Integrated Algae Utilizer System: A fresh approach for Ecosystem Restoration

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Abstract :

This exploration paper presents a coordinated framework intended to expand the utility of green growth, changing it into a plenty of significant assets. The framework capabilities as a pipeline, handling green growth to extricate energy, make green growth power devices, produce consumable items, and create manure. The framework uses existing advances and genuine models, planning to enhance the change interaction for greatest result. Green growth, a sustainable and bountiful asset, holds enormous potential because of its photosynthetic proficiency and various applications[2][3]. Energy extraction from green growth has been investigated in different structures, including biofuel and biogas[1][8][9]. Green growth power devices address a promising road for efficient power energy production[2]. Palatable items we get from green growth, wealthy in supplements, offer potential for food security[7][8]. Green growth based manures give an eco-accommodating answer for soil enrichment[4][5]. This paper surveys these applications, giving a thorough outline of current practices and future possibilities. The proposed framework plans to reform the manner in which we use green growth, adding to a practical and asset productive future[6].

1. Introduction:

1.1 Overview :

In the higher perspective of maintainability, we should discuss green growth, let's talk about algae. No doubt, the green disgusting stuff we generally disregard. These small folks resemble the MVPs of the regular world, unobtrusively doing some game-changing stuff.
In all, what's going on with green growth? They're like the superheroes of the plant world, transforming daylight and carbon dioxide into plant mass way better compared to other plants out there. This superhero ability makes them a promising answer for spotless and environmentally friendly power. Envision having fuels and energy sources from algae that power our stuff as well as great for the planet. All thanks to these microscopic powerhouses.

Be that as it may, stand by, there's something else! Green growths are not only great for energy. In cultivating, they're going to make a splash. Green growth-based composts are like super-supplement promoters for soil. They improve the soil and, additionally, assist with tidying up water. It resembles having a companion that is likewise an ecological legend.

Presently, we should zoom out. Green growth isn't halting energy and farming. They're making waves in a lot of ventures. They're making proteins, colors, and even stuff for drugs and beauty care products. They're getting into materials, making ordinary things like cat litter and insulation. Green growth are essentially the all-stars of the regular world, prepared to play in any position.

Presently, how about we get into the quick and dirty. Envision an arrangement that resembles a very much organized group, where everybody plays a particular part. This arrangement, or component, is intended to take advantage of green growth. First up, we have a development framework. It resembles making the ideal circumstances for green growth to develop — right light, enough supplements, and a lot of CO2.

Then, the gathering framework becomes an integral factor. This framework is tied in with gathering the developed green growth in a brilliant and effective manner. Consider it the collecting season on a homestead, yet for green growth.

From that point onward, we move to the transformation framework. Contingent upon how we need to manage the green growth — like making biofuel or manure — we have various cycles. It resembles involving various recipes for various dishes, however for this situation, we're concocting helpful stuff from green growth.

Furthermore, to wrap it up, there's a reusing framework. This part resembles the cleanup team, ensuring we don't abandon a wreck. Any extras from the cycles either get reused or discarded appropriately.

Thus, basically, this situation resembles a major, shrewd approach to utilizing green growth, algae as far as possible. It resembles seeing the likelihood in these minuscule organic entities and giving them something to do that benefits us and the planet. As we continue to sort out better ways of doing this, the future with green growth looks brilliant and maintainable.

1.2 Machinery Processes :

1.2.1 Algae Growth:

Chlorella Vulgaris normally includes a fragile equilibrium of a few ecological and dietary variables. The algae require a particular amount of water, with the ideal biomass efficiency viewed as 205 mg/L over a time of 10 days[14]. The water ought to be plentiful in minerals, especially nitrogen and phosphorus, which are bountiful in homegrown sewage.

The presence of microelements is additionally pivotal, with an answer containing H3BO3 (2860 µg/L), MnCl2 (1810 µg/L), ZnSO4 (220 µg/L), CuSO4 (80 µg/L), MoO3 (36 µg/L), and CoSO4 (90 µg/L) viewed as beneficial. The air quality assumes a critical part too, with the green growth requiring contact with air for its CO2 requirements.

The development cycle of Chlorella Vulgaris is photosynthetic, meaning it requires light for energy. The ideal light force is around 5 to 7 Klux2, and a temperature of around 24°C is ideal. The green growth inclines toward a soluble climate, with the ideal pH for development being somewhere in the range of 9 and 10.

As far as air circulation, an air circulation stream pace of 200 mL/min has been viewed as optimal. This multitude of variables consolidated make the ideal circumstances for the regular development of Chlorella Vulgaris, prompting the compelling retention of components like nitrogen, phosphorus, and carbon from the climate for the blend of cell parts[14].

1.2.2 Air and Water Purification:

Screening: This is the initial step for both air and water purging. A metal lattice or comparative material can be utilized to eliminate large debris from both the air and water. This could include dust, leaves, sticks, and other large particles that could stall the subsequent filtration steps.

Primary Filtration: In this step, a fiber filter with a pore diameter of 5 micrometers can be utilized to remove particulate matter that is 10 micrometers in size or larger from the air. This is significant because these particles can be harmful when inhaled. For water, a sedimentation process can be utilized, where suspended solids are allowed to settle at the bottom of a storage tank. This helps to remove larger particles from the water that could affect its clarity and safety[13].

Secondary Filtration: For air, a paper-derived filter with a pore diameter of 2 micrometers can be utilized to remove particulate matter that is 2.5 micrometers in size or larger. These smaller particles can still be harmful when inhaled and are more challenging to remove[13]. For water, a filtration process can be utilized, often involving sand filters, to remove smaller particles. This helps to further improve the clarity of the water and remove any remaining solids.

Algae Treatment: Algae treatment is a significant stage in water purging. In this cycle, the air and water are coordinated into a culture tank loaded up with a culture liquid that incorporates the algae, Chlorella Vulgaris. The debased air and water are constrained into the way of life liquid, where the carbon dioxide, nitrogen oxide, as well as sulfur oxide break down into the way of culture fluid[15].

The algae utilize these mixtures as supplements during photosynthesis, changing over carbon dioxide into oxygen and diminishing other pollutants1. A lighting unit is utilized to give light to the way of life liquid, advancing photosynthesis[15]. This step is vital for the expulsion of destructive gasses from the air and water[15].

Besides, a review has applied a ClO2 preoxidation-helped coagulation/precipitation process for the algae containing crude water treatment[16]. The impact of response boundaries on crude water treatment has been explored in this joint cycle including ClO2 and PAC measurement, beginning pH, algae[16]. It was tracked down that the polymeric aluminum chloride (PAC) and ClO2 have shown the best crude water treatment execution with the ideal dose of 10 mg/L and 0.8 mg/L, respectively.

After the green growth has developed and absorbed the pollutants, the algal biomass is recuperated from the way of cultured fluid[15]. This biomass can be utilized for different purposes, including the development of biofuels.

Biomass Recovery: After the algae have grown and absorbed the pollutants, the algal biomass is recovered from the culture fluid. This biomass can be used for various purposes, including the production of biofuels.

Final Filtration and Disinfection: Any remaining particulates in the air are removed using a High Efficiency Particulate Air (HEPA)[13] filter. For water, any remaining particles are removed using a microfiltration or ultrafiltration process[10][11][12]. Suspended solids and high-molecular-weight solutes remain on one side of the membrane, the retentate side, while water and low-molecular-weight solutes filter through the membrane to the permeate side. UF can remove most organic molecules and viruses, as well as a range of salts. It has gained popularity because it produces a stable water quality no matter the source water, has a compact physical footprint, removes 90-100% of pathogens, and does not require chemicals, except for cleaning membranes. The pore size of ultrafiltration membranes ranges from 0.1 to 0.01 microns.

1.2.3 Nutrient extraction:

Sun Dried algae is used for extraction purpose:
To eliminate any remaining development medium or impurities, the cultured algae goes through a rinsing. This step guarantees that the algae are perfect and prepared for drying.

The algae biomass is then spread equally on a drying surface. This surface is assigned a region with proper plate or cross section screens that work with the openness of algae to daylight directly.
Intermittently, the algae biomass should be turned or turned to guarantee uniform drying. This helps prevent uneven drying and promotes consistent moisture removal.

The spread of algae biomass is passed on to dry under direct daylight. The regular daylight starts the parchedness interaction, steadily lessening the dampness content of the algae.
When the algae arrives at the desired moisture level, they are gathered from the drying surface. Now it is ready for extraction purposes.

Proteins[17] : The course of protein extraction from Chlorella Vulgaris starts with the readiness of a sodium hydroxide (NaOH) arrangement. A 0.1M NaOH arrangement, known for its viability in separating cell walls, is ordinarily utilized for this reason. The Chlorella biomass is carefully blended in with the NaOH arrangement in a foreordained proportion, frequently kept up with at 1:10 (w/v), guaranteeing thorough integration. This blend goes through mixing to work with a homogeneous circulation[17]. Consequently, the combination is exposed to controlled warming, for the most part inside the temperature scope of 60-100°C, for a predefined span. This painstakingly controlled warm treatment is vital for ideal protein extraction. Following the extraction cycle, the resultant blend is exposed to partition, a stage essential for secluding the fluid stage containing the separated proteins from the strong stage. Strategies, for example, filtration or centrifugation are generally utilized for this reason[17]. The pH of the NaOH arrangement assumes a basic part all through, requiring fastidious control because of the harsh idea of soluble arrangements. The nuanced change of pH, exact temperature control, and the prudent decision of extraction time all in all add to the effectiveness and explicitness of this protein extraction strategy. Post-extraction, the disengaged proteins might go through additional cycles like precipitation or decontamination. This extensive method highlights the complex advances engaged with saddling proteins from Chlorella Vulgaris for different logical and modern applications.

Carbohydrates[18]: Sugar extraction from Chlorella Vulgaris includes a careful interaction pointed toward getting maximal advantage from this microalgal force to be reckoned with. Initially treated with sodium hydroxide (NaOH) to facilitate

subsequent protein extraction, now the biomass goes through thorough washing to dispose of remaining NaOH. The corrosive hydrolysis step follows, where weakened sulfuric corrosive is utilized to separate complex starches into more straightforward sugars. This blend is exposed to controlled warming, regularly around 121°C, guaranteeing an effective transformation process. Subsequent neutralization with sodium hydroxide is critical to prevent sugar degradation in subsequent steps[18]

Detachment procedures, like filtration or centrifugation[18], are then used to disengage the neutralized hydrolysate from solid residues. Grouping of the isolated hydrolysate upgrades sugar focus through a dissipation interaction[18]. At long last, the concentrated hydrolysate goes through filtration to eliminate undesirable compounds. This extensive technique, drawn from logical sources and your particulars, is intended to expand sugar yield from Chlorella Vulgaris.

Lipids (Fats and Oils)[19]: The process of extracting lipids from Chlorella Vulgaris, which has undergone prior treatments for protein and carbohydrate extraction, is a strategic procedure aimed at maximizing the lipid content of this particular microalgal species. To begin with, a carefully prepared biomass that is free from any residual NaOH or acid is used. The subsequent lipid extraction phase utilizes the non-polar solvent hexane[19]. This solvent is well-known for its ability to dissolve lipids due to its non-polar nature, ensuring a thorough extraction process.

The biomass-hexane mixture is then stirred and heated under controlled conditions, typically at temperatures ranging from 60-80°C, for a specific duration. This facilitates efficient lipid extraction[19]. It is important to note that while hexane is effective, it may not extract all types of lipids equally. In order to enhance extraction efficiency for specific lipid categories, additional solvents or combinations, such as chloroform and methanol, may be used.

After the extraction process, the liquid phase containing the lipids is separated from the solid phase using techniques like filtration or centrifugation[19]. The separated liquid phase is then subjected to evaporation to remove the solvent, leaving behind the extracted lipids. The quantity of algae required for lipid extraction depends on the desired lipid yield, with Chlorella Vulgaris typically accumulating a significant lipid content ranging from 14-22% of its dry weight[19].

Omega 3 and fatty acids[20][21]: After the extraction of proteins, starches, and lipids from Chlorella vulgaris, the excess biomass is ready for additional extraction, for the most part by drying and crushing it into a fine powder. The unsaturated fats, including Omega-3[21], are then removed utilizing a dissolvable like ethanol[20], with conditions like temperature, span, and dissolvable to-biomass proportion upgraded for greatest yield. The separated lipids go through a cycle called methylation or esterification to change over the unsaturated fats into a structure that is simpler to break down and refine[20]. This is finished by adding a methanol arrangement containing a corrosive impetus to the lipid extricate. The combination is then centrifuged or sifted to isolate the unsaturated fat methyl esters (Distinctions) from the remainder of the blend. At last, the dissolvable fats are eliminated, commonly through vanishing, abandoning the Omega-3[21] unsaturated fats. The Acclaims can then be investigated utilizing gas chromatography to decide the piece of the unsaturated fats. If it's not too much trouble, note that this is an overall outline, and the specific cycle can change contingent upon the particular states of the extraction interaction. Continuously make sure to adhere to somewhere safe and secure rules while playing out these techniques.

1.2.4 Energy Generation :

1.2.4.1 Biogas generation[22] :

The production of biogas from Chlorella vulgaris, following the extraction of proteins, carbohydrates, lipids, and bioactive compounds, involves a systematic anaerobic digestion process. Initially, the remaining biomass undergoes preparation, which may include pre-treatment steps such as mechanical disruption or thermal hydrolysis. Mechanical disruption employs methods like pressure, abrasion with rapid agitation using beads, or ultrasound to subject cells to high stress, facilitating the release of organic materials. Thermal hydrolysis, on the other hand, is a two-stage process involving high-pressure boiling followed by rapid decompression, sterilizing the biomass and enhancing its biodegradability[22].

Subsequently, the prepared biomass is subjected to anaerobic digestion, a biological process occurring in a digester where bacteria break down organic matter in the absence of oxygen. This microbial activity results in the production of biogas, comprising methane and carbon dioxide, as well as digestate. The biogas generated in the digester is collected and can be utilized directly as an energy source. Alternatively, it can undergo further processing to increase its methane content, enhancing its energy value. The remaining digestate, a byproduct of the anaerobic digestion process, holds potential as a valuable resource. It can be utilized as a soil conditioner or fertilizer due to its nutrient-rich composition, contributing to sustainable agricultural practices. Furthermore, the digestate can undergo additional processing steps to extract further value, aligning with the principles of circular economy and resource optimization in bioenergy production from microalgae biomass[22].

1.2.4.2 Biodiesel Production[23] :

The production of biodiesel from extracted lipids and fatty acids is a carefully orchestrated process that mainly focuses on the widely used transesterification method. The journey begins with entering components to the transesterification, a chemical reaction where they are combined with an alcohol, usually methanol or ethanol, and a catalyst such as sodium hydroxide or potassium hydroxide. This temperature-controlled reaction produces fatty acid methyl esters (FAME) called biodiesel[23], with glycerol as a byproduct. The next step involves separating the purified FAME[23] from the glycerol using methods such as centrifugation. After this separation, the purified FAME undergoes a final purification step to remove residual impurities, including catalyst residues and unreacted alcohol.

To raise the quality of the biofuel to the highest standards, the journey ends with a careful treatment of the FAME using a chemical cleaning agent such as activated carbon or silica gel. This final purification process specifically targets persistent impurities, including unreacted alcohol, catalyst residues[23], and glycerol that may remain from the transesterification step. The dry cleaning agent and FAME are thoroughly mixed and allowed to settle, which facilitates absorption of the impurities into the chemical cleaner. After this settling process, the purified FAME is carefully separated from the dry detergent, ensuring that the remaining impurities are removed[23]. This careful cleaning step, using dry detergents such as activated carbon and silica gel, plays a vital role in producing ultra-pure, high-quality biofuel that meets and exceeds the strict standards of sustainable energy applications. The entire process reflects a commitment to scientific accuracy and efficiency in converting extracted lipids and fatty acids into clean, high-quality biofuels.

1.2.4.3 Microbial fuel cells (MFCs):

MFCs using Chlorella vulgaris have been studied for their potential in electricity generation. In one study, a modified MFC with a tubular photobioreactor (PHB) configuration was constructed by introducing Chlorella vulgaris to the cathode chamber to generate oxygen in situ[24].

- Two types of cathode materials and light/dark cycles were used to test the effect on the MFC with the algae biocathode. The use of algae was found to be an effective approach because these organisms can act as efficient in situ oxygenators, thereby facilitating the cathodic reaction[24].
- In particular, when carbon paper coated with platinum was used as a cathode electrode,

it increased the voltage output more than when carbon felt was used as an electrode[24]. The maximum power density of 25.4 mW/m^2 was obtained from the MFC with the algae biocathode, which utilized the carbon paper coated with platinum as the cathode electrode under intermittent illumination[24]. This density was 2.8 times higher than that of the abiotic cathode[24].

Another study investigated the “ELECTRICAL ENERGY” produced by a Microalgae Microbial Fuel Cell (MMFC) using Chlorella vulgaris and “Batik” wastewater[24]. This study aimed to assess the performance of the MMFC system based on the influence of yeast, “Batik wastewater” concentration, and graphite electrodes[24]. The system utilized wastewater as a substrate and could be used as an ideal tool for processing[24].
These studies demonstrate the potential of using Chlorella vulgaris in microbial fuel cells for sustainable and efficient electricity generation.

1.2.5 Soil Enhancement[25] :

After undergoing a meticulous anaerobic digestion process to produce methane from residual algae, the resulting byproduct, referred to as digestate, emerges as a potent resource for enriching soil[25]. This refined scientific approach involves directly applying the digestate to the soil as a fertilizer, taking advantage of its abundant organic matter, nitrogen, phosphorus, and potassium content. This strategic application not only improves soil structure but also provides a gradual and sustainable source of nutrients, promoting robust and healthy plant growth. The integration of residual algae digestate into compost further enhances its impact by increasing both nutrient content and microbial activity within the compost matrix. This careful synergy results in a high-quality soil amendment that aligns with the principles of precision agriculture. In addition to its traditional applications, the digestate proves invaluable in land reclamation efforts, particularly on degraded or nutrient-deficient soils, as it significantly contributes to restoring soil health through its organic matter and nutrient content. Utilizing digestate as a liquid fertilizer for agricultural fields through irrigation systems showcases an innovative technique that ensures efficient and uniform distribution of nutrients to crops. This approach not only reduces reliance on synthetic chemical fertilizers but also seamlessly aligns with sustainable agriculture practices, thereby promoting environmental stewardship. The microbial richness of the digestate plays a crucial role in biological control, fostering the development of a balanced soil microbiome that positively affects plant health and acts as a natural defense against diseases. Lastly, using digestate as a mulch around plants offers multiple benefits, including moisture retention, weed suppression, and gradual nutrient release into the soil. In conclusion, the comprehensive and scientifically-driven utilization of residual algae digestate represents a paradigm shift in sustainable practices[25].

1.3 Machinery Components :

1) Thermomate Electronic 50Kgs Digital Luggage Weighing Scale : Thermomate Electronic 50Kgs Digital Luggage Weighing Scale is a portable and digital device that can measure the weight of your luggage or baggage. It has a capacity of 50 kg and an accuracy of 5g or 10g.
2) Arduino Uno R3: It is a microcontroller board based on the ATmega328P, an 8-bit microcontroller with 32KB of Flash memory and 2KB of RAM. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started .
3) DC geared motors: They are compact and efficient motors that can provide high torque at low speeds. They are easy to control and can be used for various applications such as robotics, automation, and machinery.
4) Plastic transparent box: To grow algae in a transparent container that allows sunlight to

reach the algae. Plastic container to create a transparent box of dimensions 80 cm x 80 cm x 80 cm.

5) Filter sheets : A filter mesh sheet is a device that can filter air and water by trapping impurities and particles. It consists of a mesh or screen that allows the air or water to pass through while blocking the impurities.
6) Filter paper : It is a type of porous paper that can be used to filter water from micro particles. It consists of a thin sheet of paper that has small pores or holes that allow water to pass through while trapping the impurities.
7) Wheel or Disc: A circular wheel or disc with four equally spaced holes or slots to hold buckets. The size of the wheel or disc depends on the size of the buckets and the specific requirements of your application.
8) Buckets: Four buckets attached to a wheel or plate. Buckets must be evenly spaced and balanced to ensure smooth rotation. The size and shape of the buckets will depend on the specific requirements of your application. Axle: A shaft attached to a wheel or disc used to transmit power from an engine or transmission. The size and material of the shaft will depend on the specific requirements of your application.
9) Gearbox: A motor or gearbox used to turn a wheel or disc. The torque and speed of the engine or gearbox must be sufficient to turn the wheel or disc with the buckets. The type of motor or gearbox depends on the specific requirements of your application. Sensor or Controller: A sensor or controller used to detect rotation of a wheel or disc and control the speed and direction of rotation. The type of sensor or controller depends on the specific requirements of your application.
10) Support Structure: A frame or support structure used to hold the wheel or disc, buckets, axle, motor or transmission, and sensor or controller. The frame or support structure must be strong, stable and durable.
11) Wheel bolts and machine bolts are fasteners used to attach the wheel or disc to the shaft.
12) Cap nuts are used to cover the end of a bolt or screw.
13) Expansion nuts are used to create a secure and tight fit between two parts.
14) U-nuts are used to attach a panel or a sheet to a frame or a support structure.
15) Long Pipe of diameter 4cm with 80cm length.
16) Blade: The diameter of the blade should be 1/3 the diameter of the tank. For heavier materials, the blade diameter should be increased to allow maximum flow for the most efficient mixing.
17) 28BYJ-48 stepper motor : The 28BYJ-48 stepper motor is a commonly used stepper motor that is relatively easy to control with any basic microcontroller.
18) Arduino SIM800A Uno Leonardo : Arduino SIM800A Uno Leonardo is a microcontroller board featuring the ATmega32u4 chip with GSM/GPRS capabilities using the SIM800A module. It enables communication over mobile networks, making it suitable for IoT applications.

1.4 Software Components :

In the development of algae project, the following software and libraries are essential to program and connect the hardware components:

a) Arduino Software (IDE): We have used the Arduino Integrated Development Environment (IDE) as our primary tool for coding and uploading to our Arduino Uno. Available online and offline, this versatile IDE makes it easy to program an Arduino to read load cell data using the HX711 module. In addition, it allows servo motor control to operate the gate and gear motor

control via the L293D motor controller circuit.

b) HX711 Library: We are adding our Arduino code to the HX711 library to seamlessly interface with the HX711 load cell amplifier module. This library plays a key role in allowing the Arduino to accurately read and interpret weight data from the load cell. Inclusion reached #include <HX711.h> directive.
c) Servo Library: To precisely control RC (hobby) servo motors, we integrated the Servo Library into my Arduino code. This library facilitates dynamic gate control based on load cell weight data. Including this function is possible through #include <Servo.h> directive.
d) Motor Driver Library: To efficiently use motor drivers like the L293D, we add a motor driver library to my Arduino code. This library is required to control the reducer engine, which contributes to the overall functionality of the project. The necessary inclusion is achieved by the corresponding #include directive.
e) Arduino Web Editor: The web-based approach, allows us to write and upload code directly to your Arduino board from a web browser.
f) Arduino IoT Cloud: Since we are interested in Internet of Things (IoT) applications, we can use Arduino IoT Cloud. Compatible with select Arduino boards, this platform provides an intuitive environment for building and managing IoT systems.
g) Arduino Libraries: We explore various Arduino libraries to speed up coding and improve performance. Prewritten sections of code perform a variety of functions, from the interface to GPS components to car controls, sensors, displays, and more.

2. LITERATURE REVIEW

Algae, a diverse group of aquatic organisms, have emerged as an invaluable resource with wide-ranging applications in energy, consumer products, and ecosystem restoration. This article navigates the vast landscape of seaweed utilization and introduces innovative dimensions that promise a sustainable future.

The research begins with the long journey of algae and their role in energy recovery through the fields of biofuels and biogas. The characteristic factor of this work is the introduction of algae power devices, which represents a paradigm shift towards efficient and clean energy production. This new dimension increases the potential of algae beyond traditional applications, positioning them as a dynamic influencer in the global energy landscape. A notable aspect is the emphasis on paper and algae-based consumer products as a critical aspect of food security. The nutrient-rich composition of algae has been used to produce edible products in various industries, including pharmaceuticals and cosmetics. This versatile approach highlights the versatility of algae not only as a source of energy, but also as a storehouse of various compounds important for human consumption and industrial processes.

The proposed framework extends its impact to environment friendly soil enrichment with algae-based fertilizers and presents a holistic approach to sustainable agriculture. The systematic recycling of nutrients from algae complies with the principles of the circular economy and creates a symbiotic relationship between algae cultivation and soil improvement. This application presents algae as more than an energy source and positions them as an integral part of the ecological balance.

The paper delves into the intricate details of algae processes and reveals a deep understanding of how algae grow, clean air and water, capture nutrients and produce energy. This research is distinguished by the integration of advanced machine parts and technology. Mention of specific tools such as the electronic digital package scale Thermomate, Arduino Uno R3 and DC motors emphasize the practicality and optimization of algae-related processes with modern instrumentation.

Basically, this article provides a comprehensive overview of algae and their potential beyond

traditional applications. Combining innovative dimensions from energy production to consumer goods and soil enrichment makes algae a cornerstone of sustainable development. The strategic use of advanced machine parts and technology highlights the practical feasibility of the proposed framework. As algae emerge from the shadows as mere pond nuisance, this paper positions them as champions of sustainable innovation poised to redefine our approach to energy, agricultural and ecological balance.

3. Methodology :

1) Cultivation of Algae: The process begins with the cultivation of Chlorella Vulgaris in a clear plastic bucket. This bucket is attached to the engine and blade and placed in a suitable climate for algae growth. Water and air are directed through a tubular structure for cleaning, and filters are used to ensure proper cleaning.

2) Harvesting: When the algae stops growing, a constant weight is reached after several times. At this point, the Arduino GSM GPRS Shield for the Arduino SIM800A Uno Leonardo Mega signals the opening of the gate, allowing the water to pass through and collect. The blade then rotates to collect the algae, which is fed through a roller onto a plate, which the Arduino R3 rotates until the algae spreads onto the plate.

3) Sun drying: The seaweed is then left to dry in the sun on the plastic sheet. The Arduino rotates the plate to ensure even drying of the algae.

4) Nutrient extraction: After drying, the algae's nutrients are extracted. This is done with a conveyor belt made of durable plastic sheets. A conveyor belt feeds the algae onto a rotating wheel to which four buckets are attached for different chemical extractions such as protein, carbohydrate, lipid, omega-3 and fatty acid extraction. With each extraction, the conveyor carries the algae to the upper bucket where the nutrient is extracted. At the end of the specified time, the nutrient is separated by a strong shaking of the solid algae through the upper half of the filter and the nutrients remain in the bucket. The algae are then sent to a combined sun-drying belt for the next cycle.

5) Utilization: After four cycles, a part of the algae is composted for methane production, other part for additional energy production in a microbial fuel cell (MFC), and biofuel is produced separately from lipids and FAME. We get fertilizer from compost to enrich the soil. The movement of the bucket is stopped mechanically and the Arduino R3 signals the turret to stop when the second bucket reaches the top. This process is repeated for each extraction process and is controlled by the Arduino.

6) Methane production and energy production: After nutrient extraction, nutrient components, especially proteins and carbohydrates, are used in composting. The process is anaerobic digestion, a microbial process. During anaerobic digestion, the nutrient-rich fractions are broken down by microorganisms in the absence of oxygen, producing methane. It can be collected and used as a renewable energy source. At the same time, the Microbial Fuel Cell (MFC) converts biological energy into electricity. These MFCs use the chemical energy available in nutrient-rich fractions, especially carbohydrates, and convert it into electrical energy through a series of biological reactions. Lipids extracted from biodiesel also contribute to this energy production process. Biodiesel is a renewable energy source that can be used to replace fossil fuels.

7) Soil Enrichment : The final step of the lawnmower is thanks to Mother Earth. The digestate, a product of anaerobic digestion, is used as a soil conditioner. Whether applied directly to the soil or mixed with compost, the digestate strengthens the soil structure, increases nutrients and activates microbial activity. This not only improves soil fertility but also contributes to the sustainability of agricultural systems. From growing algae to harvesting, drying, nutrient extraction, and finally methane production and soil enrichment, every transition in this process is carefully controlled by Arduino.This machine acts as the silent singer of this ecological song.

3.2 Softwares and Modules :

a) **SoftwareSerial** : SoftwareSerial, a flexible Arduino library, plays a key role in enabling serial communication with alternative digital pins on an Arduino board. This versatile tool uses software to replicate the functionality of traditional hardware serial ports, allowing you to create multiple software serial ports. All these ports support speeds up to 115,200 bps. In particular, the inclusion of the parameter allows reverse signaling to devices that require such a protocol. It is worth noting that the version of SoftwareSerial for Arduino 1.0 and above is based on Mikal Hart's NewSoftSerial library.
Protocol Access Path:SoftwareSerial creates an available path for serial connection for non-default pins.
History:SoftwareSerial, derived from the NewSoftSerial library, has evolved into a standard solution for flexible serial communication needs.

b) **Sim800L library Revised**: The updated Sim800L library, designed specifically for the Sim800L module, simplifies communication by providing robust functionality. These features make it easy to send and receive data with the Sim800L module. To integrate the Sim800L Arduino library into the Arduino IDE, users can go to Sketch and Include library Manage Libraries, search for "Sim800L" and click "install". The library forms a communication protocol with the Sim800L module, ensuring seamless integration and better performance.
Protocol usage path: The library defines a clear communication protocol with the Sim800L module, which facilitates integration.
History: Library revisions may be due to changing requirements and user feedback to improve Sim800L module communication.

c) **AHT_SIM800**: Mainly designed for SIM800/SIM900 modules, the AHT_SIM800 library enhances Arduino projects with GSM/GPRS and GPS functionality. Its features include data rate detection, support for different GSM types (currently SIM800, future compatibility with SIM5300 and UC15) and more. The library forms a complete communication protocol with SIM800/SIM900 modules that ensures smooth GSM, GPRS and GPS functionality.
Protocol usage path: AHT_SIM800 defines the communication protocol of SIM800/SIM900 modules, which ensures smooth integration of GSM, GPRS and GPS functions.
Major Projects: The library is widely used in projects involving GPS tracking, remote monitoring and various IoT applications.

d) **BareBone SIM800 Library**: The BareBone SIM800 library, tailored for SIM800 modules, offers basic but comprehensive functionality. This essential tool supports sleep mode, facilitates sending and receiving text messages, provides location and time updates, and enables HTTP

communication. It defines the access path to the main functions of the SIM800 module, including SMS, sleep mode and HTTP communication. **Protocol Access Path**: The library describes the access path to the main functions of the SIM800 module, improving SMS, sleep and HTTP communication.

Large Projects: Widely used in projects that require SMS functionality, location tracking and low power consumption.

4. Result and Discussion :

The algae processing machine, designed for the cultivation of Chlorella Vulgaris and the subsequent production of bioproducts, showed remarkable efficiency in all stages of its operation. In the context of growing algae, a carefully designed initial setup characterized by a transparent plastic container above the rotating mechanism created a favorable environment for the algae. The use of a DC motor controlled by an Arduino Uno R3 helped to organize an optimal growth environment, which demonstrates the integration of advanced control systems into biological processes.

In the harvesting phase, the synchronized interaction of the Arduino Uno R3 and the Thermomate electronic digital pack scale enabled accurate biomass measurement and expert harvesting. The well-considered time of the door opening and the application of the cutting mechanism emphasize the efficiency of the machine and work in harvesting biomass, which is a key part of the growth cycle. Major achievements were made in nutrient recovery, where the algae utilization machine successfully extracted proteins, carbohydrates, lipids and omega-3/fatty acids from cultured algae. This result positions the machine as a viable platform for the production of valuable bioproducts with possible applications in the food, biofuel, pharmaceutical and cosmetic industries.

In addition to the ability to produce bioproducts, the machine performs anaerobic digestion, which produces methane for renewable energy applications. However, the composting of nutrient-rich fractions is an example of its role in waste management and the circular economy, which incorporates its versatile benefit in sustainability efforts.

The versatile applications of the Algae Processing Machine extend to agriculture, soil health improvement, aquaculture, livestock feeding, environmental monitoring and education. This adaptability highlights its potential as a versatile tool that meets the challenges of various sectors and promotes the sustainable use of resources.

Although the results are promising, further research and development is needed to continue optimization. Possible avenues include refining the nutrient recovery process, researching sustainable algae cultivation methods, and evaluating the machine and its applicability in previously unexplored industries. This recognition of potential research directions underscores the iterative and evolving nature of efforts toward sustainable bioproduct production.

In conclusion, it can be stated that the scientifically developed methods and proven effectiveness of the Algae Utilization Machine is a promising tool for the sustainable production of organic products. Its combination of technological precision and versatility positions it as a potential catalyst for the advancement of sustainable practices and resource-efficient solutions in various fields of science and industry.

5. Applications of the algae drive:

1. Production of organic products: The machine extracts proteins, carbohydrates, lipids and Omega-3/fatty acids from Chlorella Vulgaris. These nutrient-rich extracts can be used to produce a variety of organic products. For example, proteins and carbohydrates can be used to make nutrient-dense foods, providing a healthier alternative to traditional foods. Lipids can be used in the production of biofuels, providing a sustainable alternative to fossil fuels.

Omega-3 fatty acids, which are good for heart health, can be used in dietary supplements.

2. Renewable energy production: The machine and the anaerobic digestion process produce methane, which is a powerful source of renewable energy. This methane can be recycled and used for various purposes, such as heating or electricity generation. In addition, lipids extracted from algae can be converted into biodiesel, a biofuel that can be used unmodified in diesel engines.
3. Waste management and circular economy: The machine and holistic approach to waste management involves composting the nutrient-rich parts of the algae. This not only contributes to the management of organic waste, but also promotes the circular economy by turning waste into valuable resources. The prepared compost can be used as a soil conditioner, which improves the fertility of the soil and promotes plant growth.
4. Improve agriculture and soil health: Digestate, which is a byproduct of the anaerobic digestion process, can be used as a soil conditioner. It is rich in nutrients and can help improve soil structure, increase its water capacity and promote the growth of beneficial soil microorganisms. This can improve yields and promote sustainable farming practices.
5. Aquaculture and livestock nutrition: Nutrients extracted from algae, especially proteins and omega-3 fatty acids, can be used in food production. It can promote the health and growth of aquatic organisms and livestock, increasing productivity in aquaculture and animal husbandry.
6. Environmental monitoring and restoration: The machine and its water and air purification functions can be used for environmental monitoring and restoration. Algae can absorb pollutants from air and water, helping to improve air and water quality. This can be particularly useful in areas with high levels of pollution.
7. Advances in Education and Science: The machine can be a valuable learning tool, providing students and researchers with hands-on experience in algae cultivation, nutrient recovery and sustainable practices. It can promote innovation and knowledge in bioprocess and environmental sciences.
8. Pharmaceutical industry: Nutrients extracted from algae can be used in the pharmaceutical industry. For example, proteins can be used to make therapeutic products and omega-3 fatty acids can be used to make dietary supplements related to heart health.
9. Cosmetics and hygiene products: Nutrients extracted from algae can be used in the preparation of various cosmetic and personal care products. For example, proteins and lipids can be used in moisturizers and anti aging creams that promote skin health.
10. Production of bioplastics and biomaterials: The remaining biomass after nutrient extraction can be used in the production of bioplastics and biomaterials. It offers a sustainable alternative to oil-based plastics and helps reduce plastic waste.
11. Carbon Bond: Growing algae promotes carbon sequestration, as algae absorb carbon dioxide during photosynthesis. This can help curb climate change by reducing greenhouse gasses.
12. Wastewater treatment: Algae can be used in water purification because they can absorb nutrients and heavy metals from the water. This can improve water quality and reduce the environmental impact of wastewater.
13. Biofertilizer Production: The residual biomass after nutrient extraction can be used to produce biofertilizers. These fertilizers can provide essential nutrients to plants and improve soil health, promoting sustainable agriculture practices.
14. Nutrients: Extracted nutrients, especially proteins and omega-3 fatty acids, can be

used in food production. Nutraceuticals are products derived from food that provide additional health benefits in addition to the basic nutritional value of food.

15. Bio Correction: Algae can absorb pollutants from the environment in a process known as bioremediation. This can be particularly useful in areas with high levels of pollution, helping to improve air and water quality.
16. Carbon credits: Growing algae promotes carbon sequestration, as algae absorb carbon dioxide for photosynthesis. This can help curb climate change by reducing greenhouse gas emissions. Companies may be able to earn carbon credits from this, which can be sold to other companies as part of carbon trading schemes.
17. Research and development: The seaweed processing machine can be a valuable tool in research and development in various fields such as biochemistry, environmental science and sustainable agriculture. With the help of the machine, scientists can study the growth of algae under different conditions, the efficiency of nutrient recycling processes and the efficiency of different bioproducts.
18. Climate change mitigation: By providing a sustainable source of biofuel, an algae processor can help reduce our dependence on fossil fuels and thus curb climate change. In addition, the machine and its ability to sequester carbon can further contribute to mitigating climate change.
19. Biocarbon production: Biomass remaining after nutrient extraction can be pyrolyzed to produce biochar, a type of charcoal used for soil improvement. Biocarbon can improve soil fertility, increase agricultural productivity and sequester carbon, thus contributing to climate change mitigation.
20. Recovery of nutrients from wastewater: Algae can absorb nutrients such as nitrogen and phosphorus from sewage. This not only helps with waste water treatment, but it also allows these nutrients to be recycled and reused in, for example, agriculture or the production of biofertilizers.
21. Biogas and hydrogen production: In addition to methane, anaerobic fermentation of algae can also produce biogas, i.e. a mixture of methane and carbon dioxide that can be used.

6. Conclusion :

In conclusion, it can be said that the development and introduction of a seaweed processing machine represents a transformational approach to the sustainable production of bioproducts and environmental protection. The machine and its versatile functionality, ranging from nutrient recovery to waste management, make it an innovative solution in several industries. Its ability to produce high-quality organic products, promote renewable energy production, improve soil health, and air and water quality underscores its potential to promote a more sustainable and resource-efficient future.

In addition, the Algae Application Machine and its role in advancing education and science will create a platform for innovation and knowledge transfer that will advance the development of bioprocessing and environmental science. The machine and its versatility extends to the pharmaceutical industry, the manufacture of cosmetics and hygiene products, the production of bioplastics and biomaterials, and even carbon sequestration, demonstrating its wide range of applications. The algae engine and its contribution to job creation and the local economy further underline its social impact. As the world grapples with the challenges of climate change, natural resource depletion and

environmental pollution, Lävägyökone offers a beacon of hope that demonstrates the power of innovative technology to drive sustainable solutions.

Future research should continue to optimize the machine and processes and explore new applications to keep the Algae Drive Machine at the forefront of sustainable technology. As we continue to improve and expand this technology, the Algae Processing Machine promises to play a key role in our journey to a more sustainable and resource-efficient world.

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