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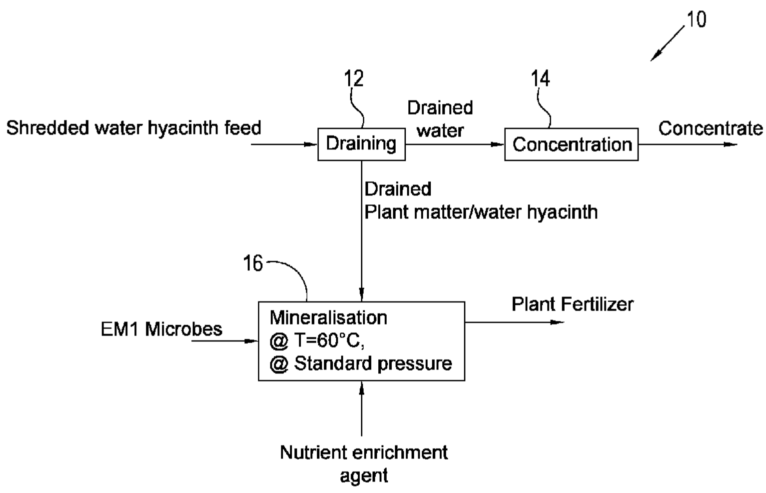

Figure 1

(57) Abstract: The invention relates to a method of converting chemicals absorbed by an angiosperm into a plant nutrient, the method comprising the step of draining at least a portion of the water in the angiosperm for use as a liquid nutrient for plants. The method also relates to a method of converting an angiosperm into a nutrient for plants, the method comprising the steps of draining at least a portion of the water in the angiosperm until the moisture content of the angiosperm is at a predefined moisture content; and converting the angiosperm into a nutrient for plants.

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METHOD OF MAKING AN ORGANIC PLANT FERTILIZER FROM WATER HYACINTH

FIELD OF INVENTION

THIS invention is in the fields of the manufacture of organic fertilizers.

BACKGROUND OF INVENTION

Water hyacinth (*Eichhornia crassipes, Family Pontederiaceae)* is known as "the world's worst water weed" because it can spread fast and widely, grows very quickly both sexually and vegetatively, and causes considerable damage to water eco-systems, riparian vegetation, people's livelihoods, and general human economic development.

The water hyacinth, *Eichhornia Crassipes*, is a free floating aquatic weed originating from South America. It can be recognized by its large swollen leaves and violet flowers arranged in spikes. It was introduced as an ornamental species into the USA, South East Asia and South Africa in the late 19th century and is now naturalized in most tropical and subtropical areas. It can be found between 38°N and 38°S and is referred to as a noxious weed in more than 50 countries on five continents.

The plant thrives in eutrophicated and polluted water bodies. In these water bodies, heavy metals and other chemical elements are taken up by the plant for its livelihood and healthy growth.

The water hyacinth is considered to be responsible for reduction of biodiversity. Once introduced, it takes over the whole environment blocking waterways, rivers, irrigation canals and lakes. Ships and boats used for fishing and transportation have severe problems with their navigation because of water hyacinth mats. Fishermen struggle to reach fishing areas, resulting in loss of livelihood. Water hyacinth can also block irrigation canals, reducing the water flow and resulting in poor irrigation and floods.

The water hyacinth plant is unusual in many ways. It is a truly floating plant which invades and colonises all water courses in which it grows, destroying their eco-system. On the other hand, this same invasive plant has positive properties to absorb chemical elements from the water courses it grows in.

Generally all plants require 16 nutrients in varying proportions: 3 major (macro) nutrients; Nitrogen, Potassium, Phosphorous (N:P:K) as basic necessary nutrients for healthy growth; and 13 micronutrients necessary to enhance root growth; cell formation; water absorption rates and regulation; disease control; metabolic reactions; strength of plants; photosynthesis, protein production, fruit, flower, seed and leaves development, and chlorophyll production, etc.

It is the object of this invention to provide a method of converting the inherent chemical elements the water hyacinth absorbs from water and atmosphere into a useful product, typically a nutrient for plants.

It is also an object of the invention to provide a nutrient for plants having the 16 micronutrients necessary for the growth and development of the plant.

SUMMARY OF INVENTION

According to a first aspect of the invention there is provided a method of converting chemicals absorbed by an angiosperm into a plant nutrient, the method comprising the step of draining at least a portion of the water in the angiosperm for use as a liquid nutrient for plants.

In an embodiment, the step of draining the retained water in the angiosperm, preferably of the *Family Pontederiaceae,* typically of the genus *Eichhornia,* specifically of the species *Eichhornia crassipes* commonly known as water hyacinth, may comprise dewatering the water hyacinth to remove at least a portion of the water in the water hyacinth.

In an embodiment, the method may comprise a step of concentrating the drained water.

In an embodiment, the step of concentrating the water removed from the water hyacinth may comprise filtering the drained water, and collecting the drained water in a container, in particular a concentration tank.

In an embodiment, the method includes the step of concentrating the drained water, the step including the step of evaporating about 60% of the drained water preferably under standard temperature and atmospheric pressure conditions, typically under sunlight for about a week in order to obtain a concentrate for use as a liquid nutrient for plants.

According to a second aspect of the invention, there is provided a method of converting an angiosperm into a nutrient for plants, the method comprising the steps of

draining at least a portion of the water in the angiosperm until the moisture content of the angiosperm is at a predefined moisture content; and

converting the angiosperm into a nutrient for plants.

In an embodiment, the step of draining the water in the angiosperm, preferably of the *Family Pontederiaceae,* typically of the genus *Eichhornia,* specifically of the species *Eichhornia crassipes* commonly known as water hyacinth, may comprise dewatering the water hyacinth typically in a dewatering unit, such as a press, so as to squeeze the inherent water and intracellular-trapped water in the water hyacinth until the moisture content of the water hyacinth is between about 30% and 40%.

In an embodiment, the method may comprise a step of concentrating the drained water.

In an embodiment, the step of concentrating the water removed from the water hyacinth may comprise filtering the drained water, and collecting the filtrate in a concentration container/tank for concentrating the filtrate into a concentrate solution for use as a liquid nutrient for plants.

In an embodiment, the step of concentrating the filtrate includes evaporating about 60% of the filtrate preferably under standard temperature and atmospheric pressure conditions, typically under sunlight for about a week in order to obtain a concentrate solution for use as a liquid nutrient for plants.

In an embodiment, the method may comprise an optional step of cutting, preferably chopping or shredding, the water hyacinth preferably to a maximum length of about 50mm, more preferably 40mm, to remove the air trapped in the intercellular spaces in the plant tissues, for preventing automatic fermentation of the water hyacinth and for increasing the surface area of the water hyacinth that can be exposed to conversion agents downstream.

In a first version, the conversion step may be a mineralization process typically conducted in a reactor at a temperature of about 60 degrees Celsius, preferably 40 degrees Celsius, and at least at atmospheric pressure.

In the first version, the mineralization process may comprise a step of feeding a first conversion agent, in particular a nutrient enriching agent, typically a Nitrogen enrichment agent, such as chicken manure/litter, goat manure, sheep manure, pigs manure, guano (such as bats and sea birds) manure, to the drained or de-watered water hyacinth.

In the first version, the mineralization process may comprise a step of blending the combination of the nutrient enriching agent and the drained water hyacinth in the reactor or prior to being introduced into the reactor.

In the first version, the mineralization process may comprise a step of feeding a second conversion agent, such as microbes, preferably EM-1 microbes, to the combination of the nutrient enrichment agent and the drained water hyacinth for enhancing the mineralization of the water hyacinth to achieve a mineralization rate of about 80% in up to ten days.

In the first version, the method may comprise the step of removing the mineralized plant matter from the reactor for use as solid plant nutrient.

In a second version, the method comprises the step of windrowing the shredded and de-watered water hyacinth plants to create a predefined bulk density of about 650 kg/m^3 so as to enable adequate oxygen flow, and afford free air space of between 55 to 65% by volume in order to induce optimal aerobic conditions for the onset of the organomineralisation process of the water hyacinth plant.

In this second version, the method may comprise the step of feeding EM-1 stock solution diluted with clean un-chlorinated water at a ratio of about 1:500 to 1:1000, and mixed with 1% molasses to the windrow of shredded and de-watered water hyacinth at a rate of about 25 litres (diluted EM-1 solution) per 70 tonnes of the water hyacinth, preferably twice a day.

In embodiment, the EM-1 stock solution comprises 6.8×10^7 CFU/ml lactic acid bacteria (Lactobacillus casei) and 2.4×10^2 CFU/ml Yeast (Saccharomycess cerevisiae). Typically, these selected beneficial phototropic microorganisms attack the organic matter of the water hyacinth plants to breakdown the plant tissues as part of the mineralisation process.

In an embodiment, the method includes the step of aerating the windrow material (i.e. water hyacinth), preferably three times a day, more preferably two times a day, more preferably once a day to maintain the temperature of the windrow material at about 40^0C.

In an embodiment, the step of aerating the windrow material comprises turning over the windrow material.

In an embodiment, the method comprises the step of adding the dewatered water from the water hyacinth or concentrate solution to the windrow material during the aeration step.

In an embodiment, the method comprises repeating the aeration step and the step of adding the water drained from the water hyacinth or concentrate solution for about 10 to 14 days to achieve about 80% mineralisation rate so as to form a mineralised product for use as farm inputs to crops on farms.

In an embodiment, the method may comprise the step of screening the mineralised product through a screen of a predefined aperture size to achieve mineralised product having a consistent product size.

BRIEF DESCRIPTION OF DRAWINGS

The invention will now be further described, by way of example, with reference to the accompanying diagrammatic drawings.

In the drawings:

FIG. 1 shows a block diagram of a method for making a fertilizer from water hyacinth in accordance with a first version of the invention; and

FIG. 2 shows a block diagram of a method for making a fertilizer from water hyacinth in accordance with a second version of the invention.

DETAILED DESCRIPTION OF AN EXAMPLE EMBODIMENT

The following description of the invention is provided as an enabling teaching of the invention. Those skilled in the relevant art will recognise that many changes can be made to the embodiment described, while still attaining the beneficial results of the present invention. It will also be apparent that some of the desired benefits of the present invention can be attained by selecting some of the features of the present invention without utilising other features. Accordingly, those skilled in the art will recognise that modifications and adaptations to the present invention are possible and can even be desirable in certain circumstances, and are a part of the present invention. Thus, the following description is provided as illustrative of the principles of the present invention and not a limitation thereof.

As shown in Fig. 1, a method 10 of manufacturing plant fertilizer from water hyacinth is provided. The method 10 includes receiving the water hyacinth which was previously harvested in a harvester as described in more detail in a related, simultaneously filed PCT Application that is based on South African provisional patent application No. 2017/05135. Alternatively, the water hyacinth may be sized manually or by means of any sizing unit that is capable of shredding or cutting or chopping the water hyacinth to predefined lengths. Typically, the shredded water hyacinth would have a length of not more than 50mm, preferably 40mm to ensure loss of molecular memory in the water hyacinth. The shredding of the plant matter (i.e. water hyacinth) rids the plant matter of the air trapped in the intercellular spaces in the plant tissues. This air, if left trapped into the tissues, initiates fermentation of the plant materials and promotes formation of methane gas, and inhibits the mineralisation rate of the plant matter into nutrients.

The shredded water hyacinth contains about 90% moisture. This moisture is inherent in the plant but is also soaked up in the voids of the intercellular spaces in the plant. To initiate mineralisation of the water hyacinth, the moisture content should typically be in the range of 35-40%. Accordingly, the method 10 includes the step of draining or dewatering 12 the shredded water hyacinth. Typically, the step of dewatering 12 the water hyacinth may be conducted in a draining/dewatering process unit such as a press having an arrangement of rollers defining spaces between them for squeezing the shredded water hyacinth between the rollers. The shredded water hyacinth having the moisture content of about 90% would be fed into the draining unit and subsequently squeezed or pressed by the draining unit. The product released from the draining unit is drained water/fluid and drained plant matter (i.e. drained water hyacinth). Moisture control in the draining unit (i.e. draining step 12) takes place to prevent on-setting of fermentation which is the opposite of the required mineralisation process. Ordinarily, mineralisation is compromised at moisture levels lower than 30%. The drained water hyacinth would typically have a moisture content of between 30% and 40%.

The water drained from the water hyacinth is fed to an open ended/uncovered concentration tank which is subjected to sunlight during the day. Typically, about 60% of the water in the concentration tank would be evaporated under standard temperature, typically sunlight, and atmospheric pressure conditions in order to obtain a concentrate solution which can be packed in bottles and fed directly to crops as liquid fertilizer.

Upon dewatering the water hyacinth, and modulating the moisture content to the predefined, abovementioned moisture content, the method 10 includes the step of converting 16 the dewatered water hyacinth into fertilizer. Typically, the conversion of the water hyacinth into a solid fertilizer includes subjecting the dewatered hyacinth to a mineralization process that is conducted in a mineralisation processing unit, typically a reactor (not shown). The reactor (not shown) is arranged to be operated preferably at about 60 degrees Celsius, preferably at about 40 degrees Celsius and atmospheric pressure.

It had been discovered during the testing of the water hyacinth that the inherent Nitrogen levels in raw water hyacinth is between 2.3 – 2.9%. Since Nitrogen is a predominant macro-nutrient for plants, it is required that the Nitrogen content in the water hyacinth to be boosted to at least about 5% in order for the water hyacinth to be used as a nutrient for plants. It is known in the art that at least about 3.0% Nitrogen is the minimum Nitrogen content required for the growth of most living plants. Accordingly, the water hyacinth needs to be enriched/boosted with Nitrogen so that it can be used as a plant nutrient.

Therefore, in order to boost the Nitrogen content in the water hyacinth, the method 10 includes the step of feeding animal litter, such as chicken manure/litter, goat manure, sheep manure, pigs manure, and/or guano (such as bats and sea birds) manure, into the reactor and which is then mixed with the shredded water hyacinth in the reactor in order to activate the mineralisation of the water hyacinth. Typically, the reactor has an agitator or stirrer that is used to mix the animal litter and the shredded water hyacinth. The stirrer may be operated continuously or semi-continuously (i.e. in batches). The animal litter is added into the reactor in predefined proportions until Carbon to Nitrogen ratio of the water hyacinth and the animal litter in the reactor is about 24.3:1. It has been found that this ratio meets favourable conditions for the mineralization process to effectively take place.

In general, in order to enhance the mineralisation process, microbes, typically EM-1 microbes should be added to the reactor. Accordingly, the method 10 includes the step of feeding the microbes in predefined proportions into the reactor (not shown) and mixed, preferably by using the agitator that is fitted to the reactor, with the combination of the animal litter and shredded water hyacinth. In an embodiment, the proportions of the EM-1 microbes and the nutrient enriching agent added to the water hyacinth may be such that the overall Carbon to Nitrogen ratio is about 24.3:1. Typically, the EM-1 microbes are derived from stock solution consists of $6.8x10^7$ CFU/ml lactic acid bacteria (Lactobacillus casei) and $2.4x10^2$ CFU/ml Yeast (Saccharomycess cerevisiae). The stock solution can be diluted with clean un-chlorinated water at a ratio of 1:500 to 1:1000 (depending on climatic conditions), and mixed with 1% molasses. Typically, about 25 litres of diluted EM-1 solution is fed to the reactor comprising the mixture of the shredded water hyacinth and animal litter. The mineralisation process typically takes up to 10-14 days to reach 80% mineralisation rate.

In accordance with a second version of the invention, the method of manufacturing fertilizer (i.e. plant nutrients) using the water hyacinth 100 includes sizing the water hyacinth, typically by feeding the water hyacinth into a sizing unit 102, such as a shredding/cutting machine, that is arranged to shred the water hyacinth up to a maximum length of about 50mm, preferably 40mm. The shredding of the water hyacinth plants can occur in a harvester that is described in the simultaneously filed PCT application referred to above. The sizing, i.e. shredding of the water hyacinth can be conducted by other means, for example it may be conducted manually by users wielding knives or machetes. The method 100 includes dewatering 104 the intercellular-trapped and inherent water in the water hyacinth from 90% to between 30 to 40% inherent moisture content. The dewatering 104 of the water hyacinth can occur in a press comprising rollers that are spaced apart by 5mm to 10mm to define a space in which the water hyacinth can be squeezed in order to remove or drain the water trapped therein. The 30-40% moisture content is the optimal moisture content which creates the optimal conditions for microorganisms, which are used in converting the water hyacinth to plant nutrients, to breakdown the organic matter of the water hyacinth plants.

The method 100 further includes the step of concentrating the de-watered fluids/water 106. The concentration step includes optionally passing the fluids through a filter (not shown) and feeding the filtrate into a holding, concentration tank. The concentration tank is opened at the top and is typically arranged to be in direct sunlight. It is required for about 60% of the filtrate to evaporate under standard temperature and atmospheric pressure conditions in order to form a concentrate solution for use as liquid organic fertiliser (i.e. liquid plant nutrient).

The method 100 further includes arranging the de-watered water hyacinth plants in windrows 108 to create bulk density of 650 kg/m^3 to enable adequate oxygen flow, and afford free air space of between 55 – 65% by volume. This would typically induce optimal aerobic conditions for the onset of an organomineralisation process of the organic plant material.

The method 100 includes feeding EM-1 stock solution that is diluted with clean un-chlorinated water at a ratio of 1:500 to 1:1000 (depending on climatic conditions), and mixed with 1% molasses to the dewatered windrows of water hyacinth plants at the rate of 25 litres (diluted EM-1 solution) per 70 tonnes of materials (i.e. shredded water hyacinth). The EM-1 stock solution can be applied to the windrows at least once, preferably twice a day. It has been found that the use of the diluted EM-1 stock solution along with the water hyacinth in the windrows have a Carbon to Nitrogen ratio of 24.3:1 which is effective to ensure that mineralisation of the water hyacinth takes place.

Typically, the EM-1 stock solution consists of 6.8×10^7 CFU/ml lactic acid bacteria (Lactobacillus casei) and 2.4×10^2 CFU/ml Yeast (Saccharomycess cerevisiae). These selected beneficial phototropic microorganisms attack the organic matter of the water hyacinth plants to breakdown the plant tissues as part of the mineralisation process. During the aerobic mineralisation process, organic matter of the water hyacinth plant breakdown during the redox (reduction and oxidation) reaction into organic ions, Carbon dioxide, and macro and micronutrients. This is an exothermic reaction process in which high heat is generated. In this reaction temperature can therefore rise to over 70^{0}C. The aerobic optimal microorganism activity is achieved at 40^{0}C. The windrow material therefore needs to be aerated (typically by turning over the windrows). Accordingly, the method 100 includes the step of aerating 110 the windrows, typically once a day, preferably two times a day, more preferably three times a day to maintain the temperature at about 40^{0}C. In an embodiment, the step of aerating the windrows may comprise tossing and turning the windrows, preferably by using a turner machine or manually. The aeration of the windrows achieves the following:

- consistent aeration with oxygen is thoroughly distributed throughout the mineralised plant material to prevent decomposition and fermentation.

- aeration maintains temperature levels to below 50^{0}C (optimally at 40^{0}C). At above 60^{0}C, microbes begin to die which process slows down the microorganism activity and in turn the mineralisation process.

- aeration evenly affords sustenance of moisture content by preventing evaporation of nutrients from the top surface, and their drainage from the bottom surface materials.

In an embodiment, the method 100 may include the step of adding about 5 to 20% of animal litter, preferably chicken manure, in addition to the mixture of the diluted EM-1 solution and windrow material, in order to boost the Nitrogen in the final product. In another version, the 5 to 20% of animal litter can be added and blended with the windrow material prior to the step of feeding the EM-1 solution to the windrow material.

The method 100 includes adding the concentrated solution mentioned above while the windrow material is turned over. Typically, the addition of the concentrated solution to the windrow material has two main effects, i.e. it aids to reduce the temperature to below 50^{0}C, and adds extra nutrients squeezed out of the water hyacinth during the de-watering step.

Typically, the process achieves 80% mineralisation rate in 10 -14 days from harvesting time depending on climatic conditions, by which time the material is in the form of organic nutrients and carbon matter which can be applied as farm inputs to crops on farms.

The method 100 includes the step of screening 112 the resultant, mineralised product in a suitable screen having a predefined aperture size to achieve consistent product size. The screened mineralised product is then used as a fertilizer.

It has been discovered that the water hyacinth plants survive by absorbing the following chemicals and nutrients from the air and water bodies in which they grow: Nitrogen (N); Phosphorus (P); Potassium (K); Magnesium (Mg); Sulphur (S); Chlorine (Cl); Calcium (Ca); Copper (Cu); Zinc (Zn); Boron (B); Iron (Fe); Manganese (Mn); Molybdenum (Mo); Cobalt (Co); Nickel (Ni), Hydrogen (H) from water and air; Carbon (C) from air; and Oxygen from air.

It has been found that the mineralisation of the water hyacinth at a rate of about 80% mineralisation converts the chemicals inherent in water hyacinth to the following ions/mineral forms which are effective nutrients for the growth and development of living plants: Nitrate (NO3-) and Ammonium (NH4+) ions; Orthophosphate ions (HPO_4^{2-} ; $H_2PO_4^-$); Potassium ion (K^+); Mg^{2+};SO_4^{2-}; Cl^-; Ca^{2+}; Cu^{++}; Zn^{++}; H_3BO_3; Fe^{2+}; Fe^{3+};Mn^{2+} ; Mn^{3+}; and Molybdate (MoO4).

The ions produced during mineralization of the water hyacinth constitute the 16 nutrients required to enhance root growth; cell formation; water absorption rates and regulation; disease control; metabolic reactions; strength of plants; photosynthesis, protein production, fruit, flower, seed and leaves development, and chlorophyll production etc.

It is believed that the conversion of the water hyacinth as described above will result in the manufacture of organic fertilizers as shown in FIG. 1 and FIG. 2. It is envisaged that the organic fertilizers produced in accordance with this invention can be manufactured at a fraction of a cost compared to other fertilizers that are currently available in the market.

While the invention has been described in detail with respect to a specific embodiment and/or example thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily conceive of alterations to, variations of and equivalents to these embodiments.

CLAIMS

1. A method of converting chemicals absorbed by an angiosperm into a plant nutrient, the method comprising the step of draining at least a portion of the water in the angiosperm for use as a liquid nutrient for plants.

2. The method of claim 1, wherein the step of draining the water in the angiosperm, preferably of the f*amily Pontederiaceae,* typically of the genus *Eichhornia,* specifically of the species *Eichhornia crassipes* commonly known as water hyacinth, comprises squeezing the water hyacinth to remove at least a portion of the water in the water hyacinth.

3. The method of claim 2, comprising the step of concentrating the drained water.

4. The method of claim 3, wherein the step of concentrating the water removed from the water hyacinth comprises collecting the drained water in a concentration tank; and exposing the drained water to standard temperature and pressure conditions so as to evaporate a predefined amount of the drained water and collect the residual fluid in the tank defining a concentrated solution for use as a liquid nutrient for plants.

5. A method of converting an angiosperm into a nutrient for plants, the method comprising the steps of:

   draining at least a portion of the water in the angiosperm until the moisture content of the angiosperm is at a predefined moisture content; and

   converting the angiosperm into a nutrient for plants.

6. The method of claim 5, wherein the step of draining the water in the angiosperm, preferably of the *Family Pontederiaceae,* typically of the genus

Eichhornia, specifically of the species *Eichhornia crassipes* commonly known as water hyacinth, comprises squeezing the water hyacinth to remove the inherent water and intracellular-trapped water in the water hyacinth until the moisture content of the water hyacinth is between about 30% and 40%.

7. The method of claim 6, comprising the step of concentrating the drained water.

8. The method of claim 7, wherein the step of concentrating the water removed from the water hyacinth comprises collecting the drained water in a concentration tank; and exposing the drained water to standard temperature and pressure conditions so as to evaporate a predefined amount of the drained water and collect the residual fluid in the tank defining a concentrated solution for use as a liquid nutrient for plants.

9. The method of claim 8, wherein the step of converting the drained water hyacinth is preceded or followed by the step of cutting, preferably shredding the water hyacinth to a maximum length of about 50mm, preferably 40mm, to remove the air trapped in the intercellular spaces in the plant tissues, for preventing automatic fermentation of the water hyacinth and for increasing the surface area of the water hyacinth that can be exposed to conversion agents downstream.

10. The method of claim 9, wherein the conversion step comprises mixing a nutrient enriching agent with the cut water hyacinth to achieve a Carbon to Nitrogen ratio of the mixture of about 24.3:1.

11. The method of claim 10, wherein the nutrient enriching agent is a Nitrogen enrichment agent.

12. The method of claim 11, including the step of feeding microbes to the mixture of the nutrient enriching agent and cut water hyacinth to achieve about 80% mineralisation rate in about 10 days so as to form a mineralised product for use as a solid, organic fertilizer.

13. The method of claim 9, including the step of arranging the shredded water hyacinth in a windrow.

14. The method of claim 13, including the step of feeding conversion agents to the windrow.

15. The method of claim 14, wherein the step of feeding conversion agents includes feeding a diluted EM-1 solution to the windrow.

16. The method of claim 15, including the step of aerating the windrow.

17. The method of claim 16, wherein the step of aerating the windrow includes turning the windrow.

18. The method of claim 17, including the step of adding the concentrated solution to the windrow during the step of aerating the windrow to maintain the temperature of the windrow material below about 60^{0}C.

19. The method of claim 18, including the step of repeating the aeration step and the step of adding the concentrate solution for about 10 to 14 days to achieve about 80% mineralisation rate so as to form a mineralised product for use as farm inputs to crops on farms.

20. The method of claim 19, comprising the step of screening the mineralised product to achieve mineralised product having a consistent product size.

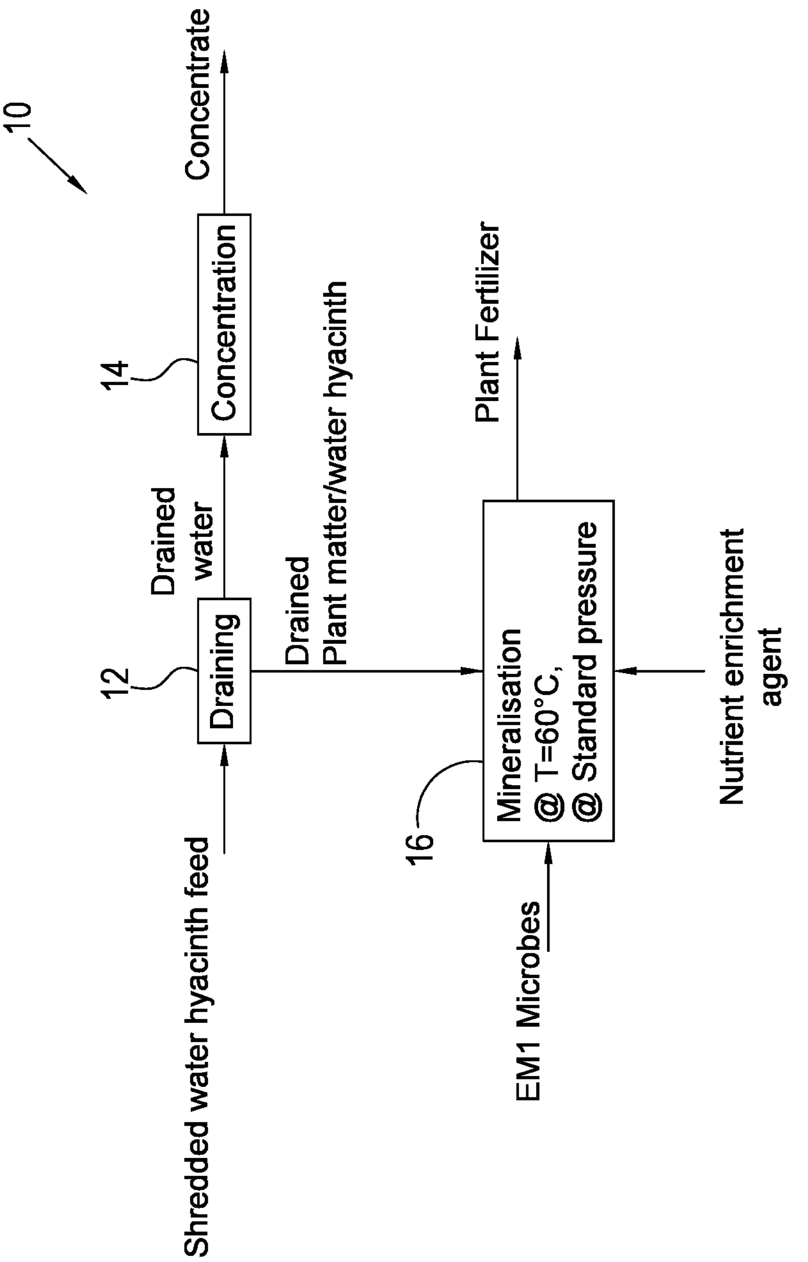
10
Shredded water hyacinth feed
12
Draining
Drained water
14
Concentration
Concentrate
Drained
Plant matter/water hyacinth
16
Mineralisation
@ T=60°C,
@ Standard pressure
Plant Fertilizer
EM1 Microbes
Nutrient enrichment agent

Figure 1

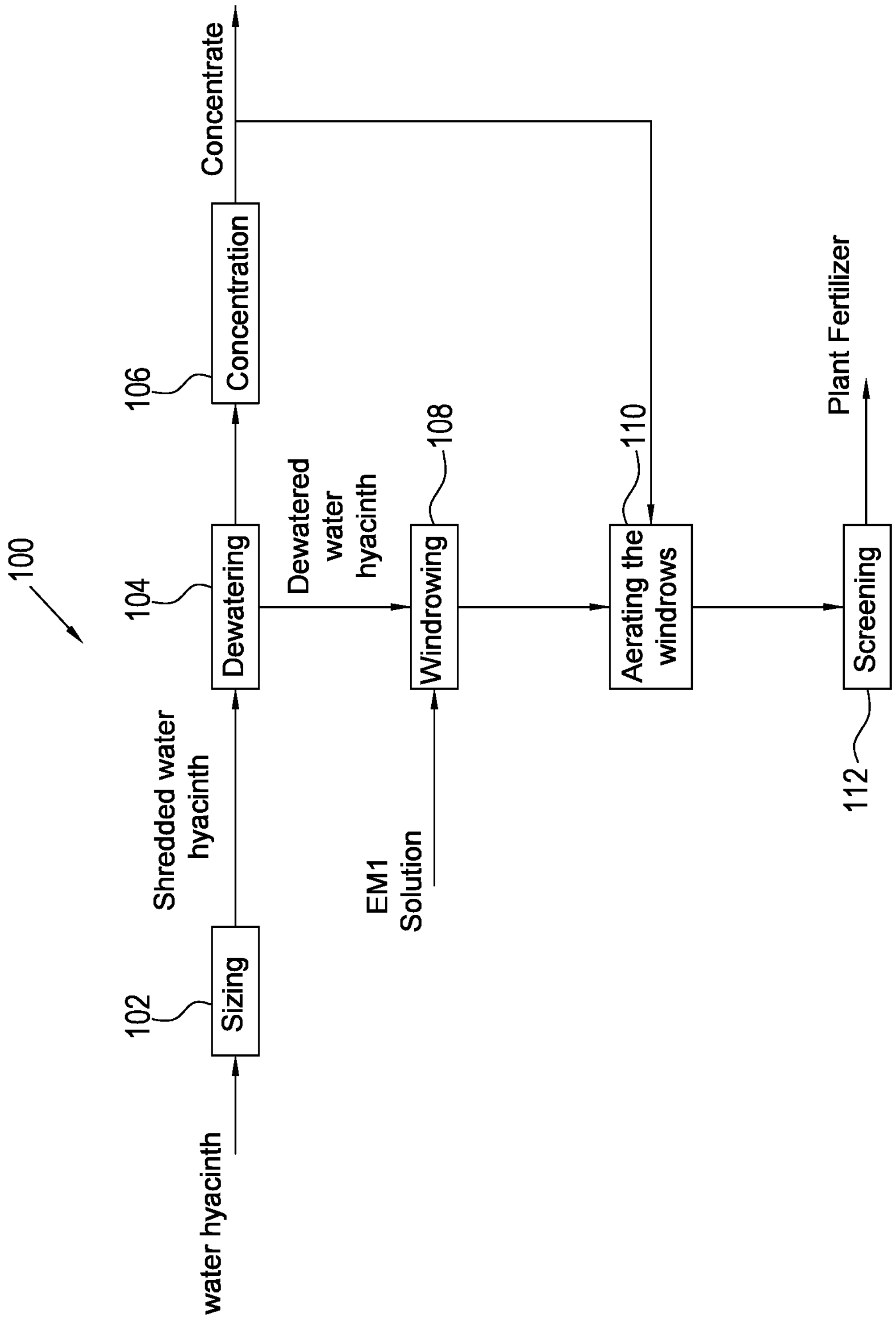
100
water hyacinth
102
Sizing
Shredded water hyacinth
104
Dewatering
Dewatered water hyacinth
106
Concentration
Concentrate
EM1 Solution
108
Windrowing
110
Aerating the windrows
112
Screening
Plant Fertilizer

Figure 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB18/55685

A. CLASSIFICATION OF SUBJECT MATTER
IPC - C02F 11/12; C05F 9/04 (2018.01)
CPC - C02F 11/12; C05F 9/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,961,774 A (BROCHIER, J) 9 October 1990; column 2, lines 35-40; column 3, lines 15-30; column 4, lines 33-37, 55-65; claim 1	1-5 --- 6-9
Y	US 2006/0277887 A1 (DALTON, RE) 14 December 2006; paragraph [0020]	6-9
Y	SARIKA, D et al. Study of physico-chemical and biochemical parameters during rotary drum composting of water hyacinth. International Journal of Recycling of Organic Waste in Agriculture, September 2014, published online 15 August 2014, 3-63, pp. 1-10; abstract; page 2, column 2, paragraph 1; page 5, figure 3a	9
A	NEKLYUDOV, AD et al. Intensification of Composting Processes by Aerobic Microorganisms: A Review. Applied Biochemistry and Microbiology, Vol. 44, No. 1, 2008, pp. 6–18; page 15, column 1, paragraph 7	10-12
A	ROLZ, C et al. Windrow composting of sugarcane and coffee byproducts. Sugar Technology Vol. 12, No. 1, 2010, pp. 15-20; page 15, column 2, paragraph 2	13-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 October 2018 (25.10.2018)	26 NOV 2018

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