

**METHOD FOR TREATING HUMAN OR ANIMAL URINE BY
BASIFICATION AND USES OF THE URINE OBTAINED IN PARTICULAR
AS FERTILISING SUBSTANCE**

5 TECHNICAL FIELD

[0001] The invention relates to the treatment and recycling of human or animal urine. In particular, the invention relates to a method for treating urine and to the use of the transformed urine obtained, and also coproducts of the method,
10 in particular as raw materials used for the manufacture of fertilizers.

PRIOR ART

[0002] Urine is considered to be waste that should be eliminated. The current
15 way in which it is eliminated, predominantly by draining into sewers, is problematic for water treatment plants and more generally has an impact on the sustainable management of water resources. Indeed, the content of nitrogen and micro-pollutants in urine poses problems of algae growth and fish feminization.

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[0003] The prior art describes several methods for treating blackwater comprising a mixture of urine and excrement in order to obtain fertilizing substances or fertilizer. In particular, document CN101125767 describes a method for treating livestock excrement, in particular for the purposes of
25 recycling into fertilizer.

[0004] Document FR2371399 describes a method for treating waste of animal origin, in particular for use thereof in animal feed or on soil.

30 [0005] Document KR20040062918 describes a method for composting manure.

[0006] The methods described in the prior art are not suitable for the treatment of urine alone. The use of blackwater does not make it possible to obtain a stable fertilizing substance having a basic pH, which is rich in microorganisms, rich in NPK and which meets the safety criteria of the applicable regulations.

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[0007] Human urine is known to have a proven fertilizing potential in agriculture, in the same way as animal urine, which is already used by farmers. Indeed, urine is rich in nitrogen (N), phosphorus (P) and potassium (K), which are essential elements for fertilizing soil and crops.

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[0008] However, urine is not stable when it is collected. It rapidly loses its characteristics and its NPK content, in particular via the hydrolysis of urea into ammonia, which makes industrial use thereof unsuitable and currently impossible.

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[0009] There is therefore a need for stable urine which meets the safety criteria of the applicable regulations, in particular regarding the content of trace metal elements and of pathogenic organisms, and which has characteristics enabling it to be used as a fertilizing substance suitable for agricultural use.

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SUMMARY OF THE INVENTION

[0010] By working on the treatment of urine, the inventors have developed a biological method which makes it possible to stabilize and decontaminate human or animal urine and also enrich it in microorganisms. The fertilizer obtained by implementing this method preferentially has a pH of greater than 9 and a concentration of microorganisms, preferentially of bacteria, of at least 10^6 CFU.mL⁻¹.

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[0011] The invention therefore relates to a method for treating human or animal urine, preferentially fresh urine, comprising:

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- a step of basifying the urine in such a way that the urine has a pH of greater than or equal to 9, preferentially greater than or equal to 10,
- a step of filtering the urine,
- a step of transforming the urine by fermentation.

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[0012] The method comprises other steps, in particular an optional step before the basification step which consists in recovering, from the urine, at least one mineral in the form of a precipitate, in particular at least one mineral selected from nitrogen, potassium or phosphorus.

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[0013] The invention also relates to the transformed urine: basified, filtered and transformed by fermentation, obtainable by implementing the method, and which has at least one of the following characteristics: a pH of greater than or equal to 9, preferentially greater than or equal to 10, and a concentration of microorganisms, preferentially of bacteria, of at least 10^6 CFU.mL⁻¹. Without implementing the basification according to the invention, the transformed urine would not comprise microorganisms, in particular bacteria, and it would not be possible to implement the fermentation because the urine would be loaded with ammonia, which would be at concentrations that are toxic to microorganisms, particularly to bacteria.

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[0014] The invention also relates to the use of such a transformed urine, in particular as a fertilizing substance based on an inoculum of microorganisms, preferentially on a bacterial inoculum, in particular for field crops, fruit and vegetable farming and horticulture. The invention therefore also relates to a fertilizer.

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[0015] The invention also targets the use of the coproducts potentially obtained during the urine fermentation step (in particular the biofilm formed during this step), in particular as fertilizing substance, phytosanitary product or biocontrol product for agricultural use.

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BRIEF DESCRIPTION OF THE FIGURES

- Figure 1: shows, in the form of a curve, the results obtained for the basification of fresh urine (harvested less than 2 hours prior) with NaOH.
- 5 - Figure 2 shows, in the form of a curve, the results obtained for the basification of stored urine (harvested approximately 5 days prior) with NaOH.
- Figure 3: shows, in the form of a histogram, the concentrations of *P. chlororaphis* (CFU/mL) observed after 24 and 48 h of growth on urine at pH 7 or at pH 9. The * represent the significant differences obtained by the Student's
- 10 t-test.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

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[0016] For the purposes of the invention, “urine” means urine free of fecal matter, and very preferentially that has been harvested separately.

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[0017] For the purposes of the invention, “basified urine” means urine, the pH of which has been increased relative to the initial urine pH. The pH of the basified urine is a basic pH.

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[0018] For the purposes of the invention, “fresh urine” means urine which was harvested less than 12 hours prior, preferentially less than 6 hours prior, even more preferentially less than 1 hour prior.

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[0019] For the purposes of the invention, “transformed urine” means urine that has undergone a method that transformed at least one characteristic of natural urine, so that it is no longer a natural product but a transformed product obtained from a natural product. The transformed urine is preferentially a urine transformed according to the invention at least by basification, filtration and fermentation.

Method for treating human or animal urine

[0020] The invention relates to a method for treating human or animal urine,
5 preferentially fresh urine, comprising at least the implementation of the following steps:

- a step of basifying the urine in such a way that the urine has a pH of greater than or equal to 9, preferentially greater than or equal to 10,
- a step of filtering the urine,
- 10 - a step of transforming the urine by fermentation.

[0021] The human or animal urine is collected by any suitable method for implementing the method according to the invention.

15 [0022] For human urine, it may in particular be collected from different sources such as toilet rental companies, festivals, medical analysis laboratories, and local communities.

[0023] For animal urine, it may in particular be collected from different sources
20 such as animal farmers and veterinary analysis laboratories.

[0024] Human or animal urine is collected in containers such as cans, barrels or tanks for example. According to one embodiment, the containers may contain one or more bases for implementing the basification step.

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[0025] Optionally, the method according to the invention may optionally comprise a preliminary step before the basification step which consists in precipitating coproducts generated during the storage step, before basification. These coproducts are preferentially minerals, in particular minerals selected
30 from nitrogen, potassium and phosphorus (struvite). In the particular case of recovering struvite, present in the urine before basification, the method consists in adding magnesium salts in solution in order to precipitate the

phosphorus present, preferentially at a volumetric ratio of 1:1 (Mg:P). This precipitate can be recovered by filtration on a mesh filter, the mesh size of which is between 10 and 30 μm . The precipitate can subsequently undergo various treatments, such as washing, dissolution, pressing and/or drying in air,
5 in order to obtain a material in liquid or solid form.

[0026] The basification step is preferentially carried out on fresh urine which was harvested less than 12 hours prior to the basification, preferentially less than 6 hours prior, even more preferentially less than 1 hour prior.

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[0027] The urine basification step is carried out in such a way that the urine has a pH of greater than or equal to 9, preferentially of between 9 and 12, preferentially of greater than or equal to 10, and, according to one embodiment, of between 10 and 12. The basification of the urine to a pH of
15 greater than 10 is necessary because it makes it possible to inhibit the growth of pathogens and prevents the spontaneous reaction of hydrolysis of the urea into ammonia, and therefore the urine retains its nitrogen concentration. Basification can also enable the urine to have the pH necessary for fermentation of the urine by certain microorganisms, in particular by certain
20 bacteria.

[0028] The pH of the urine should further be suitable for the conditions of fermentation of the microorganisms used for the fermentation. During fermentation, it may also be necessary to stabilize the pH of the urine, either
25 by adding a new base in order in particular to compensate for a reduction in pH during fermentation, preferentially selected from calcium hydroxide, potassium hydroxide, sodium hydroxide and mixtures thereof; or by adding an acid in order in particular to compensate for an increase in pH during fermentation, preferentially selected from sulfuric acid, acetic acid,
30 hydrochloric acid, phosphoric acid, nitric acid, lactic acid and mixtures thereof.

[0029] The basification step can be carried out by any means that makes it possible to obtain a urine with the desired basic pH. In particular, the basification step can be carried out by adding at least one basic pH adjuster to the urine, preferentially at least one base, and even more preferentially at least one base selected from calcium hydroxide, potassium hydroxide, sodium hydroxide and mixtures thereof, and also the equivalents thereof in the form of oxides (for example, calcium oxide, more commonly referred to as lime).

[0030] In a particular embodiment of the invention, the base (or bases) used to basify the urine is added to the urine at a concentration of between 0.1 and 10% by weight of the total weight of the mixture consisting of the urine and the base, preferentially between 0.5 and 2.5%.

[0031] When the basification step is carried out by adding at least calcium hydroxide to the urine, the basification step is preferentially carried out by adding between 1 and 5%, even more preferentially between 2 and 3%, calcium hydroxide by weight of the total weight of the urine and calcium hydroxide mixture, to the urine.

[0032] When the basification step is carried out by adding at least potassium hydroxide to the urine, the basification step is preferentially carried out by adding between 1 and 5%, even more preferentially between 1.5 and 2%, potassium hydroxide by weight of the total weight of the urine and potassium hydroxide mixture, to the urine.

[0033] When the basification step is carried out by adding at least sodium hydroxide to the urine, the basification step is preferentially carried out by adding between 0.5 and 5%, even more preferentially between 0.5 and 1%, sodium hydroxide by weight of the total weight of the urine and sodium hydroxide mixture, to the urine.

[0034] The basification step is preferentially carried out at the time the urine is collected, in order to prevent the reaction of hydrolysis of the urea into ammonia. In order to minimize the loss of nitrogen, the basification step according to the invention is carried out by adding at least one base to the container in which the urine is received or poured, upstream of receiving the urine, preferentially to the bottom of the container before the urine is poured therein. Once filled, the container is preferentially hermetically sealed for transport in order to limit gas exchanges in the open air, and the container is preferentially made of plastic or metal that is resistant to corrosion by the base.

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[0035] In a particular embodiment of the invention, the base(s) can be replaced by a mixture of bacteria in basic medium, such that the basification is associated with an inoculation of bacteria. Thus, in this embodiment, the basification step of the method according to the invention is carried out by adding at least one mixture of bacteria in basic medium to the urine, such that the basification is associated with an inoculation of bacteria. When the basification step is carried out by adding at least bacteria in basic medium, the basification step is preferentially carried out by adding between 1 and 10%, even more preferentially between 2.5 and 5%, of a mixture of bacteria in basic medium by weight of the total weight of the urine and bacteria in basic medium mixture, to the urine.

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[0036] Preferentially, at the end of the basification step:

- the NH_4 /total N ratio of the urine is less than or equal to 30%, and/or

25 - the ureic N/total N ratio of the urine is greater than or equal to 50%, and/or

- the C/N ratio is greater than or equal to 1.

[0037] In one embodiment of the invention, the basification step has a duration of less than 12 days, even more preferentially less than 7 days, and in particular between 12 hours and 7 days.

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[0038] After being basified, the urine can be stored. Thus, the method according to the invention may comprise an additional step of storing the urine after basification.

- 5 [0039] The urine can be stored after the basification step and before the filtration step, or after the filtration step and before the step of transformation by fermentation.

10 [0040] The urine can be stored for an indefinite period, preferentially for a period of less than or equal to 6 months. Indeed, beyond 6 months, the urea has strongly degraded into ammonia, which makes the medium unfavorable for microbial growth.

15 [0041] Storage can be carried out in any suitable container. This may be the container in which the urine was collected, or any other plastic or metal container resistant to corrosion by a base. Preferentially, the storage is carried out in darkness, in order to avoid the effect of UV rays on the urine composition, and at room temperature (approximately 20°C). Extreme temperatures, that is below 0°C or above 40°C, are unfavorable for storage because they can
20 modify the composition of the urine.

[0042] The method according to the invention, before or after optional storage, preferentially just before the step of transformation by fermentation, comprises a filtration step.

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[0043] This filtration step must make it possible to remove unwanted particles contained in the urine, such as, in particular, body hair, head hair, pollutants in chelated form, residual salts and any other particles that may be present (dead leaves, gravel, etc.).

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[0044] The filtration step is preferentially carried out at least by filtration on a filter having meshes of between 0.1 and 80 µm. In particular, the filtration is

carried out at 25 µm. This makes it possible to eliminate unwanted particles, depending on the quality of the stored urine.

[0045] Filtration can be carried out on a filter that absorbs organic compounds,
5 such as an activated carbon filter, a chabazite filter, a zeolite filter, or any other filtration system.

[0046] After filtration, the method according to the invention comprises a fermentation step, that is a step of transformation under the influence of
10 microorganisms. The microorganisms used for the fermentation step can be selected from bacteria and fungi, in particular yeasts and molds.

[0047] When the microorganisms used for the fermentation step are fungi, they are preferentially selected from fungi of the orders Eurotiales, Hypocreales,
15 Saccharomycetales, Glomerales, and mixtures thereof.

[0048] Preferentially, the microorganisms used for the fermentation step are bacteria. These bacteria are preferentially selected from bacteria belonging to at least one of the following orders: Rhizobiales (in particular the
20 Bradyrhizobiaceae, Rhizobiaceae, and Phyllobacteriaceae families), Bacillales (in particular the Bacillaceae and Paenibacillaceae families), Rhodospirillales (in particular the Rhodospirillaceae family), Actinomycetales (in particular the Corynebacteriaceae family), Frankiales (in particular the Frankiaceae family), Burkholderiales (in particular the Burkholderiaceae
25 family), Flavobacteriales (in particular the Flavobacteriaceae family), Pseudomonadales (in particular the Pseudomonadaceae family), Eubacteriales (in particular the Micrococcaceae family), Xanthomonadales (in particular the Xanthomonadaceae family), Hyphomicrobiales, Cytophagales, Chroococcales, Gloeobacterales, Nostocales, Oscillatoriales, Pleurocapsales,
30 Stigonematales.

[0049] The bacteria used for the fermentation are preferentially selected from bacteria of the Bradyrhizobiaceae, Rhizobiaceae, Phyllobacteriaceae, Bacillaceae, Paenibacillaceae, Rhodospirillaceae, Corynebacteriaceae, Frankiaceae, Burkholderiaceae, Flavobacteriaceae, Pseudomonaceae, 5 Micrococcaceae, Xanthomonadaceae, Lactobacillaceae, Streptococcaceae, Enterococcaceae, Leuconostocaceae, Bifidobacteriaceae families, and mixtures thereof.

[0050] According to one embodiment, the fermentation is carried out with one 10 or more lactic acid bacteria, preferentially with at least one bacterium selected from the bacteria of the order Lactobacillales, in particular with at least one bacterium from a family selected from Lactobacillaceae, Streptococcaceae, Enterococaceae, Leuconostoaceae, Bifidobacteriaceae.

15 [0051] According to the invention, the microorganisms, preferentially the bacteria, used for the fermentation are selected from species for which fermentation requires a basic pH, preferentially of greater than 9.

[0052] The pH for the fermentation by microorganisms, in particular bacteria, 20 of the same family varies depending on the species. Thus, certain species of the aforementioned families may require an acidic pH, others a basic pH or yet others may require a neutral pH.

[0053] Preferably, the method according to the invention is used with species 25 of bacteria of the aforementioned families requiring a basic pH, and in particular for which the pH of the urine for fermentation by these bacteria is preferentially as follows:

- the urine is preferentially adjusted to $9 < \text{pH} < 12$ when the bacteria used for the fermentation step are bacteria of the Paenibacillaceae family,
- 30 - the urine is preferentially adjusted to $9 < \text{pH} < 11$ when the bacteria used for the fermentation step are bacteria of the Bacillaceae family,

- the urine is preferentially adjusted to $9 < \text{pH} < 10$ when the bacteria used for the fermentation step are bacteria of the Pseudomonadaceae family,
- the urine is preferentially adjusted to $9 < \text{pH} < 10$ when the bacteria used for the fermentation step are bacteria of the Burkholderiaceae family,
- 5 - the urine is preferentially adjusted to $9 < \text{pH} < 11$ when the bacteria used for the fermentation step are bacteria of the Micrococcaceae family.

[0054] In a preferred embodiment of the invention, the step of transforming the urine by fermentation consists in adding at least one source of carbon and at
10 least one inoculum of microorganisms, preferentially an inoculum of bacteria, to the urine.

[0055] The source of carbon is preferentially added in an amount of 1 to 40 g.L⁻¹ relative to the volume of basified and filtered urine to be transformed by
15 fermentation. The source of carbon may be varied. It is preferentially selected from fructose, glucose, lactose, maltose, sucrose, glucose syrup, malt syrup, and also polyols such as mannitol or sorbitol, and mixtures thereof.

[0056] The inoculum of microorganisms, preferentially the bacterial inoculum,
20 is preferably added in an amount of 0.1 to 10% by volume relative to the volume of basified and filtered urine mixture and of the source of carbon.

[0057] When the inoculum of microorganisms is a bacterial inoculum, the inoculum can be obtained from a stock solution comprising at least one source
25 of carbon, a bacterium or a mixture of at least two bacteria, and a basified or acidified urine having a pH suitable for the fermentation of said bacterium or said mixture of bacteria. For example, the inoculum can be obtained in particular from a stock solution consisting at least of:

- basified urine having a pH of greater than or equal to 9, preferentially greater
30 than or equal to 10, and particularly preferably a pH identical or close to that of the basified urine that is to be transformed by fermentation,
- a source of carbon,

- and at least one bacterium.

[0058] The fermentation step can be carried out in particular at a temperature of between 25 and 35°C. It is preferentially carried out at a temperature
5 corresponding to the optimal growth temperature of the microorganism(s) used for the fermentation.

[0059] In particular, the temperature may be, for example:

- between 20°C and 40°C for bacteria from the Bacillaceae family;
- 10 - between 25°C and 40°C for bacteria from the Paenibacillaceae family;
- between 20°C and 35°C for bacteria from the Pseudomonadaceae family;
- between 20°C and 40°C for bacteria from the Burkholderiaceae family;
- between 25°C and 40°C for the bacteria of the Micrococcaceae family.

15 [0060] In one embodiment of the invention, the fermentation step is carried out for a period of at least 12 hours, preferentially for a period of between 3 and 12 days. This period varies depending on the microorganisms and on the conditions implemented for the fermentation.

20 [0061] One or more microorganisms can be used for fermentation, preferentially one or more bacteria. The fermentation can therefore be carried out with at least two different microorganisms. According to one embodiment, the fermentation is carried out with at least two different bacteria.

25 [0062] Different variant embodiments of the fermentation step of the method according to the invention may be, for example:

- the use of one or more bacteria from the *Bacillaceae* family, at a temperature of between 20 and 40°C, preferentially 35°C, for 1 to 4 days, preferentially 2 days, on urine at a pH of between 9 and 11, preferentially 9.5, with the addition
30 of sugar, preferentially sucrose, at between 5 and 20 g.L⁻¹, preferentially at 10 g.L⁻¹,

- the use of one or more bacteria from the *Paenibacillaceae* family, at a temperature of between 25 and 40°C, preferentially 30°C, for 1 to 4 days, preferentially 2 days, on urine at a pH of between 9 and 12, preferentially 10, with the addition of sugar, preferentially glucose, at between 10 and 50 g.L⁻¹,
5 preferentially at 40 g.L⁻¹,
- the use of one or more bacteria from the *Pseudomonadaceae* family, at a temperature of between 20 and 40°C, preferentially 35°C, for 1 to 7 days, preferentially 3 days, on urine at a pH of between 9 and 10, preferentially 9.5, with the addition of sugar, preferentially glucose, at between 5 and 30 g.L⁻¹,
10 preferentially at 15 g.L⁻¹,
- the use of one or more bacteria from the *Burkholderiaceae* family, at a temperature of between 20 and 40°C, preferentially 30°C, for 1 to 5 days, preferentially 4 days, on urine at a pH of between 9 and 10, preferentially 9, with the addition of sugar, preferentially fructose, at between 5 and 20 g.L⁻¹,
15 preferentially at 10 g.L⁻¹,
- the use of one or more bacteria from the *Micrococcaceae* family, at a temperature of between 25 and 40°C, preferentially 30°C, for 1 to 7 days, preferentially 4 days, on urine at a pH of between 20 and 40°C, preferentially 25°C, with the addition of sugar, preferentially maltose, at between 5 and 40
20 g.L⁻¹, preferentially at 15 g.L⁻¹.

[0063] According to one embodiment, the fermentation is carried out with at least one bacterium from the *Pseudomonadaceae* family. In a suitable variant, the fermentation step is carried out with at least one bacterium from the
25 *Pseudomonadaceae* family at a temperature of between 30 and 35°C, for between 3 and 5 days, on basified urine at a pH of between 9 and 11, with the addition of sugar, preferentially sucrose, at between 25 and 30 g.L⁻¹.

[0064] The method according to the invention may also comprise one or more
30 additional steps.

[0065] In particular, the method according to the invention may comprise one or more step(s) that consist(s) of adding additional constituents to the urine, such as in particular sources of nitrogen (in ureic, nitrate/nitrite or ammonium form), phosphorus and/or potassium, secondary elements (calcium and/or magnesium) or trace elements (cobalt, copper, iron, manganese and/or zinc).
5 Additional constituents can be added at any time during the implementation of the method. They are preferentially added before the fermentation step.

[0066] According to a variant of the method, the method may comprise an additional step of adding at least one acid to the basified urine, with the aim of
10 obtaining an optimal pH for the growth of the microorganisms, preferentially of the bacteria, used during the fermentation step.

[0067] The method according to the invention can therefore comprise a step of
15 adding at least one acid to the basified urine. The acid is added so that the urine has a lower pH than that obtained after the basification step. The pH is adjusted so that urine has a pH suitable for the growth of the microorganisms, preferentially of the bacteria, used for the fermentation of the urine. The pH is adjusted to the desired value by modifying the concentration of the acid in the
20 urine on the basis of the pH of the basified urine, of the desired pH, and of the acid used.

[0068] Preferentially, the acid used for the step of adding an acid to the basified urine may in particular be selected from sulfuric acid, acetic acid, hydrochloric
25 acid, phosphoric acid, nitric acid, lactic acid and mixtures thereof.

[0069] This variant of the method comprising a step of adding an acid, instead of achieving the desired pH only by basification of the urine, makes it possible to achieve the desired pH in several stages (at least two steps): basification of
30 the urine according to the invention, then addition of at least one acid. Thus, regardless of the variant - with or without addition of acid - the method according to the invention allows the pH of the urine before transformation by

fermentation to have a pH suitable for the growth of the microorganisms, preferentially of the bacteria, used for the fermentation of the urine. Thus, a variant of the method according to the invention is characterized in that the pH of the urine before and/or during transformation by fermentation is suitable for the growth of the microorganisms, preferentially of the bacteria, used for the fermentation of the urine.

[0070] The step of adding an acid to the basified urine can be carried out at any time during the method after the basification step and before the step of transformation of the urine by fermentation.

[0071] During fermentation, it may also be necessary to stabilize the pH of the urine, either by adding a base in order to increase the pH, preferentially selected from calcium hydroxide, potassium hydroxide, sodium hydroxide and mixtures thereof; or by adding an acid in order to reduce the pH, preferentially selected from sulfuric acid, acetic acid, hydrochloric acid, phosphoric acid, nitric acid, lactic acid and mixtures thereof. Thus, the method according to the invention may comprise a step of stabilizing the pH by adding at least one base or at least one acid during the step of transformation of the urine by fermentation.

[0072] According to one embodiment, the method according to the invention may comprise the series of at least the following steps:

- a step of basifying the urine in such a way that the urine has a pH of greater than 9, preferentially greater than 10,
- a step of adding at least one acid to the urine (since the pH is lower: it may still be greater than or equal to 9 or 10, but it may be lower than these values; in particular, it may be lower than 6),
- a step of filtering the urine,
- a step of transforming the urine by fermentation, optionally comprising a step of stabilizing the pH by adding at least one base or acid.

[0073] According to another embodiment, the method according to the invention may comprise the series of at least the following steps:

- a step of basifying the urine in such a way that the urine has a pH of greater than 9, preferentially greater than 10,
- 5 - a step of filtering the urine,
- a step of adding at least one base to the urine (since the pH is lower: it may still be greater than or equal to 9 or 10, but it may be lower than these values; in particular, it may be lower than 6),
- a step of transforming the urine by fermentation, optionally comprising a step
- 10 of stabilizing the pH by adding at least one base or acid.

[0074] If the pH is sufficiently acidic after the step of adjusting the pH and/or during the fermentation step, the fermentation may optionally be carried out by lactic acid bacteria (lacto-fermentation), for example at least one bacterium

15 from a family selected from *Lactobacillaceae*, *Streptococcaceae*, *Enterococcaceae*, *Leuconostocaceae*, *Bifidiobacteriaceae*. In this case:

- the basified urine is preferentially subsequently acidified to $4 < \text{pH} < 5$ when the bacteria used for the lacto-fermentation step are bacteria of the *Lactobacillaceae* family,
- 20 - the basified urine is preferentially subsequently acidified to $4.5 < \text{pH} < 5.5$ when the bacteria used for the lacto-fermentation step are bacteria of the *Streptococcaceae* family,
- the basified urine is preferentially subsequently acidified to $4.5 < \text{pH} < 5.5$ when the bacteria used for the lacto-fermentation step are bacteria of the
- 25 *Pseudomonadaceae* family,

[0075] - the basified urine is preferentially subsequently acidified to $4 < \text{pH} < 5$ when the bacteria used for the lacto-fermentation step are bacteria of the *Enterococcaceae* family,

- 30 - the basified urine is preferentially subsequently acidified to $3.5 < \text{pH} < 4.5$ when the bacteria used for the lacto-fermentation step are bacteria of the *Leuconostocaceae* family,

- the basified urine is preferentially subsequently acidified to $5 < \text{pH} < 6$ when the bacteria used for the lacto-fermentation step are bacteria of the *Bifidiobacteriaceae* family.

- 5 [0076] Different variant embodiments of the fermentation step, at an acidified pH after basification, according to the invention may be, for example:
- the use of one or more bacteria from the *Lactobacillaceae* family, at a temperature of between 30 and 35°C, preferentially 35°C, for 2 to 5 days, preferentially 3 days, on urine at a pH of between 4.5 and 5.5, preferentially 5.0, with the addition of sugar, preferentially lactose, at between 30 and 45 g.L⁻¹,
10 ¹, preferentially at 40 g.L⁻¹,
 - the use of one or more bacteria from the *Streptococcaceae* family, at a temperature of between 20 and 30°C, preferentially 25°C, for 5 to 10 days, preferentially 8 days, on urine at a pH of between 5.0 and 6.0, preferentially 5.5, with the addition of sugar, preferentially glucose, at between 15 and 30
15 g.L⁻¹, preferentially at 20 g.L⁻¹,
 - the use of one or more bacteria from the *Enterococcaceae* family, at a temperature of between 25 and 35°C, preferentially at 30°C, for 3 to 8 days, preferentially 5 days, on urine at a pH of between 5.0 and 6.0, preferentially 6.0, with the addition of sugar, preferentially fructose, at between 25 and 35
20 g.L⁻¹, preferentially at 30 g.L⁻¹,
 - the use of one or more bacteria from the *Leuconostocaceae* family, at a temperature of between 20 and 30°C, preferentially at 25°C, for 8 to 12 days, preferentially 10 days, on urine at a pH of between 3.5 and 5.0, preferentially 4.5, with the addition of sugar, preferentially maltose, at between 3 and 10 g.L⁻¹,
25 ¹, preferentially at 5 g.L⁻¹,
 - the use of one or more bacteria from the *Bifidiobacteriaceae* family, at a temperature of between 30 and 40°C, preferentially at 35°C, for 2 to 6 days, preferentially 4 days, on urine at a pH of between 5.0 and 6.0, preferentially 6.0, with the addition of sugar, preferentially sucrose, at between 5 and 15 g.L⁻¹,
30 ¹, preferentially at 10 g.L⁻¹.

[0077] Finally, the method according to the invention, regardless of the embodiment, may optionally comprise one or more additional steps before the basification step, between the basification and the fermentation, or after fermentation.

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[0078] The urine obtained after the fermentation step is in liquid form. The method according to the invention may also comprise an additional step of concentrating the microorganisms, in particular the bacteria (by any suitable means, in particular centrifugation, dehydration and/or lyophilization) so as to obtain a product in solid form.

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[0079] Advantageously, the method according to the invention can be implemented on an industrial scale, and makes it possible to obtain a product in a few days. The method according to the invention advantageously makes it possible to recycle a natural raw material which is currently considered waste and which currently requires considerable, expensive and unsatisfactory treatments.

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Transformed urine according to the invention

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[0080] The invention also relates to a transformed urine, obtainable by implementing the method according to the invention, that is transformed implementing a method comprising at least one step of basifying to a pH of greater than or equal to 8, at least one filtration step and at least one fermentation step.

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[0081] The transformed urine according to the invention preferentially has at least one of the following characteristics:

- a pH of greater than or equal to 9, preferentially greater than or equal to 10, if the method does not comprise a step of adjusting the pH to a lower pH by adding an acid.

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- a concentration of microorganisms, preferentially of bacteria, of at least 10^6 CFU.mL⁻¹, preferentially at least 10^7 CFU.mL⁻¹. It may be at least 10^8 CFU.mL⁻¹.

[0082] In one embodiment of the invention, the transformed urine also has at least one of the following characteristics, preferentially at least two, even more preferentially at least three, or all:

- a solids content of greater than or equal to 1%; this has the advantage of having a particularly suitable amount of nutritional elements;
- an NH₄/total N ratio of less than or equal to 30%; this makes it possible to have an optimal nitrogen source that can be digested by the microorganisms, preferentially by the bacteria;
- a ureic N/total N ratio of greater than or equal to 50%; this characteristic makes it possible to have a nitrogen source that cannot be digested by the microorganisms, preferentially by the bacteria, but that releases nitrogen for the plants when the transformed urine is used on plants;
- a C/N ratio of greater than or equal to 1; this characteristic makes it possible to have optimal growth of the microorganisms, preferentially of the bacteria.

[0083] The transformed urine according to the invention is a complex matrix which in particular comprises nitrogen, phosphorus and potassium. It also contains secondary elements, such as calcium and magnesium, as well as trace elements, such as cobalt, copper, manganese and zinc.

[0084] The transformed urine according to the invention may be in liquid form. It is then stored in any suitable container, such as bottles, cans, barrels or tanks, preferentially made of opaque plastic or metal, resistant to corrosion by basic products.

[0085] The transformed urine may also be in solid form, in particular in the form of granules, pellets or powder. The granules and/or pellets can be obtained from mineral substrates, such as zeolite and perlite, as well as from organic substrates, such as bat or bird guano.

[0086] Furthermore, the transformed urine according to the invention preferentially complies with applicable regulations regarding safety, in particular regarding the content of trace metal elements and of pathogenic organisms.

Use of transformed urine according to the invention

[0087] The invention also relates to the use of the transformed urine according to the invention, in particular of the transformed urine obtained by implementing the method according to the invention, as fertilizing substance. Thus, the invention relates to a fertilizer comprising at least the product obtained by implementing the method according to the invention, that is a fertilizer comprising at least transformed urine according to the invention.

[0088] Indeed, due to its advantageous characteristics, the transformed urine according to the invention can be used as fertilizing substance for any type of plants, including in fields, and regardless of the growth substrate (compost, soil, coco coir, etc.) in particular:

- for field crops, in particular cereals or vines,
- in fruit or vegetable farming,
- in horticulture, for any type of plants, in particular during the sowing period.

[0089] The use according to the invention is preferentially carried out before sowing or in the first weeks of growth of the plants.

[0090] It can also be used in combination with other fertilizing substances, such as mineral and/or organic fertilizers as well as soil improvers such as compost, in order to improve the absorption of minerals and/or to improve the final quality of the fertilizing substance.

[0091] In one embodiment of the invention, the transformed urine is used to stimulate the growth of plants, in particular by stimulating growth in the vegetative phase via growth factors ("Plant Growth Promoting Factors") produced by the microorganisms present in the transformed urine, in particular
5 by the bacteria.

[0092] For the use thereof:

- when the transformed urine is liquid, it is preferentially diluted in water. For applying in a field, the usage dose of liquid product is recommended to be
10 between 5 to 100 L/ha, diluted in 100 to 1000 L of water. For other applications, such as for potted plants, the liquid product is used in an amount of 5 to 50 mL per liter of water,
- when the transformed urine is solid, it is preferentially applied directly to the soil. For applying in a field, the usage dose of solid product is recommended
15 to be between 0.5 to 5 kg/ha. For other applications, such as for potted plants, the solid product is used in an amount of 0.5 to 5 g per plant.

[0093] Thus, a small amount of the product according to the invention can be used to obtain a large effect on the growth of the plants.
20

[0094] Advantageously, the fertilizing substance according to the invention is derived from a natural product. Its method does not involve any solvents. It is in no way dangerous for humans or the environment.

25 Use of coproducts of the urine transformation method

[0095] The invention also relates to the use of coproducts obtained during the implementation of a method according to the invention.

30 [0096] Indeed, coproducts are generated during the step of storage before basification and during the fermentation step, and in particular:

- before basification: minerals, in particular minerals selected from nitrogen, potassium and phosphorus (struvite),
- during the fermentation step: biofilm of microorganisms, preferentially bacterial surface biofilm. The biofilm of microorganisms is produced by the microorganisms during the fermentation. Preferentially, the bacterial surface biofilm is produced by the bacteria during the fermentation. It is composed of exopolysaccharides in particular. This surface film can be recovered by means of a scraper provided with a filter having a mesh of between 1 and 10 μm . The biofilm can subsequently undergo various treatments, such as washing, dissolution, pressing and/or drying in air, in order to obtain a material in liquid or solid form.

[0097] These coproducts have characteristics which advantageously enable them to be used as fertilizing substance, phytosanitary product, biocontrol product or for any other agricultural use.

EXAMPLES

[0098] The invention will now be illustrated using examples.

Example 1: Method for transforming urine according to the invention with NaOH and Bacillus sp.

[0099] An example of a method according to the invention comprises the following steps:

- depositing 0.6% by weight of 30.5% soda lye in the bottom of the plastic container (for 100 L of total volume urine + soda lye, add 0.6 L of 30.5% soda lye);
- adding fresh urine at initial pH (6.5 to 7) to the plastic container (for 0.6 L of soda lye already present in the container, filling up to 100 L with urine);

- the mixture has a pH of greater than or equal to 9; it may be stored under these conditions for up to 6 months in a hermetically sealed plastic container, at room temperature and in darkness;
 - filtering the basified urine with a nylon filter or a plastic filter having a mesh of 25 μm ;
 - adding 10 g.L^{-1} of glucose to the basified and filtered urine, and adding 1% by volume of an inoculum of *Bacillus sp* (1 L per 100 L of basified urine), at 30°C for 5 days with continuous stirring (approximately 150 revolutions per minute);
 - recovering the basified and transformed urine after recovery of the coproducts and in particular of the biofilm formed.
- [0100] The inoculum used was obtained beforehand, as follows:
- basifying 10 L of urine to reach a pH of greater than or equal to 9, by adding 0.6% by weight of soda lye at 30.5% (60 g of soda lye per 10 L);
 - filtering the basified urine with a filter having a mesh of 0.2 μm ;
 - adding 20 g.L^{-1} of glucose;
 - adding 100 mg of the strain of *Bacillus sp.* preserved in concentrated liquid form;
 - fermenting at 30°C with continuous stirring (approximately 150 revolutions per minute) for 2 days;
 - the final concentration of bacteria obtained in the inoculum is of the order of 10^7 CFU.mL^{-1} .
- [0101] The transformed urine obtained has the following characteristics:
- a pH of greater than or equal to 9,
 - a concentration of bacteria of 10^8 CFU.mL^{-1} ,
 - an $\text{NH}_4/\text{total N}$ ratio equal to 20%,
 - a ureic N/total N ratio equal to 60%,
 - a C/N ratio equal to 3.

Example 2: Method for transforming urine according to the invention with NaOH and *Pseudomonas sp.*

[0102] An example of a method according to the invention comprises the following steps:

- depositing 0.6% by weight of 30.5% soda lye in the bottom of the plastic container (for 100 L of total volume urine + soda lye, add 0.6 L of 30.5% soda lye);
- adding fresh urine at initial pH (6.5 to 7) to the plastic container (for 0.6 L of soda lye already present in the container, filling up to 100 L with urine);
- the mixture has a pH of greater than or equal to 9; it may be stored under these conditions for up to 6 months in a hermetically sealed plastic container, at room temperature and in darkness;
- filtering the basified urine with a nylon filter or a plastic filter having a mesh of 25 μm ;
- adding 30 g.L^{-1} of sucrose to the basified and filtered urine, and adding 1% by volume of an inoculum of *Pseudomonas sp.* (1 L per 100 L of basified urine), at 34°C for 5 days with continuous stirring (approximately 150 revolutions per minute).

[0103] The inoculum used was obtained beforehand, as follows:

- basifying 10 L of urine to reach a pH of greater than or equal to 9, by adding 0.6% by weight of soda lye at 30.5% (60 g of soda lye per 10 L);
- filtering the basified urine with a filter having a mesh of 0.2 μm ;
- adding 30 g.L^{-1} of sucrose;
- adding 100 mg of the strain of *Pseudomonas sp.* preserved in concentrated liquid form;
- fermenting at 34°C with continuous stirring (approximately 150 revolutions per minute) for 3 days;
- the final concentration of bacteria obtained in the inoculum is of the order of 10^7 CFU.mL^{-1} .

[0104] The transformed urine obtained has the following characteristics:

- a pH of greater than or equal to 9,
- a concentration of bacteria of 10^8 CFU.mL⁻¹,
- an NH₄/total N ratio equal to 10%,
- 5 - a ureic N/total N ratio equal to 60%,
- a C/N ratio equal to 3.

Example 3: Method for transforming urine according to the invention with Ca(OH)₂ and Paenibacillus sp.

10

[0105] An example of a method according to the invention comprises the following steps:

- depositing 1.5% by weight of powdered calcium hydroxide in the bottom of the plastic container (for 100 L of total volume urine, add 1.5 kg of calcium
- 15 hydroxide);
- adding fresh urine at initial pH (6.5 to 7) to the plastic container (for 1.5 kg of calcium hydroxide already present in the container, filling up to 100 L with urine);
- the mixture has a pH of greater than or equal to 10; it may be stored under
- 20 these conditions for up to 6 months in a hermetically sealed plastic container, at room temperature and in darkness;
- filtering the basified urine with a nylon filter or a plastic filter having a mesh of 25 µm;
- adding 20 g.L⁻¹ of glucose to the basified and filtered urine, and adding 1%
- 25 by volume of an inoculum of *Paenibacillus* sp. (1 L per 100 L of basified urine), at 32°C for 4 days with continuous stirring (approximately 100 revolutions per minute);
- recovering the basified and transformed urine after recovery of the coproducts and in particular of the biofilm formed.

30

[0106] The inoculum used was obtained beforehand, as follows:

- basifying 10 L of urine to reach a pH of greater than or equal to 10, by adding 1.5% by weight of $\text{Ca}(\text{OH})_2$ (150 g of calcium hydroxide per 10 L);
- filtering the basified urine with a filter having a mesh of 0.2 μm ;
- adding 30 g.L^{-1} of glucose;
- 5 - adding 100 mg of the strain of *Paenibacillus sp.* preserved in concentrated liquid form;
- fermenting at 32°C with continuous stirring (approximately 100 revolutions per minute) for 2 days;
- the final concentration of bacteria obtained in the inoculum is of the order of
- 10 10^6 CFU.mL^{-1} .

[0107] The transformed urine obtained has the following characteristics:

- a pH of greater than or equal to 10,
- a concentration of bacteria of 10^8 CFU.mL^{-1} ,
- 15 - an $\text{NH}_4/\text{total N}$ ratio equal to 10%,
- a ureic N/total N ratio equal to 60%,
- a C/N ratio equal to 3.

20 Example 4: Method for transforming urine according to the invention with $\text{Ca}(\text{OH})_2$ and *Micrococcus sp.*, with adjustment of the pH using lactic acid during the fermentation

[0108] An example of a method according to the invention comprises the following steps:

- 25 - depositing 0.5% by weight of powdered calcium hydroxide in the bottom of the plastic container (for 100 L of total volume urine, add 0.5 kg of calcium hydroxide);
- adding fresh urine at initial pH (6.5 to 7) to the plastic container (for 0.5 kg of soda lye already present in the container, filling up to 100 L with urine);
- 30 - the mixture has a pH of greater than or equal to 9; it may be stored under these conditions for up to 6 months in a hermetically sealed plastic container, at room temperature and in darkness;

- filtering the basified urine with a nylon filter or a plastic filter having a mesh of 25 μm ;
 - adding 20 g.L^{-1} of sucrose to the basified and filtered urine, and adding 1% by volume of an inoculum of *Micrococcus sp.* (1 L per 100 L of basified urine),
 - 5 at 32°C for 4 days with continuous stirring (approximately 150 revolutions per minute);
 - during fermentation, adjusting the pH at least twice a day with lactic acid in order to maintain a pH equal to 9 over the duration of the fermentation.
- 10 [0109] The inoculum used was obtained beforehand, as follows:
- basifying 10 L of urine to reach a pH of greater than or equal to 9, by adding 0.5% by weight of Ca(OH)_2 (50 g of calcium hydroxide per 10 L);
 - filtering the basified urine with a filter having a mesh of 0.2 μm ;
 - adding 20 g.L^{-1} of sucrose;
 - 15 - adding 100 mg of the strain of *Micrococcus sp.* preserved in concentrated liquid form;
 - fermenting at 32°C with continuous stirring (approximately 150 revolutions per minute) for 2 days;
 - the final concentration of bacteria obtained in the inoculum is of the order of
 - 20 10^6 CFU.mL^{-1} .
- [0110] The transformed urine obtained has the following characteristics:
- a pH of greater than or equal to 9,
 - a concentration of bacteria of 10^8 CFU.mL^{-1} ,
 - 25 - an $\text{NH}_4/\text{total N}$ ratio equal to 10%,
 - a ureic N/total N ratio equal to 60%,
 - a C/N ratio equal to 3.

30 Example 5: Method for transforming urine according to the invention, with basification with NaOH, then a step of adjusting the pH to acidic pH using lactic acid, and fermentation with *Lactobacillus sp*

[0111] An example of a method according to the invention comprises the following steps:

- depositing 0.6% by weight of 30.5% soda lye in the bottom of the plastic container (for 100 L of total volume urine + soda lye, add 0.6 L of 30.5% soda lye);

- adding fresh urine at initial pH (6.5 to 7) to the plastic container (for 0.6 L of soda lye already present in the container, filling up to 100 L with urine);

- the mixture has a pH of greater than or equal to 9.0; it may be stored under these conditions for up to 6 months in a hermetically sealed plastic container, at room temperature and in darkness;

- adding lactic acid to the basified urine so that the pH becomes equal to 4;

- filtering the basified urine with a nylon filter or a plastic filter having a mesh of 25 μm ;

- adding 1% by volume of an inoculum of *Lactobacillus sp.* (1 L per 100 L of acidified urine) and 25 g.L⁻¹ of sucrose (white sugar) to the acidified and filtered urine, at 34°C for 10 days under continuous stirring (between 50 and 100 revolutions per minute);

- recovering the transformed urine after recovery of the coproducts and in particular of the biofilm formed.

[0112] The inoculum used was obtained beforehand, as follows:

- acidifying 10 L of urine to reach a pH of less than or equal to 4, by adding lactic acid at 1% by weight (100 g of acid per 10 L);

- filtering the acidified urine with a filter having a mesh of 25 μm ;

- adding 100 mg of the strain of *Lactobacillus sp.* preserved in concentrated liquid form;

- adding 25 g.L⁻¹ of sucrose(white sugar);

- fermenting at 30°C for 5 days;

- the final concentration of bacteria obtained is of the order of 10⁶ CFU.mL⁻¹.

[0113] The transformed urine obtained has the following characteristics:

- a pH of less than or equal to 4,

- a concentration of *Lactobacillus* sp. of 10^6 to 10^7 CFU.mL⁻¹,
- an NH₄/total N ratio equal to 10%,
- a ureic N/total N ratio equal to 60%,
- a C/N ratio equal to 3.

5

Example 6: Method for transforming urine according to the invention, with basification with NaOH, then a step of adjusting the pH to acidic pH using nitric acid, fermentation with *Bifidobacterium bifidum* and maintaining an acidic pH during the fermentation

10

[0114] An example of a method according to the invention comprises the following steps:

- depositing 0.6% by weight of 30.5% soda lye in the bottom of the plastic container (for 100 L of total volume urine + soda lye, add 0.6 L of 30.5% soda lye);

15

- adding fresh urine at initial pH (6.5 to 7) to the plastic container (for 0.6 L of soda lye already present in the container, filling up to 100 L with urine);

- the mixture has a pH of greater than or equal to 8.0; it may be stored under these conditions for up to 6 months in a hermetically sealed plastic container, at room temperature and in darkness;

20

- adding nitric acid to the basified urine so that the pH becomes equal to 4;

- filtering the basified urine with a nylon filter or a plastic filter having a mesh of 25 µm;

- adding 1% by volume of an inoculum of *Bifidobacterium bifidum* (1 L per 100 L of acidified urine) and 20 g.L⁻¹ of glucose to the acidified and filtered urine, at 34°C for 10 days under continuous stirring (between 50 and 100 revolutions per minute);

25

- during fermentation, adjusting the pH at least twice a day with nitric acid in order to maintain a pH equal to 4 over the duration of the fermentation.

30

[0115] The inoculum used was obtained beforehand, as follows:

- acidifying 10 L of urine to reach a pH of less than or equal to 4, by adding nitric acid at 0.5% by weight (50 g of acid per 10 L);
 - filtering the acidified urine with a filter having a mesh of 25 μm ;
 - adding 100 mg of the strain of *Bifidobacterium bifidum* preserved in concentrated liquid form;
 - adding 20 g.L^{-1} of glucose;
 - fermenting at 30°C for 5 days;
 - the final concentration of bacteria obtained is of the order of 10^6 CFU.mL^{-1} .
- 10 [0116] The transformed urine obtained has the following characteristics:
- a pH of less than or equal to 4,
 - a concentration of *Bifidobacterium bifidum* of 10^6 to 10^7 CFU.mL^{-1} ,
 - an $\text{NH}_4/\text{total N}$ ratio equal to 10%,
 - a ureic N/total N ratio equal to 60%,
- 15 - a C/N ratio equal to 3.

Example 7: Method for transforming urine according to the invention with recovery of struvite, NaOH and Bacillus sp.

- 20 [0117] An example of a method according to the invention comprises the following steps:
- recovering the urine without prior addition of base in a hermetically sealed plastic container, in such a way that the urine has a pH of greater than or equal to 8;
 - 25 • separately preparing a solution of magnesium sulfate (MgSO_4) at between 100 and 150 g.L^{-1} and adding it to the non-acidified urine in an amount of 1% by volume (1 L per 100 L);
 - stirring at 50-100 revolutions per minute for 30 minutes then resting for between 12 and 24 h;
 - 30 • filtering the supplemented urine through a filter having a mesh of 10 μm in order to separate the urine from the struvite recovered in the filter;

- adding 0.3% by weight of 30.5% soda lye to the filtered urine after recovery of the struvite, which has an initial pH of 8 – 9 (for 100 L of urine, add 0.3 kg of 30.5% soda lye, that is approximately 0.2 L);
 - the mixture has a pH equal to 9.5; it may be stored under these conditions for up to 6 months in a hermetically sealed plastic container, at room temperature and in darkness;
 - filtering the basified urine with a nylon filter or a plastic filter having a mesh of 25 μm ;
 - adding 1% by volume of an inoculum of *Bacillus sp.* (1 L per 100 L of acidified urine) and 10 g.L⁻¹ of glucose to the basified and filtered urine, at 30°C for 5 days under continuous stirring (approximately 150 revolutions per minute);
 - recovering the acidified and transformed urine after recovery of the coproducts and in particular of the biofilm formed.
- 15 [0118] The inoculum used was obtained beforehand, as follows:
- basifying 10 L of urine to reach a pH of less than or equal to 9, by adding 0.6% of 30.5% soda lye (60 g of soda lye per 10 L);
 - filtering the acidified urine with a filter having a mesh of 25 μm ;
 - adding 100 mg of the strain of *Lactobacillus sp.* preserved in concentrated liquid form;
 - adding 20 g.L⁻¹ of glucose;
 - fermenting at 30°C with continuous stirring (approximately 150 revolutions per minute) for 2 days;
 - the final concentration of bacteria obtained in the inoculum is of the order of
- 25 10⁶ CFU.mL⁻¹.

[0119] The basified and transformed urine obtained has the following characteristics:

- a pH of less than or equal to 9.5,
- 30 - a concentration of *Bacillus sp.* of 10⁷ CFU.mL⁻¹,
- an NH₄/total N ratio equal to 10%,
- a ureic N/total N ratio equal to 60%,

- a C/N ratio equal to 3.

Test results

5 Evaluation of the quantity of sodium hydroxide to be added to fresh urine (pH = 6.85)

[0120] The purpose of this test is to evaluate the effect of a base, sodium hydroxide (30.5% NaOH), on the pH of fresh urine.

10

[0121] The test was carried out on 1 L of fresh urine that had been stored for less than 2 hours.

[0122] A range of NaOH concentrations was tested by weight relative to the weight of urine, between 0.05% and 2.5%.

15

[0123] The results are presented in Figure 1, which shows the variation in the pH of the fresh urine as a function of the NaOH concentration, and in the table below.

20

[Table 1]

NaOH (%)	pH of fresh urine
0.00	6.85
0.05	7.52
0.10	8.44
0.15	8.98
0.20	9.34
0.25	9.61
0.30	9.86
0.35	10.12
0.40	10.32
0.45	10.64
0.50	11.14
0.55	11.6
0.60	11.95

0.65	12.17
0.70	12.34
0.75	12.45
0.80	12.53
1.00	12.54
2.50	13.16

[0124] It is observed that the addition of 0.1% NaOH makes it possible to basify the urine, and that the addition of 0.35% makes it possible to obtain a pH of less than 10. A pH of greater than 11 is obtained after adding 0.5% NaOH.

5

Evaluation of the quantity of sodium hydroxide to be added to stored urine (pH = 9.38)

[0125] The purpose of this test is to evaluate the effect of sodium hydroxide (30.5% NaOH) on the pH of stored urine.

10

[0126] The test was carried out on 1 L of urine that had been stored for 15 days in a hermetically sealed container.

[0127] A range of NaOH concentrations was tested by weight relative to the weight of urine, between 0.05% and 2.5%.

15

[0128] The results are presented in Figure 2, which shows the variation in the pH of the stored urine as a function of the NaOH concentration, and in the table below.

20

[Table 2]

NaOH (%)	pH of stored urine
0.00	9.38
0.05	9.45
0.10	9.51
0.15	9.57
0.20	9.63

0.25	9.68
0.30	9.73
0.35	9.78
0.40	9.84
0.45	9.88
0.50	9.93
0.55	9.98
0.60	10.03
0.65	10.07
0.70	10.12
0.75	10.16
0.80	10.21
1.00	10.43
2.50	13.05

[0129] It is noted that the stored urine has a higher pH than the fresh urine but that it is however necessary to provide a greater concentration of NaOH to obtain a pH of greater than 10, namely at least 0.7% and, for a pH of greater than 11, more than 1%.

[0130] It is thus preferred according to the invention to basify fresh urine and not to store it beforehand, especially since storage of the urine without basification according to the invention leads to a loss of its characteristics and its NPK content, in particular via the hydrolysis of urea into ammonia.

Example 8: Measurement of the growth capacity of the species *Pseudomonas chlororaphis* on basified urine

[0131] The aim of this example is to evaluate the capacity of a microorganism to grow on a medium based on basified urine. The microorganism tested in this test is the native strain of *Pseudomonas chlororaphis*, CNCM I-5793. This bacterial species was selected due to its capacity to grow at basic pH, as demonstrated by earlier studies (Fillon et al., 1999).

Materials and methods

Strain used

[0132] The strain of *P. chlororaphis* used during this analysis is the native strain, CNCM I- 5793, isolated from a sample of soil from the Gironde. This bacterial strain belongs to the Pseudomonadaceae family and to the Pseudomonadales order.

Preculture

[0133] Before inoculation of the bacteria in the basified urine, preculture was carried out on liquid medium. This preculture was carried out on liquid NA medium (5 g/L yeast extract, 10 g/L peptones and 5g/L NaCl) and under aerobic conditions. This step makes it possible to revitalize the cells and to obtain cells in good physiological condition and a liquid culture that is highly concentrated in bacteria. After 2-3 days of culture at 28°C, the cells are washed with physiological water (9 g/L NaCl) and also taken up in physiological water again. Subsequently, the optical density (600 nm) was measured (DO_{600} = 0.05) and the level of inoculation is calculated and adjusted in order to guarantee the same starting concentration in all the cultures (10^5 CFU/mL).

Tested urines

[0134] Precultured *P. chlororaphis* was inoculated on urine at 2 different pHs: a neutral pH (7) and a basic pH (9). Fresh urine was used to prepare the urine solutions at pH 7 and at pH 9. The pH of the fresh urine is adjusted to 7 or 9 by adding 0.04% (w/w) or 0.15% (w/w), respectively, of a soda lye solution (30% NaOH). Once the pH has been adjusted, a glucose solution at 40 g/L was added to the urine, and the urine was then filtered at 0.2 μ m.

[0135] The bacteria were added and the urine was incubated in 250 mL erlenmeyer flasks at 28°C, with stirring (150 rpm) for a period of 3 days under aerobic conditions, filling the erlenmeyer flasks to half volume (100 mL).

Bacteria count

[0136] The populations of *P. chlororaphis* were counted at T0 at the time of inoculation and after 24, 48 and 72 h of growth. To this end, decimal dilutions of the culture to be analyzed are carried out and deposited (in 10 μ L drops) on a "Nutrient Agar" medium dish. The dishes are then incubated at 28°C, for 1 day until colonies are obtained.

10 *Statistical analysis*

[0137] In order to ascertain whether the differences obtained between the 2 modalities are significant ($p\text{-value} \leq 0.1$), a Student's test was applied after verification of the application conditions (standardized data and homogeneity of variances) and using the XLSTAT software.

Results obtained

[0138] The results obtained are shown in Figure 3. The counts were carried out by counting colonies on a Petri dish and the results are expressed as colony forming units per mL (CFU/mL).

[0139] In a first step, the results show that, regardless of the pH (7 or 9), the native strain of *P. chlororaphis* is capable of growing on urine medium, since the populations observed reach a level $> 1 \times 10^8$ CFU/mL with an initial level of inoculation of 5×10^5 CFU/mL. After 24 and 48 h, the results show significant differences between the 2 modalities, with a higher population on urine at pH 9 (7.83×10^7 CFU/mL at 48 h) compared with urine at pH 7 (2.95×10^7 CFU/mL at 48 h). This result therefore indicates that the growth of *P. chlororaphis* is favored at basic pH, which shows the benefit of using basified urine.

[0140] This test therefore makes it possible to demonstrate a benefit of using basified urine at a pH of greater than or equal to 9 for certain microorganisms.

Claims

1. A method for treating human or animal urine, characterized in that it comprises:
 - 5 - a step of basifying the urine in such a way that the urine has a pH of greater than or equal to 9,
 - a step of filtering the urine, and
 - a step of transforming the urine by fermentation.
- 10 2. The method according to claim 1, characterized in that the step of basifying the urine is carried out in such a way that the urine has a pH of greater than or equal to 10.
3. The method according to one of the preceding claims, characterized in
15 that it is implemented on urine that was harvested less than 10 hours prior.
4. The method according to one of the preceding claims, characterized in that it is implemented on urine that was harvested less than 2 hours prior.
- 20 5. The method according to one of the preceding claims, characterized in that the basification step is carried out by adding at least one base, selected from calcium hydroxide, potassium hydroxide, sodium hydroxide and mixtures thereof, to the urine.
- 25 6. The method according to the preceding claim, characterized in that the base is added at a concentration of between 0.1 and 10% by weight of the total weight of the urine and base mixture.
7. The method according to one of the preceding claims, characterized in
30 that the basification step is carried out by adding between 0.1 and 1% of sodium hydroxide, by weight of the total weight of the urine and sodium hydroxide mixture, to the urine.

8. The method according to one of the preceding claims, characterized in that the basification step is carried out by adding at least one base to the container wherein the urine is received, upstream of receiving the urine.

5

9. The method according to one of the preceding claims, characterized in that the basification step is carried out by adding at least one mixture of microorganisms in a basic medium to the urine, such that the basification is associated with an inoculation of microorganisms.

10

10. The method according to one of the preceding claims, characterized in that, after the basification step and before the step of transforming the urine by fermentation, it comprises a step of adding at least one acid to the basified urine so that it has a lower pH than that obtained after the basification step.

15

11. The method according to the preceding claim, characterized in that the acid is selected from sulfuric acid, acetic acid, hydrochloric acid, phosphoric acid, nitric acid, lactic acid and mixtures thereof.

20 12. The method according to one of the preceding claims, characterized in that the pH of the urine before and/or during transformation by fermentation is suitable for the growth of the microorganisms used for the fermentation of the urine.

25 13. The method according to one of the preceding claims, characterized in that the urine is stored after the basification step and before the filtration step, or after the filtration step and before the step of transformation by fermentation.

30 14. The method according to the preceding claim, characterized in that the urine is stored for a period of less than or equal to 6 months.

15. The method according to one of the preceding claims, characterized that the filtration is carried out on a filter having meshes of between 0.1 and 80 μm .
- 5 16. The method according to one of the preceding claims, in that the filtration is carried out on a filter that absorbs organic compounds.
17. The method according to one of the preceding claims, characterized in that the step of transforming the urine by fermentation consists in adding
10 at least one source of carbon and at least one inoculum of microorganisms to the urine.
18. The method according to the preceding claim, characterized in that the source of carbon is added in an amount of 1 to 50 g.L⁻¹ relative to the volume
15 of urine to be transformed.
19. The method according to one of claims 17 or 18, characterized in that the source of carbon is selected from fructose, glucose, lactose, maltose, sucrose, glucose syrup, malt syrup, and also polyols such as mannitol or
20 sorbitol, and mixtures thereof.
20. The method according to one of claims 17 to 19, characterized in that the inoculum of microorganisms is added in an amount of 0.1 to 10% by volume relative to the volume of the mixture of urine and the source of carbon.
25
21. The method according to the preceding claim, characterized in that the inoculum of microorganisms is obtained from a stock solution comprising at least one source of carbon, a bacterium or a mixture of at least two bacteria, and a basified or acidified urine having a pH suitable for the fermentation of
30 said bacterium or said mixture of bacteria.

22. The method according to one of the preceding claims, characterized in that the fermentation is carried out with at least one bacterium selected from the bacteria of the Paenibacillaceae, Bacillaceae, Pseudomonadaceae, Burkholderiaceae or Micrococcaceae families, and mixtures thereof.

5

23. The method according to one of the preceding claims, characterized in that the fermentation step comprises a step of stabilizing the pH, by adding at least one base or an acid.

10 24. A transformed urine, obtainable by implementing the method according to one of claims 1 to 23, characterized in that it has at least one of the following characteristics:

- a pH of greater than 9, and
- a concentration of microorganisms of at least 10^6 CFU.mL⁻¹.

15

25. The transformed urine according to the preceding claim, characterized in that it has a concentration of bacteria of at least 10^7 CFU.mL⁻¹.

20 26. The transformed urine according to one of claims 24 or 25, characterized in that it also has at least one of the following characteristics:

- a solids content of greater than or equal to 1%,
 - an NH₄/N ratio of less than or equal to 30%,
 - a ureic N/total N ratio of greater than or equal to 50%,
 - a C/N ratio of greater than or equal to 1, preferentially greater than or
- 25 equal to 2.

27. The transformed urine according to one of claims 23 to 26, characterized in that it is in liquid or solid form.

30 28. A fertilizer comprising at least one transformed urine according to one of claims 24 to 27.

29. A use of a transformed urine according to one of claims 24 to 28 as a fertilizing substance.

5 30. A use of a transformed urine according to one of claims 24 to 29, for stimulating plant growth.

31. The use according to one of claims 29 to 31, characterized in that the transformed urine is diluted in water in an amount of 1 to 50 mL of liquid transformed urine per liter of water.

10

32. Use of coproducts obtained during the fermentation step when a method according to one of claims 1 to 23 is carried out, as fertilizing substance, phytosanitary product, biocontrol product.