TREATMENT OF SEWAGE WATER FOR USE IN AQUACULTURE: A STEP TOWARDS WASTE MANAGEMENT

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ABSTRACT

Aquaculture is one of the growing sectors of the world. Use of environmental friendly practices in aquaculture is need of the hour. Treatment of sewage in fish culture is an important step in control of water pollution and economical production. Making use of that what is going to be waste is the secret behind developed nations. To get much out of the wastage, a broad knowledge is to be needed of both what is to be used and for whom is it to be used. Best way of waste management is to reuse or recycle it. Proper treatment of sewage water makes its beneficial and is useful in handy production on low costs leading to growth of the industry and environmental conservation. This water has highest percentage of dissolved nutrients thus reducing cultural costs. Simple processes can change sewage water from gutter to gold enhancing waste management.

KEYWORDS: Environmental friendly, production, management, beneficial, conservation.

I.   INTRODUCTION

Wastes are created continuously in our houses, market, government institutions, factories and industries. Most of these wastes in India find their way into water bodies whether fresh or marine leading to the pollution of respective water bodies. All the wastes whether domestic, municipal or industrial sources along with the water makes the sewage of that particular area. A better definition of sewage is " a black and foul smell fluid or semi-fluid created from house-hold washings, markets and work stations containing organic matter and minerals in dissolved or suspended condition in limits which make it lethal for living organisms and unsuitable for other domestic, municipal or industrial works. Waste management strategies are based on three R's i.e. reduce, reuse and recycle. Sewage water has got enormous amounts of nutrients in it. Using this water in culture can reduce feeding costs as the latter accounts for 40-50 % (Craig S and Helfrich L A 2002), 60% (De silva, 1988 Li and Wang, 2004) or 70 % (Muzinic et al 2004) of total aquaculture costs.

II.   Composition of sewage

Domestic sewage of all areas had the similar composition but it may vary with life style, food and trade of that area. Sewage contains 90-99.9% water (Arther 1986, Sanamdikar and Harne 2012) and the remaining inorganic and organic matter in suspended and soluble forms. Untreated sewage water is not useful for fish culture because of low dissolved oxygen, high biochemical oxygen demand, high sulphur and ammonia content, high carbon dioxide content and high bacterial load. However, sewage water has got considerable amount of dissolved nutrients to maximise yield in fish culture. Dehadrai and Ghosh (1979) observed sewage effluent to contain high amount of nutritive substances which may be utilised for productive purposes in the form of organic fertilisers. Use of sewage water in fish farms after proper treatment make fish culturists to reduce the burden of fish feed which accounts for 40-60% of total aquaculture costs.

III. History of sewage water treated fed aquaculture

Use of treated sewage water is an old practice in several countries in East, South and Southeast Asia, especially China (Edwards and Pullin 1988). Germany developed unique systems to treat water during the second half of 19th century. In India wastewater systems were developed from the 1930s. China developed waste water systems in the middle of 20th century. In the first decade of second half of twentieth century Vietnam came up with the waste water systems but they were mainly concerned for aquaculture.

IV. Current status in India

'In India Nowadays in the states like Uttar Pradesh, Madhya Pradesh, west Bengal, Tamil Nadu, Karnataka,

Bihar and Maharashtra treated sewage water is used for fish culture.''

V. About the present farm under investigation
(a) Location
The present farm is located between coordinates 23°21'17"N 77°25'02''E/23.3547403°N 77.4171237°E at the outskirts of village Islam nagar, block phanda, tehsil Huzur in Bhopal district of Madhya Pradesh India. This farm is primarily a seed production unit producing approximately 40crore seeds annually. They also produce market size fish particularly major carps.

(b) Source of water
The sources of water for this farm are bore wells, natural fresh water in the form of rain and water of patra nalla. The source of Patra nalla is lower lake located in Bhopal city and sink is Halali Dam. This nalla becomes sewage carrying drain as it passes through various densely populated areas of Bhopal receiving domestic wastes, effluents from work stations and industrial wastes. Water from bore wells and natural water in the form of rain is good in quality and is suitable for fish culture. However the sewage water coming from Patra nalla need to be treated to make it suitable for fish culture.

The present fish farm under study has got waste treatment plant which works on the principle of stabilisation, filtration and aeration.

VI. MATERIAL AND METHODS
(a) Pre treatment process
Water flowing through the channel is stopped by barrier some 2 km's from the pond. This helps in settling down of heavy waste matters. Water flows over the barrier up to 2kms where from water is pumped to waste stabilising tanks.

Fig 1: Barrier to settle heavy items present in water.

(b) Treatment process
The process of treatment involves three processes i.e. physical, chemical and biological processes.

(i) Physical or mechanical process
This is the first phase of waste water treatment which consists of four sub processes: screening, filtration, skimming and sedimentation. The area of sewage channel from which water is pumped to waste stabilising tanks is screened by bar screen so that polythene bags, plastic items and tree leaves and twigs remain behind. The tip of inlet pipe of the pump is also covered with plastic mesh so that further filtration of the water occurs. Water pumped form sewage water channel is kept in waste stabilising tanks for some days in order to settle heavy solid wastes to bottom. Waste stabilising tanks are filled up to brim so that immiscible wastes like fats, grease and oils can spill out. After proper settlement of solid wastes water is transferred to another tank keeping behind settled solid wastes. Water from second tank is pumped to overhead tank. During its passage, it has to go through graded iron meshed valves. This allows maximum removal of solid wastes. In overhead tank water is aerated with the help of fan installed on the side of tank. Water coming from the second tank is pumped into overhead tank by a porous cylinder so that water gets scattered in all directions leading to maximum aeration. Aeration helps in removal of foul odour of sewage water. From overhead tank water is transferred to chemical treatment tank joined serially.

(ii) Chemical process
After physical or mechanical process, the water is subjected to chemical treatment to make it suitable for fish culture. The aim of chemical treatment is to neutralise the harmful effects of sewage water. This includes deodorisation, sterilisation, chemical precipitation and coagulation. Keeping water stagnant for some days and adding chlorine helps in deodorisation of water. Chlorine can be also used for sterilisation of sewage water along with copper sulphate. Calcium oxide (lime) is used to neutralise ph of water as sewage water is towards acidic nature.

(iii) Biological treatment
This process is concerned with the biological degradation of organic substances into inorganic substances by using bacteria. The basic principle of this process is the attachment and growth of beneficial bacteria to filter bed that extract harmful chemicals from water and convert them to dissolved compounds of harmless nature (Geoffrey 2000). Keeping water stagnant for some days allows generation of beneficial bacteria populations which neutralise further harmful effects of sewage water. After this various parameters are checked and the water is allowed to enter into the ponds. Sewage water has given promising results reducing culturing costs to 80%. These are the simple steps which allow the present farm to maintain a continue supply of water in pond.

The water parameters were checked and analysed by A.P.H.A guidelines,2012.

VII. RESULTS
Water that comes after complete process of treatment is completely different in its physical as well chemical characteristics. Before treatment sewage water has highly foul and irritating smell but after treatment water has less

or no smell. This indicates that after treatment the smell of the water has been brought to tolerable limits.

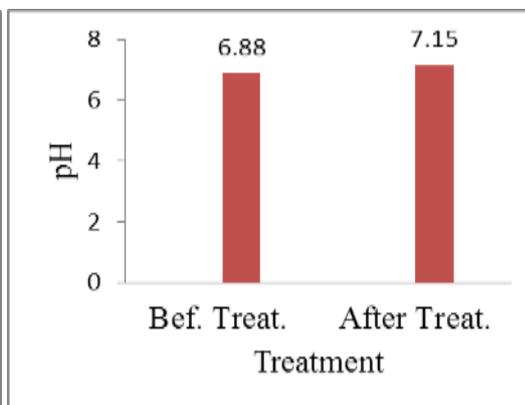Various parameters of sewage water checked before treatment.

S. No	Name of parameter	Unit	Reading
01	Temperature	^{0}C	23^0C
02	pH	-	6.88
03	Light penetration	%	65.22
04	Salinity	Ppt.	0.22
05	Alkalinity	mg/lit	552.00
06	Total hardness as $CaCO_3$	mg/lit	238
07	Chemical oxygen demand	mg/lit	50
08	Dissolved oxygen	mg/lit	2.24
09	Biological oxygen demand	mg/lit	11.00
10	Ammonia	mg/lit	0.29
11	Nitrates	mg/lit	1.76
12	Chlorides as Cl	mg/lit	84.97

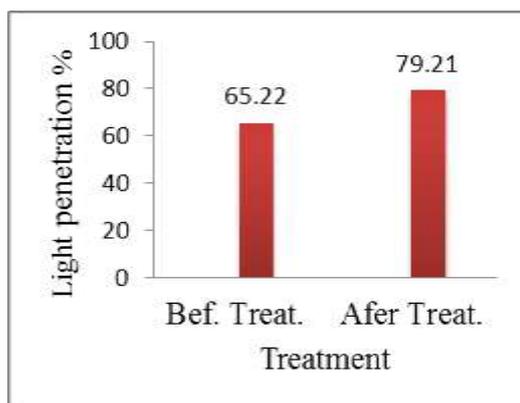Values of various parameters of sewage water checked after treatment.

S. No	Name of parameter	Unit	Reading
01	Temperature	^{0}C	26^0C
02	pH	-	7.15
03	Light penetration	%	79.21
04	Salinity	Ppt.	1.33
05	Alkalinity	mg/lit	349.25
06	Total hardness as $CaCO_3$	mg/lit	173
07	Chemical oxygen demand	mg/lit	13
08	Dissolved oxygen	mg/lit	4.25
09	Biological oxygen demand	mg/lit	5
10	Ammonia	mg/lit	<0.10
11	Nitrates	mg/lit	0.37
12	Chloride as Cl	mg/lit	37.25
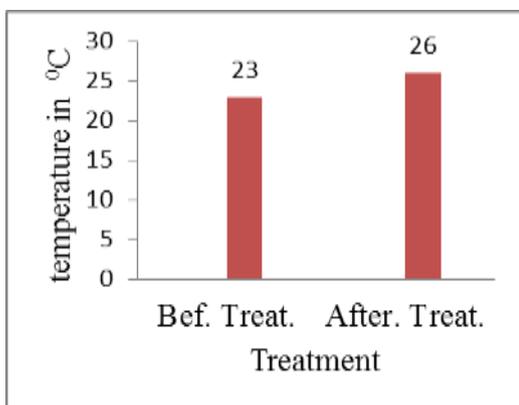
Temp. Before and after treatment
(1)

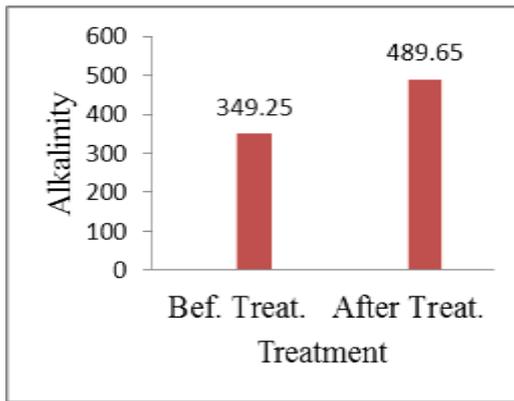**pH Before and after treatment**
(2)

Light pent. Before and after treatment
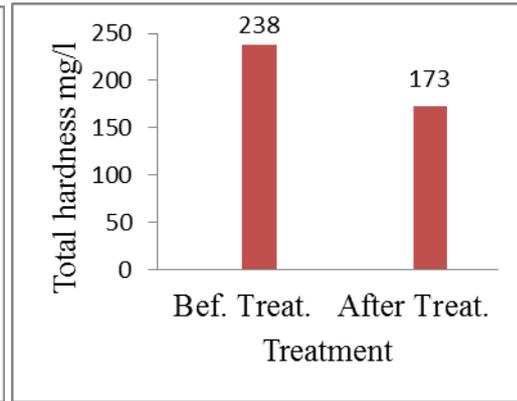**(3)**
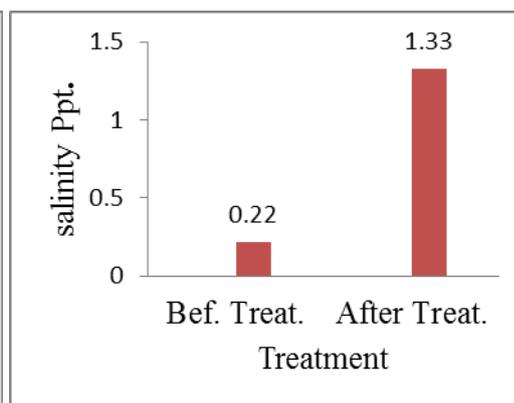
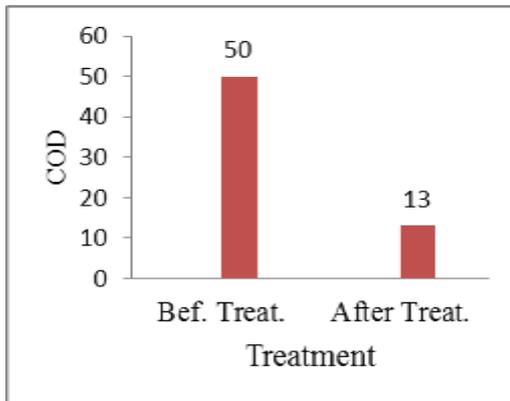**Salinity Before and after treatment**
(4)

Graphs showing various parameters checked before and after treatment of sewage water.
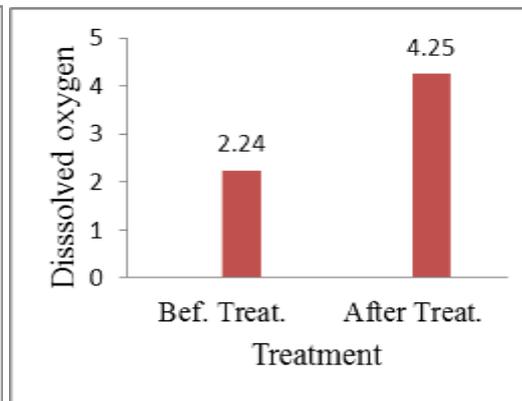
Alkalinity before and after treatment.
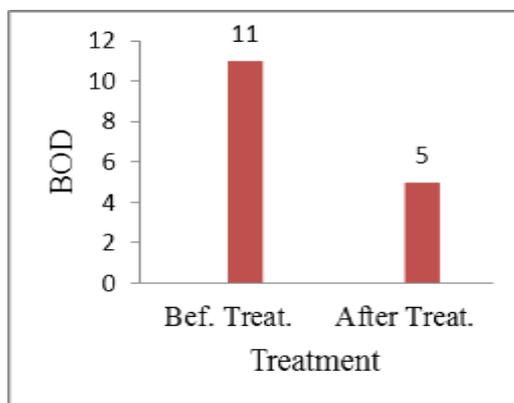(5)

Total hardness bef. and after treatment
(6)

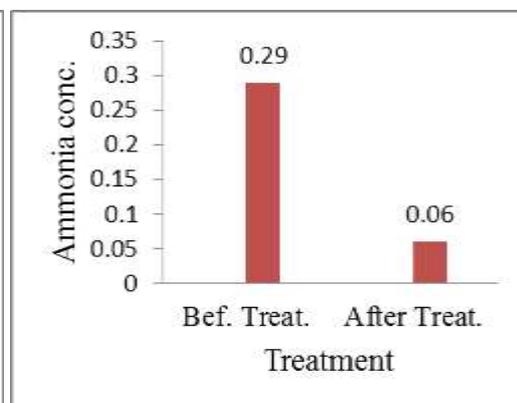
COD before and after treatment
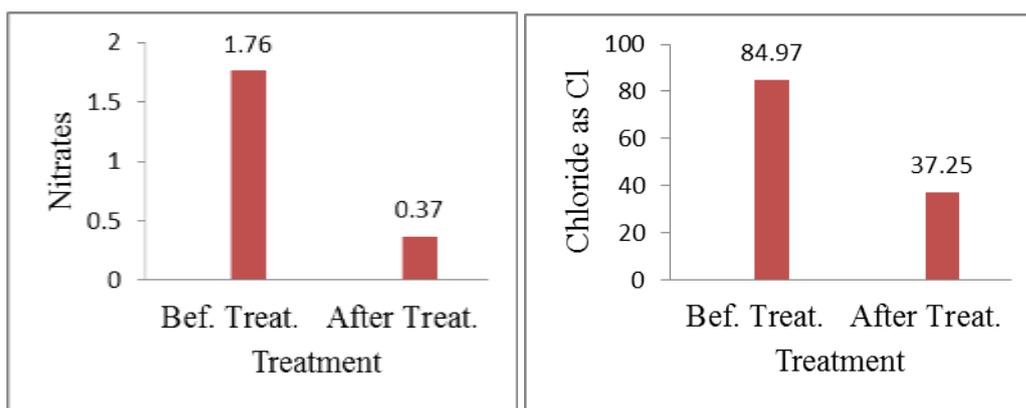(7)

DO before and after treatment
(8)

BOD before and after treatment
(9)

Ammonia conc. Bef. and after treatment
(10)

Graphs showing various parameters checked before and after treatment of sewage water

Nitrates before and after treatment (11)

Chlorides before and after treatment (12)

Graphs showing various parameters checked before and after treatment of sewage water

DISCUSSION

Sewage water is a good source of nutrients but on the other hand contains harmful substances that are harmful to aquatic life. These substances need to be separated from sewage to make it suitable for aquatic life. During the present research, it is clear that after various treatment methods sewage water is made comfortable for aquatic life. The various water parameters checked before and after treatment revealed the importance of this treatment. Those parameters which were in harmful range in sewage water had reached to tolerable limits in treated water. Research also identifies that simple steps are needed to make this waste a worth.

Temperature of water samples calculated before and after treatment does not show much variation.Temperature of untreated sewage water was calculated as 23^0C and that for treated water comes out to be 26^0C which is almost in the normal range especially for carp culture which is between 24^0C and 30^0C (Santhosh and Singh 2007), (Graph 1).

Among various parameters, the pH is changed from slightly acidic to slightly basic during treatment process but still within tolerable limits. The suitable pH range for fishes is between 6.7 and 9.5 and ideal pH level is between 7.5 and 8.5 (Santhosh and Singh 2007). So, treated water has got pH ideal for fish culture, (Graph 2).

Sewage water is low in transparency percentage due to heavy load of dissolved and suspended solids. The results of present research also indicated that sewage water has got low transparency percentage i.e. 65.22% while treated water has high transparency percentage of 79.21%. This shows that treated water has got high light penetration necessary for various aqua-fauna to grow but more transparency is also not suitable. The transparency ranging between 30 and 80cm is treated as good for fish health (Bhatnagar et al 2004), (Graph 3).

Salinity of sewage water has been found to low as compared to treated water. This could be because of chemical treatment of sewage water by various salts. It is

also good that the environment in which fishes dwell should not have low concentration of ions instead same concentration like that of fishes internal environment. Salinity of treated water was within tolerable limit i.e., 2 ppt. (Bhatnagar *et al*, 2004) but that of sewage water was extremely low (Graph 4)."

Alkalinity of treated water is high than that of sewage water because of added lime in it. Trend towards acidic nature is more harmful as compared to same trend towards basic nature. So, more alkalinity is the good to show that this watery environment for fishes is suitable. As per this research article the value before treatment was 349.25 mg L^{-1} which is low as compared to that of treated one which comes out to be 489.65 mg L^{-1}. Both values that is before and after treatment are beyond desirable limits i.e. 50-300 mg L^{-1}(Santhosh and Singh 2007) but still tolerable for carp culture, (Graph 5).

The harder the water is, the less suitable it is for use to living organisms because increase in hardness increases pH of the water sample. The results of the present research also indicate that polluted sewage water has got extremely high hardness and for that of treated water it is considerably low and nearly in optimum range. Hardness between 75-150ppm is ideal for aquaculture, less than 20ppm cause stress and greater than 300ppm is lethal for fish life (Bhatnagar et al 2004), (Graph 6).

Sewage water has got high chemical oxygen demand as is evident from the present research. The results indicate that sewage water has got extremely high chemical oxygen demand means it is unsuitable for aquaculture farming. The treated water shows extremely low chemical oxygen demand showing the importance of treatment. This limit of chemical oxygen demand had no adverse effects on aquatic life, (Graph 7).

Dissolve oxygen concentration is one of the most important parameter of aquaculture water as most aquatic animals find water as their only medium to obtain oxygen. If this dissolved oxygen is more in concentration, the water is said to be good for culturing.

Dissolved oxygen concentration was found to be low in sewage water and high in treated water. This is because of the reason that sewage water during treatment process is circulated throw pipes, aerated with the help of fan fitted with the treatment plant and thrown out with high speed from a very considerable height gaining more aeration. The minimum concentration is $1mgL^{-1}$ for fish to survive and $5mgL^{-1}$ is adequate for fish growth, (Graph 8).

The sewage water shows high level of biochemical oxygen demand which coincides with high pollution. As during our work we check the biochemical oxygen demand of sewage water before treatment. It comes out to be $11mgL^{-1}$. This shows that sewage water is polluted and unsuitable for fish culture. So this water should be treated, diluted so that it can be made suitable for culturing practises. During our work after treatment of sewage water, the biochemical oxygen demand was checked and it was $4.5mgL^{-1}$ which is considered to be normal for fish culture. Water containing BOD levels between $1.05mgL^{-1}$ and $2.05mgL^{-1}$ is considered clean, $3.05mgL^{-1}$ is fairly clean, $5.05mgL^{-1}$ doubtful and $10.05mgL^{-1}$ definitely bad and polluted (Ekubo and Abowei 2011), (Graph 9).

Ammonia concentration in both sewage water and treated water is almost in the optimum concentration. Sewage water has got slightly higher ammonia concentration but still not lethal for fish culture but treated water has normal ammonia concentration. Bacterial degradation by Nitrosomonas and Nitrobacter species help in fixing ammonia. In both waters the ammonia concentration is below harmful concentration i.e. 0.2 mg L^{-1} (Bhatnagar and Singh, 2010), (Graph 10).

Chloride concentration of water for fishes should be not below 30mg/l and not above 100mg/l. The concentrations beyond these limits are thought to unsuitable for fish culture. The present work shows that sewage water has got high chloride content but still in tolerable range but the chloride content of treated water is low and good for fish growth. Actually chloride and nitrite concentration, good for fish culture should be in the ratio of 10:1, (Graph 11).

Nitrate is actually harmless for aquatic fresh water life except when present in exceedingly higher concentration (above 90 mgL^{-1} Stone and Thomforde, 2004). As per our study the nitrate concentration of both sewage water and treated water was in low concentration. These concentrations are non-toxic to aquatic life, (Graph 12).

CONCLUSION
Sewage water has got enormous nutrients which are helpful in fish growth subsequently reducing culturing costs. But supplementing this water as such to fish farm has adverse effects owing to its polluted nature. This water should be treated to make it free from pollution before supplying to ponds. During the present research work, the treatment process done to sewage water samples is showing extremely good results. All the parameters after treatment were in an optimum range and suitable for fish culture. Promising results are found in treated sewage water fisheries producing good yield and reducing culturing cost. Waste water fed fisheries systems have positive environmental effect if planned and managed. But much more knowledge in respective field is necessary to get promising results. Waste water treatment plants should be installed where ever waste channels are flowing to utilise it for aquaculture industry and for environmental sustainability.

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