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EXPERIMENTAL STUDY ON DESALINATION OF BRACKISH WATER USING ALGAE

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ABSTRACT- *Water is the most critical resource throughout the world. As world population is constantly growing, the demand of water increases each and every day. Now a days, the demand of drinking water is one of the rising problem in many cities. Almost 95% of the earth's water is saline and can't be used for drinking purpose. For this demand, the desalination of brackish water provides an opportunity to obtain additional drinking water. Yet, Reverse osmosis (RO) which is the most widely used method for desalination. And also some unicellular species is also used for desalination, this method of desalination is called as Biological Desalination. The Aim of this study is to conduct an experimental study on desalination of brackish water using fresh water (Cyanobacteria) in Parangipettai region. In this study, Attempts were made to study and analyze the physico-chemical characteristics of the water. Various parameters like Appearance, odour, Turbidity NTU, Total dissolved solids and Electrical Conductivity, pH, Alkalinity, Total hardness. Calcium, Magnesium, Sodium, Potassium, Iron, Manganese, Free ammonia Nitrite, Nitrate, Chloride, Fluoride, Sulphate, Phosphate (Brackish water and Desalinated water) etc.., By observing the result it can be concluded that the parameters which were taken for study the water quality are satisfy the requirement for the use of various purposes like drinking, irrigation, industrial etc.*

Key Words: Desalination; Brackish Water; Algae; Nutrient Removal

1. INTRODUCTION

The World is facing formidable challenges in meeting rising demands of clean water as the available supplies of freshwater are decreasing due to (i) extended droughts, (ii) population growth, iii) more stringent health-based regulations, and (iv) competing demands from a variety of users. With only 3% of all available water on the planet being fresh water, seawater is the most abundant available source of drinking water and water for industrial use in many regions, and innovations in the development of novel technologies to desalinate water are among the most exciting and promising. Water is desalinated in order to obtain fresh water suitable for animal consumption or irrigation or if almost all of the salt is removed, for human consumption. Sometimes the process produces table salt as a by-product. In many parts of the world local demand is exceeding conventional resources. More economical use of water, reducing distribution losses and increased use of recycled water can help alleviate this problem but if there is still a shortfall then desalination of seawater or brackish water is a must.

1.1 ALGAE

Algae are a wide range of plants heterogeneous in all shapes, sizes and physiological functions, except that they contain chlorophyll pigments and others. Algae include members of the nucleus of Primitive prokaryote such as blue-green algae. Some algae are microscopic, whereas others reach up to several meters in length. Algae are abundant in salt water and fresh and stagnant pools of water, lakes and in humid places or on the rocks. Large numbers of algae are also found on soil. Furthermore, Algae are also used for the drinking water which mostly required a treatment process.

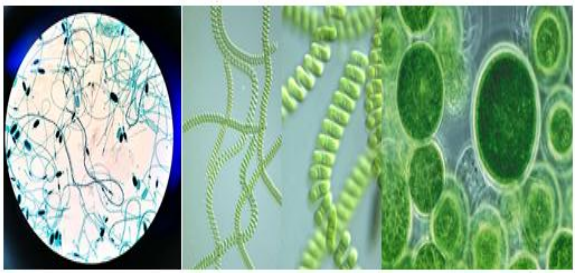

Fig -1: Microscopic view of blue green algae

1.2 NEED FOR THE STUDY

Water is the necessary resource for human survival, is indispensable in daily life. With the world's population consuming water in record amounts and water scarcity causing a host of geopolitical and humanitarian problems, technology can be harnessed to help meet the demand.

1.3 OBJECTIVE OF STUDY

The Main objective of the study are

- To desalinate saline/brackish water using fresh water algae.
- To analyses the physic chemical properties of desalinated water.
- To identify the suitability of desalinated water for different purpose.

AkiliD.Khawaji, et al. (2007) demonstrated the study on Advances in seawater desalination technologies. In this study they explained about a number of seawater desalination technologies had been developed during the last several decades to augment the supply of water in arid regions of the world. Due to the constraints of high desalination costs, many countries are unable to afford these technologies as a fresh water resource.

Arya Krishnan et al. (2013) are investigated the research work in the field of Waste water treatment by algae. The algae selected for the study was oedo gonium and char asp. Various parameters like Biological demand(BOD), Chemical oxygen demand(COD), Ammonia, Nitrogen, Phosphate were observed after the treatment.

Pan Zhang.,et al (2013) reported the study on Research progress of brackish water desalination by reverse osmosis. The study explained that the brackish water (BW) desalination was a primary path to relieve the shortage of water. As one of the BW desalination methods, reverse osmosis (RO) technology has advantage for both technology and process procedure.

E I Sergany F.A.R., et al (2014) are reported the research work in the field of Brine desalination by using algae ponds under nature condition. They proposed the suitability of using algae for brine water disposed from desalination as a new conceptual technique using algae ponds under the nature circumstances.

2. MATERIAL AND METHODS

Water is a basic and crucial resource for survival and growth of life. However, there is a research by Fiorenza (2002) shows that nearly one fourth of mankind is suffering from inadequate fresh water supply. Considering water shortage concerns about 80 countries and has caused some serious results in many places. Desalination of salt containing water is a solution to reduce this problem.

2.1 Location of Study Area

Parangipettai (Lat. 11°29'50.45"N; Long. 79°46'32.01"E) is a small coastal town, situated about 250 km south of Chennai. This station comprises riverine, estuarine, backwater, mangrove and neritic biotopes .The rivervellar which originates from the sharvarayan hills of Salem district, Tamil Nadu, flows through a distance of about 480 km.

2.2 Selection of Algae

For the present study fresh water algae (Cyanobacteria) are taken. The Cyanobacterial samples are collected in Pitchavaram mangrove estuary (Latitude 11°29′ and Longitude 79° 46′). Algae samples of suitable amount was collected in cans and washed thoroughly with tap water and placed in the respective set up for the experimental study.

2.3 Selection of Brackish Water

Brackish water is a broad term used to describe water that is more saline than freshwater but less saline than true marine environments. Often these are transitional areas between fresh and marine waters. An estuary, which is the part of a river that meets the sea, is the best known example of brackish water. Brackish water are choosen in parangipettai which contains heavy metals. Experimental study are performed under laboratory based conditions.

2.4 Field Conditions

The Cyan bacterium are to be grown in aerated and non-aerated conditions under laboratory. After few days of growth, the cyanobacteria was harvested and to be placed under biological treatment.

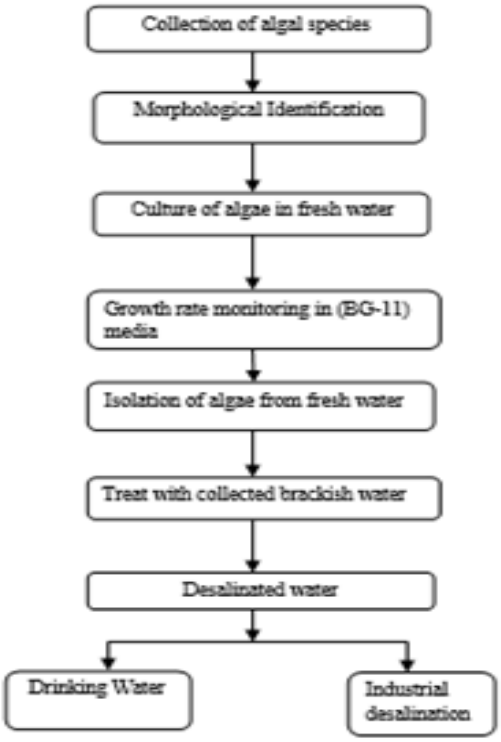

Fig -2: Flowchart Showing Methodology for Desalination Using Algae

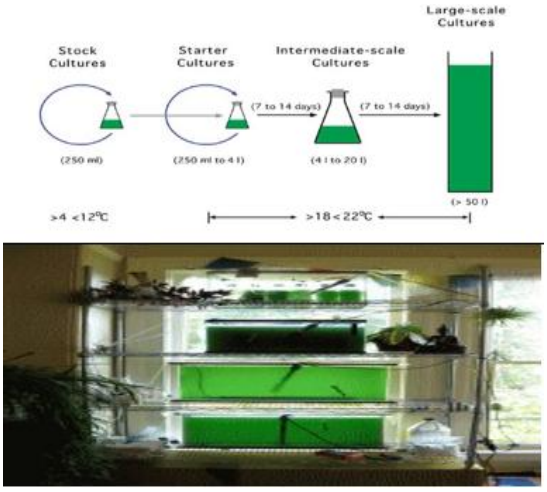

Fig -3: Experimental setup for algae culture

2.5 Isolation and Purification of Algae

Isolation of individual species of cyanobacteria from sample was most important for establishment of pure cultures. As the field samples were contained more than one cyanobacteria species, other bacterial and fungal spores. It necessary to isolate single species from these samples. The mechanical separation of cyanobacteria species from other organism is generally regarded as the most satisfactory method of obtaining pure cultures of cyanobacteria. The isolation and purification of cyanobacteria strains collected from the study area was carried out by direct isolation method.

2.6 WATER TESTING METHOD

GENERAL

Generally the water samples may be testing the laboratory of an educational institute. When the samples are brought to test in the Centre during the holidays, the samples to be preserved in the refrigerator for 2 to 3 days. In such cases sometimes the result may not be representative. Using water kit can test nearly 15 parameters of the collected samples immediately.

PHYSICAL TEST

APPEARANCE: Record appearance as follows
Colorless & clear / brownish/ slightly brownish/ greenish/ slightly greenish/blackish/ slightly blackish/ slightly whitish/ turbid etc..,

ODOUR: Record odour as follows

None/ soil smell/ algal smell/ objectionable odour/ slightly objectionable odour/ rotten egg smell.

pH: pH booklets have been provided to measure pH value of water. Tear a portion of pH paper hold it by your fingers. Using the ink filler and add one drop of water sample on the paper. Wait for 10 seconds, the color change taking place on the wet portion of the ph paper is observed and compared with the pH chart provided in the cover page of pH booklet. Record the pH value.

CHEMICAL TEST

ALKALINITY

Using the 10 ml cylinder, measure 20 ml of water sample (2X 10 ml) and pour it into the clean titration cup. Add 5 drops of 'A1' liquid. The water turns bluish green. Using the '1 ml' syringe add 'A2' liquid (starting from the 40th division).

At the end point the colour of the water change into orange/ yellow. Record the number of divisions of 'A2' added to reach the end point.

CALCULATION

Alkalinity mg/l =- Number of divisions of A2 added X 10

HARDNESS

Using the 10ml measure of the water sample (2 X 10 ml) and pour it into the clean titration cup. Add 5 drops of 'H1' liquid and five drop of 'H2' liquid. The water turns pink in color. Using the '1 ml' syringe add 'H3' liquid. At the end point, the color of the water change into bluish color. Record the number of divisions of 'H3' added to reach at the end point.

4. RESULT AND DISCUSSION

In order to determine the water quality of the desalinated water were collected from velar estuary in the parangipettai command area. The Three water samples and algae were collected properly and transported to the testing laboratory as per the standard. The samples were tested in the laboratory periodically. The results are obtained and analyzed by comparing the result value with WHO standards. The physic-chemical properties of the water samples are analyzed to assess the water quality suitability for drinking water purpose.

4.1 PHYSICAL PARAMETERS OF DESALINATED WATER

COLOUR

The water color is usually due to the presence of organic matter and dissolved organic impurities. The color of the water is compared with standard color solution or color disc. The permissible color for domestic water is 20 mg per liter on platinum cobalt scale. In this study, almost all the samples were falls in the normal range as white color.

ODOUR

Odour is recognized as a quality factor acceptability of drinking water and food prepared from it. Tainting of fish, another aquatic organisms and aesthetics of recreational waters. Most organic and inorganic chemicals contribute taste or odour. These chemicals may originate from municipal and industrial waste water discharges. Natural sources such as decomposition of vegetable matter or from associated microbial activity. Odour problem in water may be due to the presence of dead alive micro- organisms and dissolved gases such as hydrogen, sulphide, methane, carbon dioxide or oxygen also combined with organic matter.

TEMPERATURE

The surface temperature ranges were recorded 25.4 to 30°C at station respectively. The maximum values of surface water temperature were recorded in the month of May 2019 and minimum were recorded in the month of December 2018 at the station. The observed high value of temperature 29.4 0C in May was due to the intensity of solar radiation and evaporation freshwater influx and cooling and mix up with ebb and flow from adjoining neritic waters. The observed low value of December 25.4 0C was due to strong land sea breeze and precipitation.

4.2 CHEMICAL PARAMETERS OF DESALINATED WATER

pH

pH is an important factor that determines the suitability of water for various purpose, including toxicity to animals and plants. The pH is a measure of the intensity of acidity or alkalinity by measures the concentration of hydrogen ions in water. It has no direct adverse effect on human health, however a low below 4.0 will produce sour taste and higher value above 8.5 shows alkaline taste. As per WHO standard pH for aquatic life is the range of 6.5 to 9.0. In this study area the concentration of pH in the desalinated water was 7.42. It was found during 28th day. Therefore, the pH range is within the permissible limits.

ALKALINITY

Measuring alkalinity is important in determining a streams ability to neutralize the acid pollution from rainfall or waste water. It is one of the best measures sensitivity of the stream to acid inputs there can be long term changes in alkalinity of streams and rivers in response to human disturbances. The concentration of Alkalinity in desalinated water were tested and result show the level of alkalinity 200 mg/l in the study area at 28th day. According to WHO standard, the alkalinity level is between 200 to 600 mg/l. Therefore, the alkalinity level in the study area is within the permissible limits.

HARDNESS

Hardness is defined as the concentrations of calcium and magnesium loans, expressed in terms of calcium carbonate. These mineral can cause everyday problems in water. The hardness value of the desalinated water at 28th day were determined, the obtained results show the value of hardness 440 mg/l was found in the area. The average value of hardness is 300 to 600 mg/l (According to WHO standard). Therefore, the hardness level in the water is within the permissible limits.

TDS (TOTAL DISSOLVED SOLID)

TDS is a measure of the combined content of all inorganic and organic substance contained in a liquid in molecular ionized are micro- granular (colloidal solid) suspended form. The principal application of the TDS is in the study of the water quality for streams, rivers, lakes, although TDS not generally considered as a primary pollutant. The range of TDS in this desalinated water at 28th day was 762 mg/l. Therefore the level of TDS level in water is within the permissible limits.

Table -1: level of TDS

TDS Levels in mg/l	Palatability quotient
Less than 300	This is considered as excellent to drink
300 to 500	These levels are good
600 to 900	Fair
900 to 1200	This range constituents poor palatability
Above 1200	This is an unacceptable range

Table -2: physical parameter of brackish and desalinated water

Parameter	Brackish water	Desalinated water
Appearance	Colorless & clear	Colorless & clear
Odour	None	None
Turbidity (NTU)	5.3	4.5

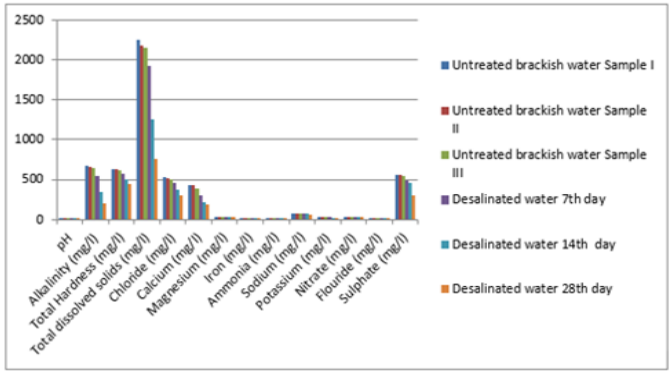

Chart -1: show the comparison between chemical parameters of brackish and desalinated water using cyanobacteria

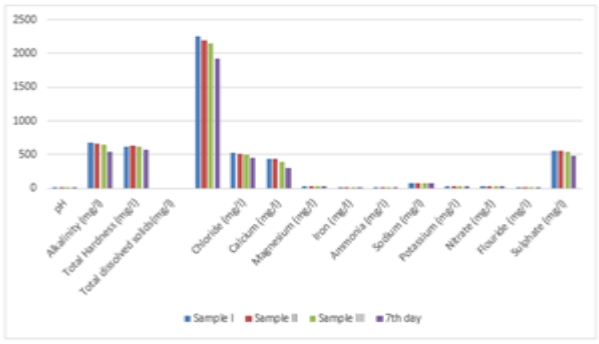

Chart -2: shows result of desalinated water 7th day using cyanobacteria

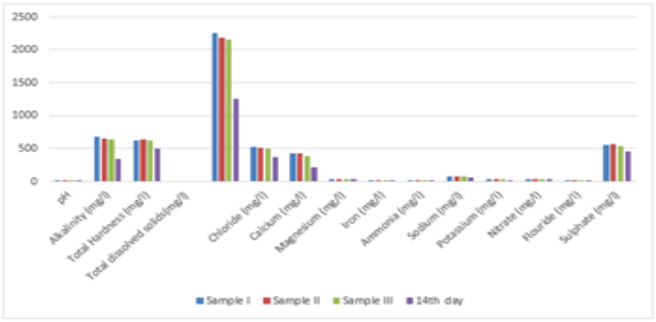

Chart -3: shows result of desalinated water in 14th using cyanobacteria

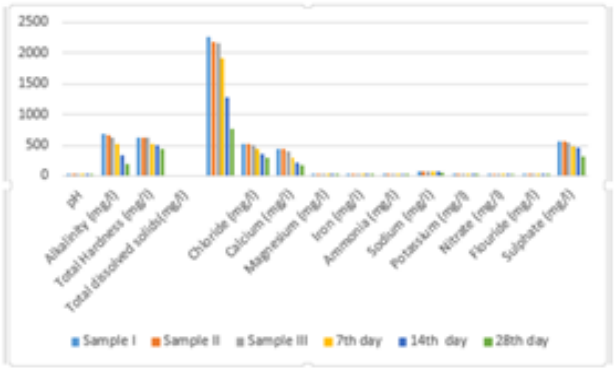

Chart -4: shows the comparison between chemical parameters of brackish and desalinated water using N. oculata

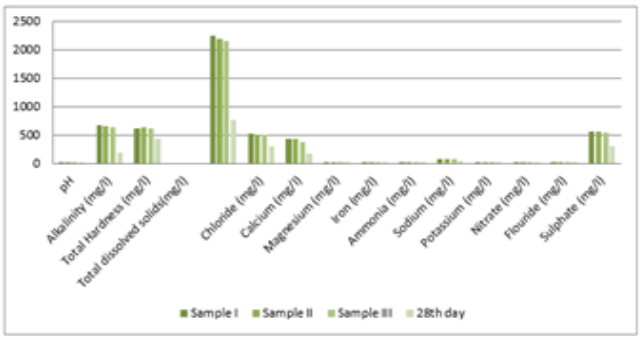

Chart -5: show result of desalinated water in 28th day using cyanobacteria

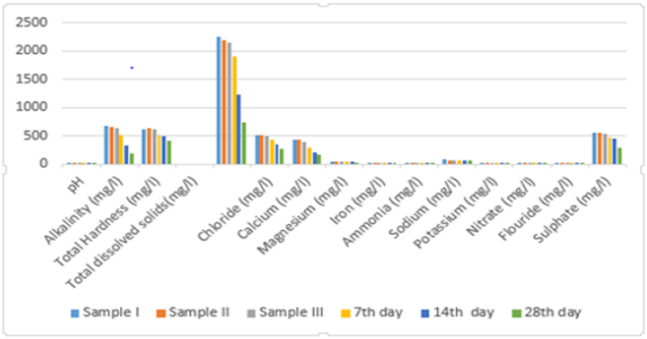

Chart -6: shows the comparison between chemical parameters of brackish and desalinated water using D. Tertiolecta

5. CONCLUSION AND RECOMMENDATIONS

The present study results that the 3 species (cyanobacteria, D. Tertiolecta, N. Oculata) is promising for desalination. The bioprocess of desalination may not largely provide safe drinking water to the coastal population in a short time. In this regard, the biological desalination process may severe the purpose by saving a great amount of energy consumed and cost involved. However a thorough involving biologist and technologist deserves special attentions. To assess the water quality, sample were collected from the velar estuary located in parangipettai area and tested under laboratory. The physic chemical properties of the desalinated water samples were analyzed and compared with WHO standards. Almost all the samples were well within the permissible limits. From this study D. tertiolecta is give better result compare to the other two species.In future to avoid some problems, this study recommend the continues treatment on the water which are essential to assess the water quality for both drinking and irrigation purpose. From this present study, the brackish water desalination showed that the water is suitable for drinking purpose. In future, the ocean water and marine water can be desalinated by following this biological desalination process.

REFERENCES

[1] Deviram GVNS et al. "Purification of Waste Water using algal species". European Journal of Experimental Biology 1(3):216-222, 2011.

[2] Edwards,C., Beattie, K.A.,Scrimgeour, C.M.Codd, G.A. Identification of anatoxin-a in benthic cyanobacteria (Blue green algae) and in associated dog poisoningsat Loch Insh, Scotland.*Toxicon*.,1992;30(10):1165-1175.
[3] McCormick, P.V.,Cairns, J.Jr. Algae as indicators of enviornmental change. *Journal of Applied Phycology.,*1991;3: 129-145.
[4] Fogg, G.E.,Steward, W.D.P.,Fay, P.,Walsby, A.E. The Blue-Green Algae. *Academic Press, London*.1973;pp 459.
[5] Herrero, A.,Flores, E. The Cyanobacteria: Molecular Biology, Geonomics and Evolution (1sted.).*Caister Academic Press.*2008, isbn 978-1-904455-15-
[6] Allen, M M.1966. Studies on the properties of blue green algae. Ph.D. Dissertation, University of California, Berkeley.
[7] Allen, M.M.1968. Simple Condiotions for growth of unicellular blue green algae on plates. J.Phycol.4:1-3.
[8] R.Y. Strainer. Purification and properties of Unicellular Blue-Green Algae. Bacteriological Reviews, June 1971,Vol.35, No.2, p.171-205.

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