text{Amount of sample taken}}$$

Determination Of Total Nitrogen Content:

For determination of total nitrogen content of tannary wastewater Kjeldahl's method was used and nitrogen content was calculated by the following formula-

$$\text{Total Nitrogen(ppm)} = \frac{(\text{mlstd.acid-ml blank}) \times \text{Normality of acid} \times 1.4007}{\text{Amount of sample taken}}$$

Biological Treatment Of Tannary Wastewater:

After determination of physiochemical parameters of tannary wastewater, it was aerated overnight by using air bubbler. Then, various concentrations of coagulating agents like alum, FeSO₄, FeCl₃ were used. Out of which alum gives effective results. So further alum dose was optimised using various concentration and finally 7% alum dose was added in effluent and allow to settle or sedimentation. Then secondary treatment of mixed tannary wastewater using potent identified proteolytic organism isolated from feather dumping site and named as *Stenotrophomonas maltophilia* YArck with accession no.KY941138 deposited in Gen Bank was carried out in which 10% inoculum of respective culture was inoculated in mixed effluent sample and incubated at R.T. on rotary shaker for 7 days. After sufficient time incubation, such effluent sample was analyzed to determine all physicochemical parameters. Results of reduction in parameters due to biodegradation were noted down and compared with initial parameters.

RESULTS AND DISCUSSION:

Characterization Of Tannary Wastewater:

Wastewater collected from different stages of tannary processing unit has variations in values of P^H, total acidity, total alkalinity, COD, BOD, TS, TDS, TVS, TSS, organic carbon content and total nitrogen content. Analysis of such physicochemical parameter sare shown in the following Table.1.

Table 1. Analysis of tannary wastewater (Before treatment)

Parameter	Effluent from stage 1 (E1)	Effluent from stage 2 (E2)	Effluent from stage 3 (E3)	Effluent from stage 4 (E4)	Mixed effluent (E5)
P ^H	10.5	6.5	5.5	4.5	5.5
Total acidity(mg/lit)	---	2102	2800	3100	2767
Total alkalinity(mg/lit)	3200	---	---	---	-----
COD (mg/lit)	8600	10800	24400	19600	21200
BOD(mg/lit)	3210	3160	3640	3380	3780
Total solids(mg/lit)	21800	16380	19260	15540	20560
Total dissolved solids (mg/lit)	20420	12860	18320	13800	18180
Total volatile solids(mg/lit)	5610	8120	9820	10060	10140
Total suspended solid(mg/lit)	2720	1840	2460	1720	2380
Total organic carbon (%)	00.25	00.45	00.82	00.32	00.47
Total nitrogen(ppm)	741.03	457.48	600.99	193.57	535.90

As values of all parameters are very high, it needs proper treatment.

Determination Of P^H

The P^H of tannary wastewater collected from various stages of processing is given in table 1. It shows P^H of effluent 1(E1) is highly alkaline while that of remaining three were acidic in nature.

Determination Of Total Acidity:

Acidity of water is generally measured by hydrogen ion concentration. In polluted water, acid comes from dissolved carbon dioxide or organic acids leached from the soil. Acid water may corrode metal or concrete. The results of present study given in table 1. Here, Effluent 4 (E4) is more acidic than that of remaining effluents while E3 and mixed effluent shows nearly same acidity content.

Determination Of Total Alkalinity:

Alkalinity of water is its acid neutralising capacity. It is sum of all bases. The alkalinity of natural water is due to presence of salts of carbonates, bicarbonates, borates, silicates and phosphates along with hydroxyl ions. The results of such study is included in table 1. It observed that, effluent 1 (E1) is highly alkaline with total alkalinity 3200 mg/lit.

Determination Of Chemical Oxygen Demand (COD):

The results of this study are represented in Table 1. COD of all effluents are higher which indicates higher concentration of organic matter. E3 and mixed effluent shows 24400 mg/lit and 21200 mg/lit respectively.

Determination Of Biological Oxygen Demand (BOD):

The results of this study given in Table 1, which indicates that all effluent samples have high organic load. Mixed effluent(E5) has maximum BOD value 3780 mg/lit.

Determination Of Total Solids (TS):

The results of this study mentioned in table 1. It clearly shows that, effluent1 (E1) has maximum TS i.e.21800 mg/lit than that of remaining effluents. The solids present in effluent causes turbidity in receiving water body.

Determination Of Total Dissolved Solids (TDS):

Results of total dissolved solids of respective effluent samples are recorded in table no.1.All effluents having higher range in which E1 shows 20400 mg/lit. The total dissolved solids may increase salinity of the water.

Determination Of Total Volatile Solids (TVS):

The results of total volatile solids of effluent sample sare represented in table no.1. Out of all other effluents, E4 shows higher TVS 10140 mg/lit. Volatile solids normally represent the amount of organic solids in water.

Determination Of Total Suspended Solids (TSS):

The results of present study given in Table no.1. in which E1 contains 2720 mg/lit TSS. These suspended impurities cause turbidity in water streams.

Determination Of Organic Carbon:

The total organic carbon present in the effluent samples are mentioned in the table no.1. It has less percentage.

Determination Of Total Nitrogen:

The nitrogen content in wastewater effluent is recorded in table no.1 It shows high nitrogen content. These high levels of Ammonia-N and nitrogen might be attributed to several components in tannary effluent.

Biological Treatment Of Tannary Wastewater:

After aeration and 7% alum dose treatment, effluent was treated using selected efficient proteolytic organism and results of this biological treatment of tannary wastewater was recorded in the Table no.2.The results indicate that, P^H of mixed effluent after treatment was increases slightly due to neutralization effect of proteolytic activity. The percent reduction in all parameters are like Total acidity 21.21%,COD 51.88%,BOD 46.03%,Total solids 55.44%,Total volatile solids 62.91%,Total suspended solids 26.89%,Total organic carbon 14.89% and Total nitrogen content

51.33%. which indicates degradation of organic matter by selected micro-organism is successful to control pollution level of tannary wastewater.

Table No.2-Analysis of Mixed Tannary wastewater (After treatment)

Parameter	Mixed effluent (Before treatment)	Mixed effluent(After treatment)	% Reduction
P ^H	5.5	6.0	-----
Total acidity(mg/lit)	2767	2180	21.21
Total alkalinity(mg/lit)	----	-----	-----
COD (mg/lit)	21200	10200	51.88
BOD(mg/lit)	3780	2040	46.03
Total solids(mg/lit)	20560	9160	55.44
Total dissolved solids (mg/lit)	18180	8720	52.03
Total volatile solids(mg/lit)	10140	3760	62.91
Total suspended solid(mg/lit)	2380	1740	26.89
Total organic carbon (%)	00.47	00.40	14.89
Total nitrogen(ppm)	535.90	260.80	51.33

CONCLUSIONS:

The present study was carried out to determine characterisation and efficient microbial treatment to reduce pollution level of tannary wastewater. The wastewater generated by tannary processing unit rich in impurities like several soluble and insoluble constituents. After analysis, all effluent samples were found to be rich in organic matter. Before treatment it was observed that, E1 was more alkaline and other effluent samples were acidic in nature. All the effluent shows high range of parameters. Effluent 3(E3) and mixed effluent (E5) shows somewhat similar values of parameters. So, present study focused on treatment of mixed effluent as it is directly disposed off in water body without any effective treatment. The use of efficient organism *Stenotrophomonas maltophilia* YArck for tannary wastewater treatment along with physical and chemical treatment gives reliable results. It was observed that, used organism *Stenotrophomonas maltophilia* YArck was found to be more effective in treatment in which maximum reduction in 7 days in all parameters like 21.21% in total acidity, 51.88% in COD, 46.03% in BOD, 55.44% in TS, 52.03% in TDS, 62.91 in TVS, 26.89% in TSS, 14.89% in total organic carbon and 51.33% in total nitrogen content were recorded.

In this investigation, selected efficient organism was directly used in treatment without any external nutrient supply. If carbon and nitrogen ratio was optimised during treatment, then it will also give better reduction due to enhancement for biodegradation. Also this method is cost effective, so future study will be concentrated on maximum degradation of tannary effluent using microbial consortium along with physicochemical processes.

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