

SYSTEM AND METHOD FOR PROPAGATING ALGAE AND/OR ZOO PLANKTONS

FIELD OF INVENTION

[0001] The present invention relates broadly, but not exclusively, to systems and methods for propagating algae and/or zoo planktons.

BACKGROUND

[0002] Algae has been known to be a source of food (the most well-known being seaweeds), superfoods, nutraceuticals, biofuel and livestock feed. Algae has also been considered a biological pollution controller, for example, by sequestering atmospheric carbon dioxide or reducing nitrogen and phosphorous contents in runoff from agricultural fields. Zoo planktons have been considered as a feed source for fish/prawn farming.

[0003] Conventionally, algae cultivation is carried out in countries that have large amounts of land and low cost of labour. Typical open farming of algae is also water-intensive and makes use of available farm wastes such as cow dung or manufactured fertilizers. In some cases, agitation of the water may be performed manually or by mechanical paddlers.

[0004] However, it has been noted that such mainly outdoor algae cultivation may be critically affected by inclement weather conditions, such as rain and/or insufficient sunlight as well as contaminations/pollutions. As a result, the yield and quality of the cultivated algae and/or any zoo planktons may be inconsistent.

[0005] A need therefore exists to provide a system and method for algae/zoo planktons propagation that can address at least some of the above problems.

SUMMARY

[0006] An aspect of the present disclosure provides a system for propagating algae and/or zoo planktons, comprising a generally flat base and a plurality of optically transparent containers mounted on the base, each container configured to contain a water-based medium to support algae and/or zoo planktons propagation, wherein each container is disposed at the same distance from a center of the base as the other containers, and wherein each container is rotatable relative to the base about a respective upright axis extending from the base through said container.

[0007] The system may further comprise a gas distribution system comprising a gas source and a plurality of tubes corresponding to the plurality of containers, each tube comprising a first end fluidically connected to the gas source and a second end disposed in one of the containers for delivering carbon dioxide or oxygen from the gas source to said container. The system may further comprise an air stone attached to the second end of each tube. Each tube may comprise a selectable gas flow rate independent of the other tubes.

[0008] The system may further comprise a plurality of sensors, and at least one sensor may be disposed in each container and configured to monitor at least one parameter in said container. The system may further comprise a control circuit, and the at least one sensor may be connected to the control circuit by a wire passing through the tube corresponding to said container.

[0009] The system may further comprise a movable platform supporting the base, and the platform may be configured to move the system between an indoor location and an outdoor location. The system may further comprise a light source mounted along an upright axis extending from the center of the base, and the light source may be operable at the indoor location. The light source may comprise at least one light emitting diode (LED) light, and a wavelength of the at least one LED light may be selected to be in a range of 300 nm to 800 nm.

[0010] Each container may comprise a rotational speed and/or direction independent of the other containers.

[0011] Another aspect of the present disclosure provides a method for propagating algae and/or zoo planktons, comprising disposing a water-based medium capable of supporting algae and/or zoo planktons propagation in a plurality of optically

transparent containers; mounting the containers on a generally flat base such that each container is disposed at the same distance from a center of the base as the other containers; and rotating each container relative to the base about a respective upright axis extending from the base through said container.

[0012] The method may further comprise providing a plurality of tubes corresponding to the plurality of containers; fluidically connecting a first end of each tube to a gas source; disposing a second end of each tube in a respective one of the containers; and delivering carbon dioxide or oxygen from the gas source through the tubes to each of the containers. Disposing the second end of each tube in a respective one of the containers may comprise attaching an air stone to the second end of each tube. The method may further comprise selecting a gas flow rate for each tube independently of the other tubes.

[0013] The method may further comprise disposing at least one sensor in each container and monitoring at least one parameter in said container using the at least one sensor.

[0014] The method may further comprise connecting the at least one sensor to a control circuit using a wire passing through the tube corresponding to said container.

[0015] The method may further comprise supporting the base on a movable platform, the base having the containers mounted thereon, and moving the platform between an indoor location and an outdoor location based on a lighting condition and/or a weather condition.

[0016] The method may further comprise mounting a light source along an upright axis extending from the center of the base, and operating the light source at the indoor location.

[0017] The method may further comprise selecting at least one light emitting diode (LED) light to be the light source, and selecting a wavelength of the at least one LED light to be in a range of 300 nm to 800 nm.

[0018] Rotating each container relative to the base may comprise rotating each container at a rotational speed and/or direction independent of the other containers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

[0020] Figure 1a is a perspective view of a system for propagating algae and/or zoo planktons according to an example embodiment.

[0021] Figure 1b is a top plan view of the system of Figure 1a.

[0022] Figure 2 is an example implementation of the system of Figure 1a.

[0023] Figure 3 is a flow chart illustrating a method for propagating algae and/or zoo planktons according to an example embodiment.

DETAILED DESCRIPTION

[0024] The present disclosure provides a system and method of propagating high-quality algae and/or zoo planktons in a bio-photoreactor by controlling growth conditions such as water, light and carbon dioxide. The system is a closed system which is modular and portable. Accordingly, the system is not affected by unfavourable weather and can provide the algae/zoo planktons with optimal conditions for grow.

[0025] Figure 1a-1b show perspective and top views, respectively, of a system 100 for propagating algae and/or zoo planktons according to an example embodiment. Figure 2 shows an example implementation of the system 100 of Figure 1a. In the drawings, like numerals denote like elements.

[0026] The system 100 includes a generally flat base (made of weather and UV resistant materials) 102 and a plurality of optically transparent containers 104 mounted on the base 102. The base 102 is substantially rigid to support the weight of the containers 104 and their contents. In a non-limiting example implementation, the containers 104 are in the form of recycled polyethylene terephthalate (PET) bottles. However, it will be appreciated that the containers can be made of a

different material (e.g. acrylic or polycarbonate) or have a different shape (e.g. cylinder) in alternate embodiments. Each container 104 can hold a water-based medium capable of supporting algae and/or zoo planktons propagation and small initial quantities of algae, such that the algae/zoo plankton can grow in the containers 104. For example, the water-based medium may include potable water, nutrients and enhancers that promote growth of algae/zoo planktons, such as food-derived materials enhanced with minerals.

[0027] The containers 104 are arranged on the base 102 such that each container 104 is disposed at the same distance from a center 106 of the base 102 as the other containers. Such an arrangement can help to ensure even exposure to light when a light source is mounted at the center 106 of the base 102, as will be described below and shown in Figure 2. In preferred embodiments, the base 102 is circular and the containers 104 are evenly distributed near the rim of the base 102. In the example shown in Figures 1a-1b, twelve containers 104 are used. However, it will be appreciated that the number of containers vary in alternate embodiments depending on, for example, the size of the containers and the size of the base. Each container 104 is a self-containing unit such that operation of one container can be controlled independently of the other containers. Accordingly, it is possible to grow different batches of algae/zoo planktons in the same set-up, or to monitor and analyse the effects of varying the growth conditions (e.g. carbon dioxide contents, nutrient contents) in different containers of the same set-up.

[0028] Moreover, each container 104 is rotatable or swivellable relative to the base 102 about a respective upright axis extending from the base 102 through said container 104. This can optimize the exposure of different parts of each container 104 to natural sunlight or artificial light. For example, the bottom of each container 104 may be secured to a plate 108, and the plate 108 may be driven by a respective actuator, e.g. a motor (not shown). As a result, each container 104 may have a rotational speed and/or direction independent of the other containers. This can help to ensure the right amount of agitation is individually applied to each container 104 depending on, for example, a parameter sensed from the container. In the event that one actuator does not function properly and needs to be repaired or replaced, the operation of the other actuators is not affected.

[0029] In a preferred embodiment, the system 100 further includes a gas distribution system to inject carbon dioxide and/or oxygen into the medium held in each container 104. The gas distribution system includes a gas source containing

e.g. carbon dioxide and a plurality of tubes 110 corresponding to the plurality of containers 104. The tubes 110 are supported on a structure 112 such that the tubes 110 are prevented from entangling with each other. Each tube 110 is substantially transparent and includes a first end fluidically connected to the gas source and a second end disposed in one of the containers 104 (e.g. through screw caps) for delivering carbon dioxide from the gas source to that container. The gas source may include associated devices, such as a pump, a set of valves corresponding to the tubes, etc. Each tube 110 may have a selectable gas flow rate that is independent of the other tubes, for example, by controlling the valve corresponding to that tube. In this way, the rate of carbon dioxide injection into each container 104 may be optimised based on the parameters or conditions in that container. In some implementations, an air stone 114 is attached to the second end of each tube 110 to provide additional microbubbling, thereby better distribution and dissolution of carbon dioxide in the water-based medium. The microbubbling also can provide agitation without requiring mechanical stirrers.

[0030] It will be appreciated that the carbon dioxide from the gas source can be pure or in a mixture with other gases. For example, the carbon dioxide may be mixed with air. In alternate embodiments, oxygen or air enriched with oxygen may be injected into the containers 104, e.g. at night when oxygen is absorbed. Typically, based on the parameters or conditions sensed from the containers 104, the control unit of the system can determine which gas/gases to be injected.

[0031] The system 100 may also include a plurality of sensors. At least one sensor may be disposed in each container 104 to monitor at least one parameter in that container. Examples of the parameters to be monitored in each container 104 include, but are not limited to, temperature, pH level, concentrations carbon dioxide (CO₂), oxygen (O₂), nitrogen (N), phosphorous (P), potassium (K), nitrates and phosphates, and light intensity. In one example implementation, the at least one sensor is connected to a control circuit (not shown) by a wire passing through the tube 110 corresponding to that container (e.g. through screw caps). It will be appreciated that the tube 110 provides a pathway for the wire into the container 104, and the wire can exit from the tube 110 at a position outside of the container 104. A seal may be disposed at the exit point of the wire to prevent a gas leak, as will be appreciated by a person skilled in the art. The sensors could then be remotely controlled/actuated/recorded by Internet of Things capability with online mobile phone interactions.

[0032] As can also be seen in Figures 1a and 2, base 102 includes compartments to house associated equipment and accessories including a power pack into an integral mobile unit free from any connected cabling. For example, the carbon dioxide gas source, pump, valves, control unit and a power supply can all be housed in the base 102. The control unit may be in the form of programmable logic controllers, circuit boards, or a computing device that can interface with and control components of the system 100. For example, the computing device not only can receive outputs from the sensors but also can control operations of the carbon dioxide gas source. The computing device may include control software to track parameters in the containers 104 and enable feedback control of light intensity, salinity, temperature, pH level, dissolved oxygen (DO) contents, turbidity, stirring, air flow rate, rotation speed and other growth control parameters. Multi-container data can be saved and collected, real-time data may be obtained through online (i.e. active) sensors, and all data exported can be displayed in text, line graph or bar chart. The computing device may also be connected to an intranet or the Internet via a wireless connection (e.g. Wi-Fi or Bluetooth) to allow remote monitoring and controlling, e.g. via a web browser.

[0033] The base 102 is supported by a movable platform 116 that can move the system 100 between an outdoor location and an indoor location. Here, the platform 116 includes a plurality of castor wheels 118 that can be driven manually or autonomously. For example, the system 100 may be moved to the outdoor location during the daytime when sunlight is available and sufficient and the weather is normal, in order to make full use of natural light and reduce energy use. Conversely, the system 100 may be moved to the indoor location during the night-time or when the weather is not favourable (e.g. rain). In example implementations that include self-mobility, movement of the system 100 may be controlled by the control unit which may receive time information, sensor data, weather information, etc. and determine whether the system should be at the outdoor location or the indoor location. The control unit can then instruct a drive unit to autonomously for example, using electronic micromotors to move the system 100.

[0034] The system 100 may also include a light source that operates at the indoor location to provide additional lighting. With reference to Figure 1b and Figure 2, the light source is in the form of at least one light emitting diode (LED) light 120 that is mounted along an upright axis extending from the center 106 (Figure 1b) of the

base 102. For example, the at least one LED light 120 may be attached to an upright post of the structure 112. With such an arrangement, the at least one LED light 120 can provide the additional lighting evenly to each of the containers 104. A suitable wavelength of the at least one LED light 120 is the range of 300 nm to 800 nm. The additional lighting can maximise the operation time of the system 100 (i.e. round-the-clock operation) such that the system 100 remains productive even at night or during unfavourable weather conditions.

[0035] Figure 3 shows a flow chart 300 illustrating a method for propagating algae and/or zoo planktons according to an example embodiment. At step 302, a water-based medium capable of supporting algae and/or zoo plankton propagation is disposed in a plurality of optically transparent containers. At step 304, the containers are mounted on a generally flat base such that each container is disposed at the same distance from a center of the base as the other containers. At step 306, each container is rotated relative to the base about a respective upright axis extending from the base through said container.

[0036] In preferred embodiments, the method further includes providing a plurality of tubes corresponding to the plurality of containers, fluidically connecting a first end of each tube to a gas source, disposing a second end of each tube in a respective one of the containers, and delivering carbon dioxide from the gas source through the tubes to each of the containers. Alternatively or in addition, the method includes supporting the base on a movable platform, the base having the containers mounted thereon, and moving the platform between an indoor location and an outdoor location based on a lighting condition and/or a weather condition. Further, a light source may be mounted along an upright axis extending from the center of the base and operated at the indoor location.

[0037] As described, the system and method according to example embodiments can provide an economical yet effective approach to algae propagation by utilising recycled components where possible and natural lighting conditions. The system is also modular, thereby allowing simple and cost-effective maintenance and replacement of components that may be subject to wear. Furthermore, by suitably controlling the growth conditions in closed containers, the algae/zoo planktons grown in the example embodiments may have a consistently high quality and may be used as seed materials for large-scale algae/zoo planktons farming.

[0038] It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. A system for propagating algae and/or zoo planktons, comprising:
a generally flat base; and
a plurality of optically transparent containers mounted on the base, each container configured to contain a water-based medium to support algae and/or zoo planktons propagation,
wherein each container is disposed at the same distance from a center of the base as the other containers; and
wherein each container is rotatable relative to the base about a respective upright axis extending from the base through said container.
2. The system as claimed in claim 1, further comprising a gas distribution system comprising:
a gas source; and
a plurality of tubes corresponding to the plurality of containers, each tube comprising a first end fluidically connected to the gas source and a second end disposed in one of the containers for delivering carbon dioxide or oxygen from the gas source to said container.
3. The system as claimed in claim 2, further comprising an air stone attached to the second end of each tube.
4. The system as claimed in claim 2 or 3, wherein each tube comprises a selectable gas flow rate independent of the other tubes.
5. The system as claimed in any one of claims 2 to 4, further comprising a plurality of sensors, wherein at least one sensor is disposed in each container and configured to monitor at least one parameter in said container.
6. The system as claimed in claim 5, further comprising a control circuit, wherein the at least one sensor is connected to the control circuit by a wire passing through the tube corresponding to said container.
7. The system as claimed in any one of the preceding claims, further comprising a movable platform supporting the base, wherein the platform is

configured to move the system between an indoor location and an outdoor location.

8. The system as claimed in claim 7, further comprising a light source mounted along an upright axis extending from the center of the base, wherein the light source is operable at the indoor location.

9. The system as claimed in claim 8, wherein the light source comprises at least one light emitting diode (LED) light, and wherein a wavelength of the at least one LED light is selected to be in a range of 300 nm to 800 nm.

10. The system as claimed in any one of the preceding claims, wherein each container comprises a rotational speed and/or direction independent of the other containers.

11. A method for propagating algae and/or zoo planktons, comprising:
disposing a water-based medium capable of supporting algae and/or zoo planktons propagation in a plurality of optically transparent containers;
mounting the containers on a generally flat base such that each container is disposed at the same distance from a center of the base as the other containers;
and
rotating each container relative to the base about a respective upright axis extending from the base through said container.

12. The method as claimed in claim 11, further comprising:
providing a plurality of tubes corresponding to the plurality of containers;
fluidically connecting a first end of each tube to a gas source;
disposing a second end of each tube in a respective one of the containers;
and
delivering carbon dioxide or oxygen from the gas source through the tubes to each of the containers.

13. The method as claimed in claim 12, wherein disposing the second end of each tube in a respective one of the containers comprises attaching an air stone to the second end of each tube.

14. The method as claimed in claim 12 or 13, further comprising selecting a gas flow rate for each tube independently of the other tubes.

15. The method as claimed in any one of claims 12 to 14, further comprising disposing at least one sensor in each container and monitoring at least one parameter in said container using the at least one sensor.

16. The method as claimed in claim 15, further comprising connecting the at least one sensor to a control circuit using a wire passing through the tube corresponding to said container.

17. The method as claimed in any one of claims 11 to 16, further comprising:

supporting the base on a movable platform, the base having the containers mounted thereon; and

moving the platform between an indoor location and an outdoor location based on a lighting condition and/or a weather condition.

18. The method as claimed in claim 17, further comprising:

mounting a light source along an upright axis extending from the center of the base; and

operating the light source at the indoor location.

19. The method as claimed in claim 18, further comprising:

selecting at least one light emitting diode (LED) light to be the light source; and

selecting a wavelength of the at least one LED light to be in a range of 300 nm to 800 nm.

20. The method as claimed in any one of claims 11 to 19, wherein rotating each container relative to the base comprises rotating each container at a rotational speed and/or direction independent of the other containers.