EPCAHP

Google Science Fair

EPCAHP: Economical Photobioreactor providing Clean Air and High-Protein diet

Problem Statement

Indian government schools especially from rural and semi-urban areas do not have enough resources to address the problems caused by:

A. Air Pollution

B. Malnutrition.

An easy to use, effective and economical solution to address the menace of pollution and malnutrition amongst school children is the need of the hour.

A. Air Pollution In India

- The air quality in New Delhi, the capital of India, according to a WHO survey of 1600 world cities, is the **worst** of any major city in the world.
- Air pollution in India is estimated to **kill 1.5 million** people every year; it is the fifth largest killer in India.
- India’s SO2 emissions have increased by 50% in the past few years.
- Children are the most affected by air pollution as they breathe in 50% more air Per Pound Of Body Weight than adults.

B. Malnutrition In India

- 39% of the children are stunted (low height-for-age).
- The World Bank estimates that India is one of the highest ranking countries in the world for the number of children suffering from malnutrition.
- Midday meals (a government sponsored scheme) are unable eliminate malnutrition in school children of India.

A. Air Purifiers For Schools (in India) ?

- Air purifiers are very **expensive** and the government schools can not afford those.
- Air purifiers consume lot of electricity.
- Each school has many classrooms which means buying air purifiers in large numbers may not be viable.
- HEPA air purifiers (which are available in market and are very costly) also can not capture harmful gases like SO2, NO2 etc. which are rampant in Indian environment

B. National Policies to address Malnutrition- Can Spirulina help to fight malnutrition?

- National Vitamin A Prophylaxis Programme (Spirulina as a source of Vitamin A: https://www.ncbi.nlm.nih.gov/pubmed/1906616)
- National Anemia Prophylaxis Programme for Mother and Child (Spirulina helps to address Anemia: https://www.elynsgroup.com/journal/article/spirulina-a-panacea-for-iron-deficiency-anemia-of-pregnancy-a-hypothesis-based-review)
- Mid-Day Meals, Special Nutrition Program https://www.antenna.ch/wp-content/uploads/2017/04/spirulina-casestudy.pdf

A. Algae As A Air Purifier

- Photoautotrophic organisms like algae can absorb air pollutants from the air.
- Algae belong to organisms which are able to absorb CO2, NO2, SO2.
- Algae also absorb carbon monoxide which is a poisonous gas.
- Algae release oxygen which reduces the chances of suffocation due to increased polluting gases.

B. Nutritional Benefits of Spirulina

- Spirulina Is Extremely High in Many Nutrients
- Spirulina has Powerful Antioxidant and Anti-Inflammatory Properties.
- It is Effective Against Anemia.
- It helps in the development of malnourished children.

https://en.wikipedia.org/wiki/Spirulina_(dietary_supplement)

https://www.omicsonline.org/open-access/impact-of-spirulina-on-nutritional-status-haematological-profile-andanaemia-status-in-malnourished-children-in-the-gaza-strip-rand-doi:mpn-1000110.php?aid=74887

What Are Photobioreactors ?

A photobioreactor is a bioreactor that utilizes a light source to cultivate phototrophic microorganisms.

In other words, it is a type of machine or device which is used to grow algae faster in the presence of light.

Photobioreactors, Are They Right For Schools?

- Photobioreactors available commercially are expensive, require continuous supply of electricity and require trained man power to maintain.
- Government schools in India will have resource constraints in terms of budget availability to buy such photobioreactors, will have issues because of interrupted power supply and will face difficulty in maintaining the systems from safety perspective especially when the school has Holidays.
- Hence the currently available Photobioreactors may not be the best choice for Government Schools in India.

Alternative to Expensive Photobioreactors?

EPCAHP: Economical Photobioreactor providing Clean Air and High-Protein diet

- Highly Economical and Sustainable - Final cost for giving clean air to one class room and producing sufficient Spirulina on Daily basis (total 100 gm powder) as dietary supplement for a class of 50 children:
  - EPCAHP working equipment price: INR 800 (if manufactured in sufficiently large quantity ,INR 500 per unit)
  - Electricity: LED lights consume less electricity and can be used only when external sunlight is not sufficient
  - Maintenance is very easy for teachers who can be trained easily to maintain EPCAHP

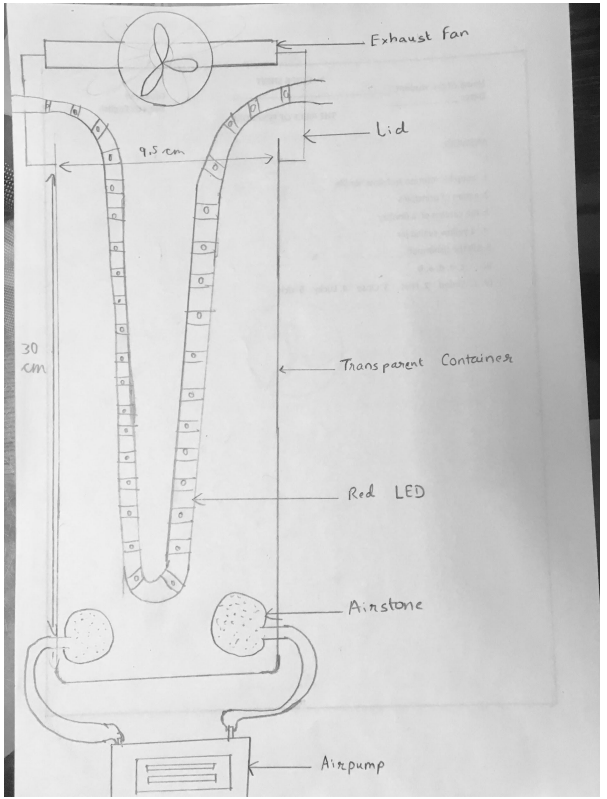
EPCAHP Design

Components Used:

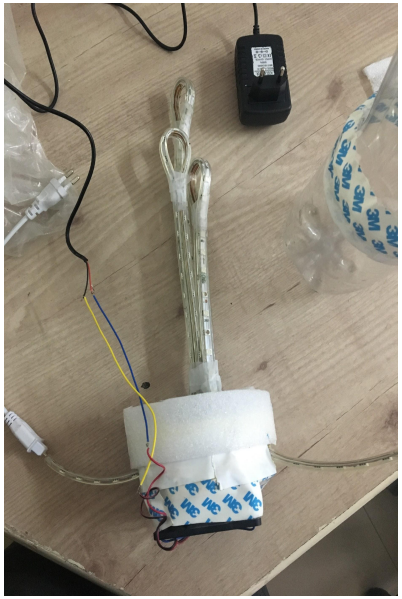
1. Recycled/Reused water bottles : 2 bottles
2. Red LED stripe
3. Exhaust Fan : Reused from a non working CPU of a computer
4. Air pump with 2 Air stones (can be bought from a local electrical shop)

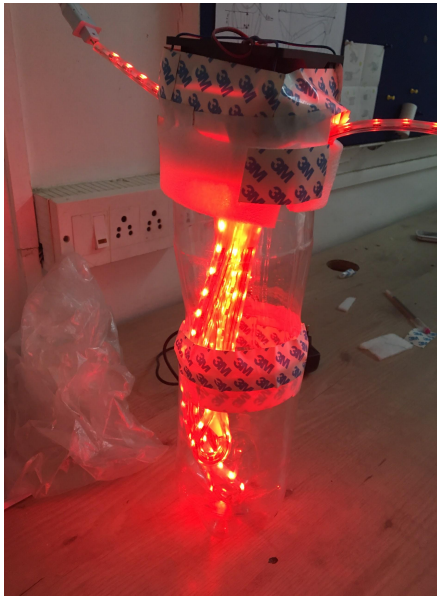
Other requirements:

1. Spirulina Culture - Can be sourced from multiple commercial or government providers - required only for 1 class room to begin
2. Spirulina feed - Baking Soda, Common Salt, Urea, Magnesium Sulphate, Potassium Nitrate (All easily available in local Fertiliser shop)

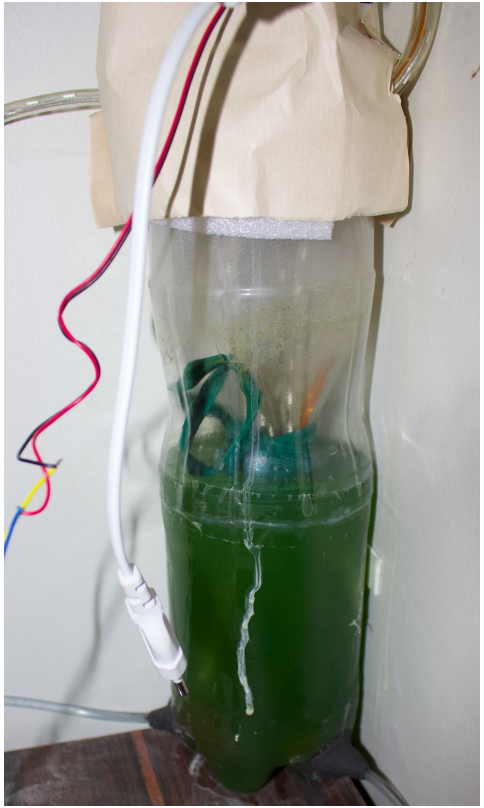


EPCAHP - Journey to build an optimal prototype



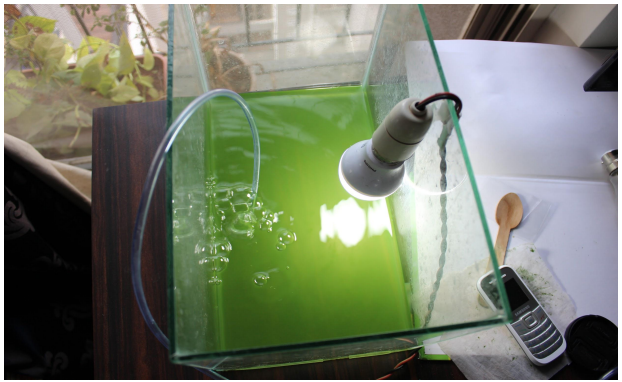


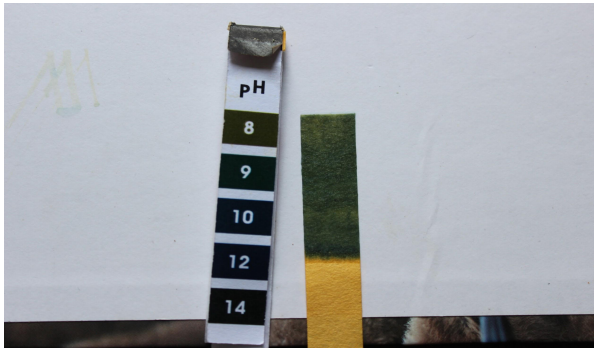
EPCAHP - How does it look - final prototype?

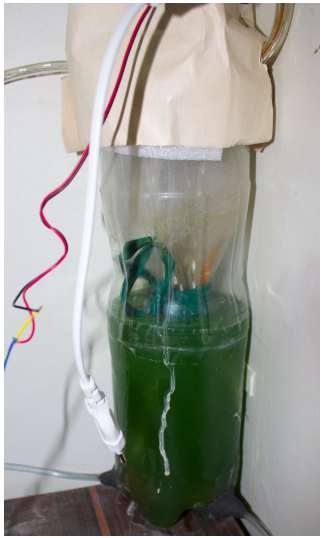


Experiment

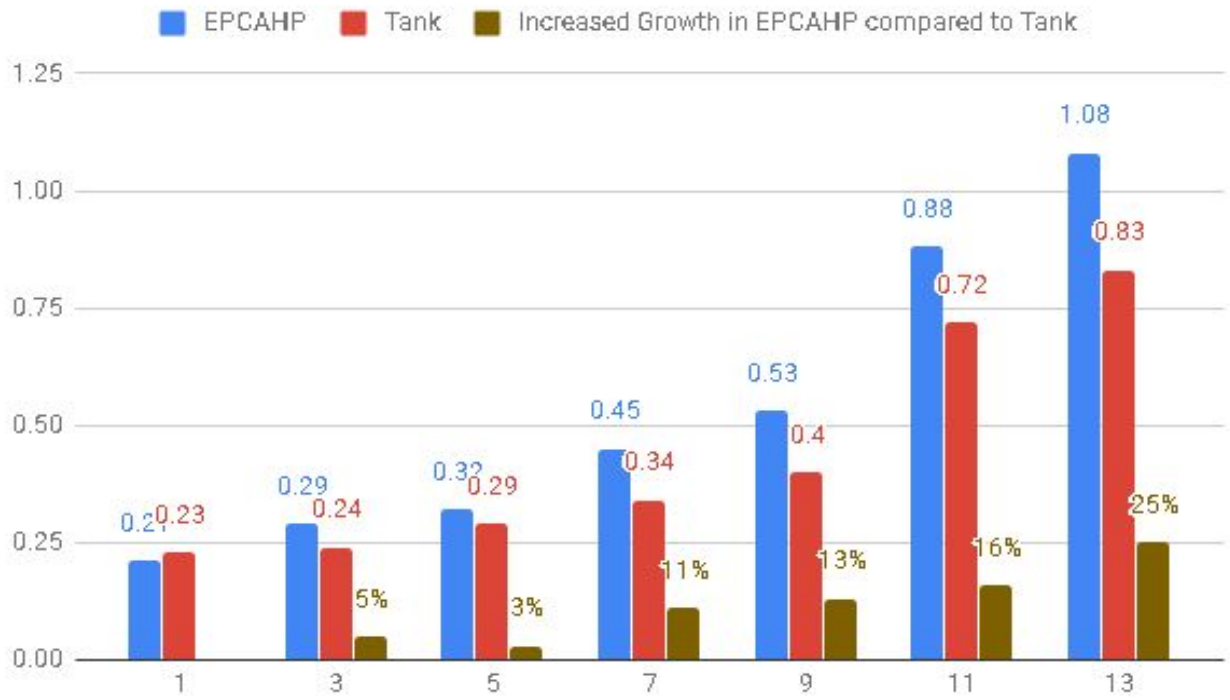
- In my experiment I tested if there is any difference in the growth rates of spirulina in EPCAHP and the tank.
- To do this I filtered out spirulina out of 40 ml of culture from both, the tank and EPCAHP, on alternate days to see the concentration of spirulina.
- I carried this out for 13 days.
- I provided same amounts of nutrients to both, the tank and the EPCAHP.







Results - in comparison with traditional method of using an aquarium tank



Overall 25% Increase in Growth Rate Observed mainly due to design and optimal values of feed nutrients, light and air - Throughout the experiment a conscious effort was made to keep all variables (such as nutrient feed, light and air) same except Design elements for both Tank and EPCAHP.

Advantages Of EPCAHP

- Economical
- Sustainable
- Easy to build in school environment
- Easy to maintain in school environment
- Easy to extract Spirulina from the container
- 25% more efficient in terms of Spirulina Growth compared to traditional methods

Conclusion

- EPCAHP (Economical Photobioreactor providing Clean Air and High-Protein diet) could be a viable alternative for developing a Sustainable and Economical solution against problems of Pollution and Malnutrition especially at the school level.
- This project of building EPCAHP taught me how to make an impactful solution with emphasis on design, reuse of waste material and using easily available components.
- If EPCAHP is manufactured at a larger scale the price comes down INR 500, which is affordable by government schools and is capable of solving the problem of air pollution and malnutrition.

Thank You !!

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