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RESEARCH ARTICLE

RECENT ANALYSIS OF SEWAGE TREATMENT PLAN (STP) USING BLUE-GREEN ALGAE

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Abstract

Wastewater treatment and recycling using Spirulina algae have become increasingly popular in recent years due to its potential to address a range of environmental and nutritional challenges (3). The primary objective of this approach is to use wastewater as a nutrient source for Spirulina algae cultivation and then harvest the algae as a feed for both Plants and animals. In this Research, we will discuss in detail the various objectives of wastewater treatment recycling using Spirulina algae and how it can help promote sustainable development(3). One of the primary objectives of using Spirulina algae to treat wastewater is to promote environmental sustainability(1). Wastewater treatment iscrucial to reducing the environmental impact of untreated wastewater, which can harm aquatic life and pollute water bodies. By using Spirulina algae as a means of treating wastewater, we can reduce the level of harmful pollutants in the water and promote a healthier ecosystem(2). Spirulina algae can absorb and metabolize a range of contaminants, including nitrogen and phosphorus, which are often found in wastewater. As a result, using Spirulina algae for wastewater treatment can help reduce the level of pollutants released into the environment, ultimately promoting a more sustainable and healthier ecosystem. Another significant objective of using Spirulina algae to treat wastewater is to promote nutritional benefits. Spirulina is a highly nutritious food source that is rich in protein, vitamins, and minerals.(4) By cultivating Spirulina using wastewater and then using the harvested algae as a food source, we can provide a sustainable and nutritious foodsource that can benefit both human health and the environment. Spirulina has been shown to have numerous health benefits, including reducing inflammation, boosting the immune system, and improving digestive health. Additionally, Spirulina is an excellent source of protein, making it an ideal food source for vegetarians and vegans. Moreover, the use of Spirulina algae for wastewater treatment andrecycling can help promote economic development.(5) Spirulina cultivation can be a profitable business opportunity, particularly in areas where water and other resources are scarce. (6)Additionally, the use of Spirulina algae for wastewater treatment can help reduce the costs associated with traditional wastewater treatment methods. As a result, using Spirulina algae for wastewater treatment and recycling can create new economic opportunities while also promoting sustainabledevelopment.

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Introduction:-

Wastewater treatment has traditionally been focused on removing harmful contaminants and pollutants from water before it is discharged back into the environment. (3)However, there is growing interest in using wastewater as a resource for sustainable agriculture, including the cultivation of Spirulina algae. Spirulina is a type of blue-green algae that is known for its high nutritional content. It contains a wide range of vitamins, minerals, and antioxidants, as well as protein and essential fatty acids.(7) In addition to being a potential food source for humans, Spirulina is also used as a feed supplement for livestock and aquaculture. One approach to Spirulina cultivation involves using wastewater as a nutrient source. This approach has several advantages over traditional cultivation methods, including reducing the amount of wastewater that needs to be treated and providing a low-cost, sustainable source of nutrients for the algae.

To implement this approach, wastewater is first treated to remove any harmful contaminants or pollutants. This can be done using a variety of methods, including physical, chemical, and biological treatment processes.(8) Once the water has been treated, it is then used as a nutrient source for the Spirulina algae. Spirulina cultivation can be done using a variety of systems, including open ponds, closed photobioreactors, and hybrid systems.(9) Each system has its own advantages and disadvantages, and the choice of system will depend on factors such as the availability of space, resources, and the desired yield of algae. Once the algae has been harvested, it can be used as a feed for both Plants and animals. Spirulina can be consumed in a variety of forms, including dried powder, tablets, and capsules. It is often added to smoothies, juices, and other foods as a nutritional supplement.

In addition to being a source of food, Spirulina cultivation using wastewater can also have environmental benefits(10). By using wastewater as a nutrient source, the amount of nutrients that are discharged into the environment can be reduced, which can help to prevent harmful algal blooms and other environmental issues.

Overall, the use of wastewater as a nutrient source for Spirulina algae cultivation has the potential to be a sustainable and cost-effective approach to producing a nutritious food source. While there are stillchallenges to be overcome, such as ensuring that the wastewater is free of harmful contaminants and optimizing the cultivation process, this approach has the potential to play an important role in sustainable agriculture and food production.

Materials And Method Stock Culture Maintance:-

Maintaining a stock culture of Spirulina is important to ensure its continued growth and availability. Store the culture in a cool and dark place: Spirulina culture should be stored in a cool and dark place to prevent overgrowth and to preserve its quality.(11) The ideal temperature range for storing Spirulina culture is between 4 to 10 degrees Celsius. With the use sterilized equipment to avoid contamination and also Maintain suitable pH levels: Spirulina thrives in an alkaline environment with pH levels between 8.0 to 10.0. Regularly monitoring and adjusting the pH levels can help to maintain the health and growth of the culture , Regularly add nutrients: Spirulina requires specific nutrients to grow, such as nitrogen, phosphorus, and potassium. Adding fresh nutrients to the culture on a regular basis can help to maintain its growth and health(12). Store the culture in small amounts: To prevent deterioration or contamination, it is recommended to store Spirulina culture in small amounts. This also makes it easier to subculture and maintain the culture.

Characterisation Of Spirulina

Domain	Bacteria
Phylum	Cyanobacteria
Class	Chroobacteria
Order	Oscillatoriales
Family	Phormidiaceae
Genus	Arthrospira

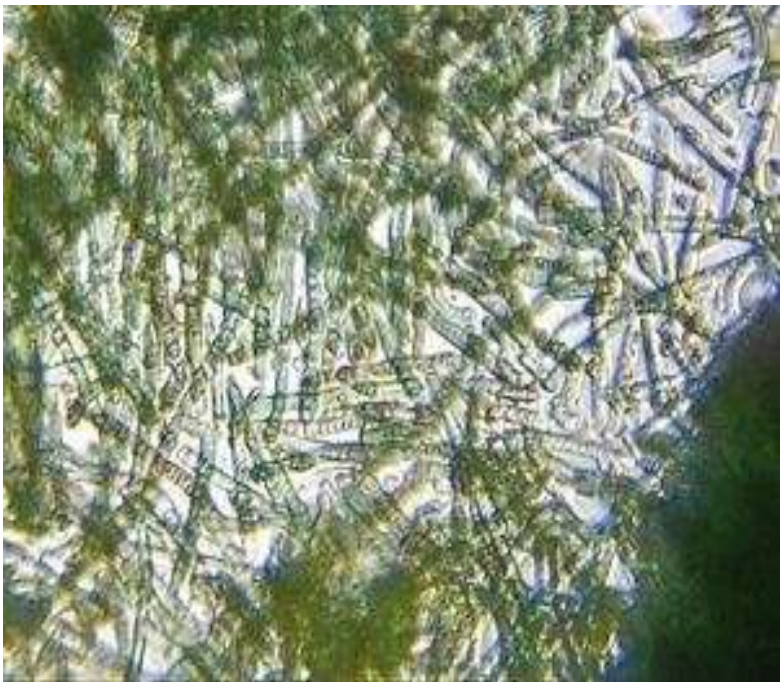


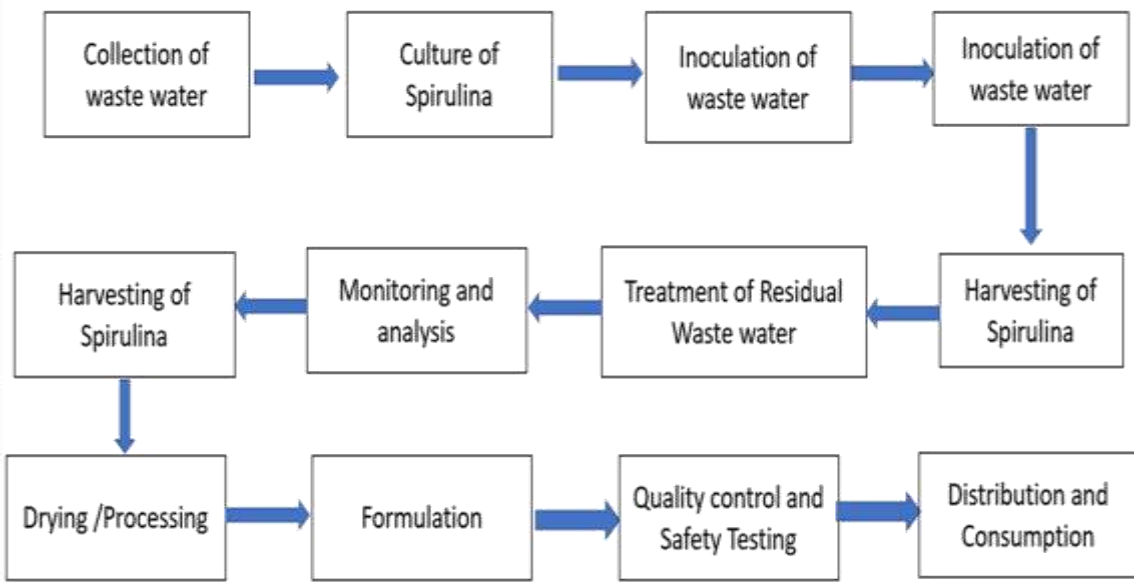
Fig 1:- Spirulina.

Nutritional Analysis Of Spirulina In (% of dry matter).
Tab 01:-

Elements	Percentage (%) **(b)**	Other microalgae	Other macroalgae
Moisture (%) **(a)**	12.66 ± 1.7	<9%	7.4–10.4%
Ash (%)	14.56 ± 0.74	7.4–10.4%	60–71
Protein (%)	76.65 ± 0.15	60–71	3–47%
			6–13%
Lipids (%)	2.45 ± 0.82	6–13%	>5%
CF (%)	4.07 ± 1.42	1.36–7.73%	15–25%
Carbohydrates (%) **(c)**	6.46 ± 0.32	10–27%	20–68%
Energy (kcal/100 g)	436.18 ± 2.29	ND	ND

Expressed as percentage of freeze-dried samples**. (b)**Data are mean values ± SD of three determinations. **(c)**Calculated by difference (=100 − crude protein − crude lipid − total dietary fiber (TDF)−ash). Dried Spirulina sp. % at 70°C of cell constituents is calculated after themoisture content was subtracted. ND: not detected.

Fig 2:- Block diagram of Sewage Treatment Plan (STP) using Spirulina.



Collection Of Waste Water

The collection of municipal wastewaters is a critical component of the overall wastewater management system(13). Wastewater is generated by households, businesses, and other sources within a municipality and must be collected and transported to a treatment facility for proper treatment and disposal. The collection system typically consists of a network of pipes, pumps, and other infrastructure that transport the wastewater to a centralized treatment facility.

The system must be designed to ensure that the wastewater flows efficiently and that there are no leaks or other issues that could result in contamination of the environment or public health risks.(14)

Municipal wastewater is typically a complex mixture of organic matter, nutrients, pathogens, and other contaminants that can pose significant environmental and public health risks if left untreated. Proper collection and treatment of municipal wastewater are therefore critical for protecting public health and the environment and ensuring the sustainable use of water resources.(15) Once the wastewater arrives at the treatment facility, it undergoes a series of treatment processes to remove contaminants and pollutants. These processes may include physical, chemical, and biological treatment methods, depending on the nature and concentration of the contaminants in the wastewater.

Overall, the collection of municipal wastewaters is a complex process that requires careful planning, design, and management to ensure that the wastewater is collected and treated in a safe and effective manner. (16)Proper wastewater management is critical for protecting public health and the environment and ensuring the sustainable use of water resources for future generations(16)

Culitivation Of Spirulina

The cultivation of Spirulina is a process of growing and harvesting this blue-green algae for various purposes, including food and dietary supplements. Spirulina is known for its high nutritional value and is a rich source of protein, vitamins, and minerals. The cultivation process involves the use of a culture medium that provides the necessary nutrients for the growth of Spirulina. The culture medium can be prepared using various sources of nutrients, including synthetic chemicals, agricultural by products, and organic waste materials. Spirulina can be grown using a variety of cultivation systems, including open ponds, closed photobioreactors, and hybrid systems. The choice of system will depend on factors such as the availability of space, resources, and the desired yield of algae.

During the cultivation process, the Spirulina culture is exposed to optimal growing conditions, including the right temperature, pH, and light intensity. The algae can double in size within 24 hours under the right conditions. Once the Spirulina has reached the desired level of growth, it is harvested using various methods, including filtration, centrifugation, and sedimentation.(17) The harvested Spirulina can be processed into a variety of forms, including dried powder, tablets, and capsules, for consumption as a dietary supplement or food ingredient.

Overall, the cultivation of Spirulina is a relatively simple and sustainable process that can provide a valuable source of nutrition and economic opportunities. Spirulina cultivation can also contribute to environmental sustainability by using waste materials as a nutrient source and reducing the environmental impact of conventional agriculture

Inoculation Of Waste Water

Inoculation is the process of introducing a small amount of a culture or microbial population into a larger volume of wastewater to initiate or accelerate the growth of microorganisms. In the context of Spirulina cultivation, inoculation involves adding a small amount of Spirulina culture to the wastewater to start the growth of the algae.(18) The inoculation process can be done in several ways, including the addition of concentrated Spirulina culture, dried Spirulina powder, or fresh Spirulina biomass. The inoculation rate and timing will depend on several factors, including the size of the culture volume, the nutrient content of the wastewater, and the desired growth rate of the Spirulina. (19)Once the inoculation is complete, the Spirulina culture will begin to grow, using the nutrients present in the wastewater as a source of energy and building blocks for its growth. The growth of the Spirulina can be monitored over time using various techniques, including cell counting and spectroscopic analysis.

Inoculation of wastewater with Spirulina can have several benefits. Firstly, it can help to reduce the nutrient load of the wastewater by removing excess nitrogen and phosphorus, which are essential nutrients for the growth of Spirulina.(20) Additionally, the growth of Spirulina can help to remove other contaminants from the wastewater, including heavy metals and organic pollutants. Finally, the harvested Spirulina can be used as a source of food or feed, providing economic opportunities and contributing to the sustainability of the wastewater treatment system.(21)

Harvesting Of Spirulina

Harvesting Spirulina is the process of separating the algae biomass from the growth medium and preparing it for further processing or use. The harvesting process is a critical step in Spirulina cultivation, as it determines the yield, quality, and efficiency of the overall production process. The most common method of harvesting Spirulina is by filtration, using a variety of filter media such as cloth, nylon, or paper filters.(22) The harvested biomass is then washed with clean water to remove any remaining growth medium and debris.

Another method of harvesting Spirulina is by centrifugation, which involves spinning the culture at high speeds to separate the biomass from the growth medium. This method is more efficient than filtration but requires more energy and capital investment in equipment. After harvesting, the Spirulina biomass can be dried using various techniques, including sun-drying, hot-air drying, or freeze-drying. Drying the biomass removes most of the water content and stabilizes the biomass for further processing or storage. The harvested and dried Spirulina biomass can be used in a variety of applications, including food and feed production, dietary supplements, and cosmeticproducts.(23) The biomass can be further processed into various forms, such as powders, tablets, capsules, or extracts, depending on the intended use.

Overall, the harvesting process is a critical step in the cultivation of Spirulina, as it determines the yield, quality, and efficiency of the overall production process. Proper harvesting and processing techniques can help to maximize the benefits of Spirulina cultivation and contribute to the sustainable production of food and feed.

Treatment Of Residual Wastewater

After the Spirulina algae have been harvested, the residual wastewater that contains the remaining nutrients and contaminants must be treated to minimize its environmental impact. There are several methods of treating residual wastewater, including physical, chemical, and biological treatment. Physical treatment involves the use of physical processes, such as sedimentation, filtration, and evaporation, to remove suspended solids and other contaminants from the wastewater. Chemical treatment involves the addition of chemicals, such as coagulants and disinfectants, to remove contaminants and disinfect the wastewater.(24) Biological treatment involves the use of microorganisms to break down organic contaminants in the wastewater.

One of the most effective methods of treating residual wastewater from Spirulina cultivation is by using a combination of biological and physical treatments. The wastewater is first treated by physical methods, such as sedimentation and filtration, to remove the solids and contaminants. Then, the remaining wastewater is treated by biological methods, such as aerobic or anaerobic digestion, to remove the remaining organic contaminants.(25) Aerobic digestion involves the use of oxygen to break down organic contaminants, while anaerobic digestion involves the use of bacteria that can break down organic contaminants in the absence of oxygen. Both methods produce biogas, which can be used as a source of renewable energy.

The treatment of residual wastewater is essential for minimizing the environmental impact of Spirulina cultivation. Proper treatment methods can help to remove contaminants and nutrients from the wastewater, making it safe for discharge or reuse, and contributing to the sustainability of the production process(26)

Monitoring And Analysis

Monitoring and analysis of wastewater using Spirulina is an important aspect of the production process to ensure the efficient and effective removal of nutrients and contaminants from the wastewater. The monitoring process involves the regular measurement of various parameters, such as pH, temperature, nutrient concentrations, and biomass growth rate. The pH level of the wastewater is critical for the growth and survival of Spirulina. The ideal pH range for Spirulina growth is between 7.5 and 9.5. Therefore, the pH level of the wastewater must be regularly monitored and adjusted as necessary to maintain optimal conditions for Spirulina growth.

Temperature is another important factor that affects the growth of Spirulina. The ideal temperature range for Spirulina growth is between 25°C and 35°C. Therefore, the temperature of the wastewater must be carefully monitored and maintained within the optimal range Nutrient concentrations, such as nitrogen, phosphorus, and carbon, must be regularly monitored to ensure that they are present in the optimal concentrations for Spirulina growth. Nutrient concentrations that are too high or too low can negatively impact Spirulina growth and biomass production. Biomass growth rate is also an important parameter to monitor. The growth rate of the Spirulina biomass can be measured by various methods, such as cell counting, optical density measurement, or spectroscopic analysis.(27) Monitoring the biomass growth rate can help to optimize the harvesting schedule and ensure the maximum yield of Spirulina biomass. Overall, monitoring and analysis of wastewater using Spirulina is critical for maintaining optimal growth conditions,(28) optimizing nutrient removal, and maximizing biomass production. Regular monitoring and analysis can help to identify and address any issues that may arise during the production process and ensure the efficient and sustainable cultivation of Spirulina

Harvesting Of Spirulina

The harvesting of Spirulina from wastewater involves the separation of the Spirulina biomass from the treated wastewater. There are several methods of harvesting Spirulina, including sedimentation, filtration, and centrifugation.

Sedimentation involves allowing the Spirulina biomass to settle to the bottom of the tank under the force of gravity. Once the biomass has settled, the wastewater can be decanted and removed, leaving behind the concentrated Spirulina biomass.(29)(30) Drying the Spirulina biomass helps to extend its shelf life and makes it easier to transport and store. The harvesting of Spirulina from wastewater is an important step in the production process, as it allows for the recovery of a valuable food source while simultaneously treating the wastewater. Proper harvesting methods can help to maximize the yield of Spirulina biomass and ensure the efficient and sustainable cultivation of Spirulina.(29)(30)

Drying And Processing

After the Spirulina biomass has been harvested from wastewater, it must be dried and processed to make it suitable for consumption or use in various applications. There are several methods of drying and processing Spirulina biomass, including spray drying, freeze drying, sun drying, and milling.

Spray drying is a common method of drying Spirulina biomass, which involves spraying the biomass into a hot chamber where it is rapidly dried into a powder form. Spray drying is fast and efficient, and it can produce a high-quality Spirulina powder with good nutrient retention.

Freeze drying, on the other hand, involves freezing the Spirulina biomass and then removing the water through sublimation. This method preserves the nutrient content and colour of the Spirulina powder, but it is slower and more expensive than spray drying.

Sun drying is a traditional method of drying Spirulina biomass, which involves spreading the biomass on mats or trays and exposing it to sunlight. Sun drying is simple and inexpensive, but it can result in a lower-quality product with reduced nutrient content and higher levels of contaminants.

After the Spirulina biomass has been dried, it can be further processed into various forms, such as tablets, capsules, or flakes. Milling is a common method of processing Spirulina biomass, which involves grinding the dried biomass into a fine powder. The powder can then be compressed into tablets or encapsulated to make it easier to consume. The

drying and processing of Spirulina biomass from wastewater is a critical step in the production process, as it helps to make the biomass suitable for consumption and use in various applications. The choice of drying and processing methods depends on various factors, such as the quality of the harvested biomass, the desired end- product, and the available resources.

Formulation

Formulation of Spirulina from wastewater involves combining the harvested and processed Spirulina biomass with other ingredients to create a final product with specific nutritional or functional properties. There are several forms in which Spirulina can be formulated, such as tablets, capsules, powders, or flakes. The formulation of Spirulina tablets involves compressing the powdered Spirulina biomass with binders and excipients to create a solid dosage form. The tablets can be designed to provide a specific dose of Spirulina or a combination of Spirulina and other nutrients.

Capsules can also be formulated with Spirulina by encapsulating the powdered biomass in gelatine or other shell materials. Capsules can offer a more convenient dosage form than tablets for some individuals, and they can also provide targeted release of the Spirulina biomass in the digestive system. Powders and flakes are other common forms of Spirulina formulation, which can be used as ingredients in various food and beverage products or as a standalone supplement. These forms offer versatility in terms of their applications, and they can be easily incorporated into smoothies, juices, or other recipes.

In addition to these common forms, Spirulina can also be formulated as an extract or concentrate, which can provide higher concentrations of specific nutrients or bioactive compounds. Extracts can be obtained through various methods, such as solvent extraction, enzymatic hydrolysis, or supercritical fluid extraction. The formulation of Spirulina from wastewater offers various opportunities to create products with specific nutritional or functional properties.(31) The choice of formulation depends on various factors, such as the desired end-product, the intended use, and the target market.

Quality Control And Safety Testing

Quality control and safety testing are important aspects of Spirulina production from wastewater to ensure that the final product is safe and meets the desired quality standards.(32)(33) Here are some of the quality control and safety testing measures that can be implemented:

Microbial testing:

Spirulina can be contaminated with various microorganisms, such as bacteria, fungi, and viruses, which can pose health risks to consumers. Therefore, microbial testing should be conducted to ensure that the Spirulina product is free from harmful microorganisms.

Nutritional analysis:

Spirulina is known for its high nutritional value, including its protein content, vitamins, minerals, and antioxidants. Nutritional analysis can be conducted to ensure that the Spirulina product meets the desired nutrient profile and label claims.

Heavy metal testing:

Spirulina can accumulate heavy metals from the surrounding environment, which can be harmful to human health. Therefore, heavy metal testing should be conducted to ensure that the Spirulina product is safe and within acceptable limits.

Pesticide and herbicide testing:

Spirulina can also accumulate pesticides and herbicides from the surrounding environment. Therefore, testing for these contaminants should be conducted to ensure that the Spirulina product is safe and free from harmful residues.

Shelf-life testing:

Spirulina products can have a shelf life of up to two years if stored properly. Shelf-life testing can be conducted to ensure that the product maintains its quality and stability over time.

Allergen testing:
Spirulina can potentially cause allergic reactions in some individuals, particularly those with existing allergies to seafood or algae. Therefore, allergen testing should be conducted to ensure that the Spirulina product is free from potential allergens.

Finally, quality control and safety testing are important aspects of Spirulina production from wastewater to ensure that the final product is safe and meets the desired quality standards. These measures can help to build consumer trust and confidence in the Spirulina product, and they can also help to identify any potential issues in the productionprocess.

Distribution And Consumption
Distribution and consumption of Spirulina from wastewater involve getting the product to the intended market and ensuring that it is consumed safely and effectively. (34)Here are some of the factors to consider:

Packaging and labelling: Spirulina products should be packaged and labelled appropriately to ensure that they meet regulatory requirements and are appealing to consumers. (35)The packaging should protect the product frommoisture, light, and other environmental factors that could affect its quality. The labelling should provide clear information on the product's ingredients, nutritional content, and usage instructions.

Distribution channels:
Spirulina products can be distributed through various channels, such as health food stores, online marketplaces, and direct sales. The choice of distribution channel depends on the target market and the company's marketing strategy(36).

Education and marketing:
Spirulina from wastewater is still a relatively new product, and many consumers may not be familiar with its benefits or how to use it. Therefore, education and marketing efforts are crucial to build awareness and demand for the product. This can include online content, social media campaigns, and in-store demonstrations.

Food safety and handling:
Spirulina products should be handled and stored properly to ensure that they are safe for consumption. This includes proper storage temperature, avoiding cross-contamination with other food products, and following appropriate hygiene practices.

Consumer feedback and reviews:
Consumer feedback and reviews can provide valuable insights into the product's quality, effectiveness, and market demand. Companies should be open to feedback and use it to improve their products and marketing strategies.

Overall, distribution and consumption of Spirulina from wastewater require careful planning and execution to ensure that the product reaches the intended market and is consumed safely and effectively. Companies should focus on building consumer trust and awareness through education, marketing, and quality control measures.

Result:-

Spirulina, a type of blue-green algae, has been shown to have potential for wastewater treatment due to its ability to remove nutrients and pollutants from wastewater through phytoremediation. This process involves using plants to absorb and break down contaminants in the water. Spirulina has been found to be particularly effective at removing nitrogen and phosphorus, which are two common pollutants found in wastewater. In addition to removing pollutants, spirulina can also produce oxygen and fix carbon dioxide during photosynthesis, which can improve the overall water quality. The algae can also be harvested and used as a source of protein and other nutrients, making it a potentially valuable by product of wastewater treatment. How ever, the effectiveness of spirulina for wastewater treatment can depend on several factors, such as the concentration of pollutants in the wastewater, the temperature and pH of the water, and the species and strain of spirulina being used. In some cases, the use of spirulina may notbe as effective as other wastewater treatment methods, such as activated sludge or membrane filtration.

spirulina can be a useful tool for treating wastewater, but its effectiveness and applicability will depend on the specific circumstances of each case. Further research is needed to fully understand the potential benefits and limitations of

spirulina for wastewater treatment and to determine the most effective ways to integrate it into existing wastewater treatment systems

Conclusion:-

The use of Spirulina in wastewater management can be an effective way to remove contaminants and improve water quality.(37) Spirulina is a type of algae that can absorb nutrients and contaminants from wastewater, while also producing oxygen and biomass. The biomass produced by spirulina can then be used as a feed supplement for plants and animals.This approach can have several benefits. It can help to reduce the amount of pollutants in wastewater, thus improving the quality of the water that is discharged into the environment.(38) Then it can provide a source of low-cost feed for agricultural and aquaculture systems.(41)(40) Finally, it can help to create a circular economy by turning waste products into a valuable resource.

However, there are also some potential drawbacks to this approach.(39) For example, the use of spirulina in wastewater treatment systems requires careful management to ensure that the algae does not become contaminated with harmful pathogens or toxins. Additionally, the use of spirulina as a feed supplement for animals and plants may raise questions about food safety and potential health risks.

Finally, the use of spirulina in wastewater management and as a feed supplement shows promise as a sustainable solution for managing waste and creating value from it. However, further research and careful management are needed to fully realize its potential benefits.

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