ABSTRACT: The present invention relates to a process and to nutraceutical compositions obtained by using it for the treatment of plants, said compositions having surprising nutritional and biostimulant properties while enhancing the endogenous defenses of plants against fungi, bacteria and viruses. Said compositions also make plants more resistant to biotic infections, by limiting or avoiding the application of agrochemicals.
Nutraceutical compositions for plants and method for their preparation

DESCRIPTION

Background art
Humic substances have critical functions in soil and plants. In soil, they bind to the -elements present, particularly phosphorous and iron, thus promoting the bioavailability thereof towards the plant, avoiding the insolubilization due to the high pH and to the high content of active lime. They also promote the biodegradability of the toxins produced by plants and of all pollutants of organic origin brought to the soil or contained therein. They improve the chemical, physical and biological conditions of the soil by bringing organic carbon of biological origin, which play a catalytic role in promoting the absorption of nutrients by the plants. They also improve and homogenize the germination of seeds, have a strong rhizogenic action, i.e. promote the development of adventitious roots and enhance the biochemical activity of the soil and plants.

Humic substances play a very important complexing and carrier role, specifically of carboxylic and phenolic groups contained therein. In fact, the higher the content of organic carbon and its degree of humification, the stronger the complexing and carrier action they exert against the substances or elements to which they are associated.

Salicylic acid is an aromatic hydroxy acid found in plants, fruits and roots of *Spiraea ulmaria*, which belongs to the rosacea family, in hyacinths, tulips, strawberries and grapes. Salicylic acid is widely used in pharmaceuticals and cosmetics for its recognized anti-inflammatory, moisturizing, keratolytic action. In plants, salicylic acid activates the protein synthesis and participates in cellular destruction and SAR (Systemic Acquired Resistance) induction. This resistance is expressed against a wide range of harmful organisms and differs in its action according to
the inductor pathogen agent. However, a use thereof on a large scale in agriculture has not yet become widespread, since a formulation which promotes the bioavailability thereof has not yet been developed.

Active silver nanoparticles (AgNPs) are known for their antimicrobial activity against harmful organisms for plants, fungi, bacteria, viruses.

Over the past 50 years, the shift to intensive agriculture has led to abuse in the use of fertilizers and agrochemicals, with serious and irreversible damage to the environment, the ecosystem in general and to the people, with the explosion of many cancerous diseases.

For this reason, the need for innovative solutions for use in agriculture is strongly felt. In particular, the need is strongly-felt for a composition for fertilizing crops in an eco friendly manner, which should allow a reduction in the use of agrochemicals and an increase in yields and quality of agricultural production.

**Description of the invention**

The present invention relates to a process and to nutraceutical compositions obtained by the same for the treatment of plants, said compositions having surprising nutritional and biostimulant properties and of enhancement of endogenous defenses of plants against fungi, bacteria and viruses. Said compositions also make plants more resistant to biotic infections, by limiting or avoiding the application of agrochemicals.

**Detailed description of the invention:**

Definition: "fossil material" denotes a material containing at least 80% w/w of total organic substance, at least 80% w/w of extractable organic substance and 80% w/w of humified organic substance. In a preferred embodiment, the most advantageous fossil material has a total organic matter content of 90% w/w, with a percentage of extractability of the organic substance of 90% and a degree of humification of 90%.
Fossil material is particularly rich in humic substances.

A first object of the present invention is a process for the preparation of nutraceuticals for plants which comprises:

a) Preparing a muddy mixture of fossil material, by mixing said fossil material finely divided with an aqueous solution comprising AgNPs having a diameter of <100 nm, preferably from 20 to 30 nm, with a concentration of silver in said aqueous solution from 20 ppm to 300 ppm;

b) Adding salicylic acid to the mixture resulting from step a) with the mixture under stirring until complete homogenization of all the slurry;

c) Adding an alkaline agent to the mixture of step b) under stirring, preferably selected from the group comprising potassium hydroxide, potassium carbonate, potassium bicarbonate, ammonium hydroxide or mixtures thereof.

The alkaline extraction allows the optimum extraction of the humic substances contained in the fossil material.

In an alternative embodiment, said method also comprises, in said step c), an ultrasonic treatment at very high power, approximately 80 kHz, at a temperature from 50 to 70 °C. The exposure to ultrasounds allows an effective extraction, even in the presence of low concentrations of alkaline agent.

Said fossil material is preferably selected from the group comprising: leonardite, lignite, peat coal, xylite, peat and mixtures thereof, preferably leonardite.

Preferably, said fossil material is finely ground and characterized by a particle size from 100 to 200 mesh, even more preferably from 100 to 150 mesh or from 120 to 150 mesh.

In one embodiment, the fossil material and the aqueous solution are mixed in a ratio from about 1:0.1 to about 1:10, or from about 1:0.2 to about 1:8, or from about 1:0.3 to about 1:6.

Said mixing ratios of the fossil material with the aqueous solution are also selected on the basis of the final formulation
to be obtained, i.e. the ratios are in favor of the fossil material if a solid final formulation is desired.

Preferably, salicylic acid is added in an amount from 1% to 10%, preferably from 3 to 7%, preferably it is about 5% or 3% w/w of the mixture.

Typically, the percentages of the alkaline agent added to the mixture are in the range from 3% to 7% w/w with respect to the mixture itself and in any case, their concentration is always proportional to the percentages of salicylic acid.

The slurry being worked which comprises said mixture of fossil material, salicylic acid, alkaline agent is kept under stirring for at least 1 hour, preferably for 2 hours, even more preferably for 5-6 hours. It is also possible to carry out said process with a continuous industrial plant.

According to the present invention, the process described herein allows to obtain two basic compositions of nutraceuticals: an acidic composition at pH from 5.5 to 6.0 and an alkaline composition at pH from 9.5 to 12.00, depending on the percentages of salicylic acid used and alkaline agent used for the extraction of humic substances.

These formulation features are useful and essential in the selection of specific compositions for different productions/mixtures, for different soils (acidic or basic soils) and for different crops (acidophilus or basophilic crops).

Below is the selection of suitable and targeted formulations for every need, by way of example, formulations suitable for hydroponic or soilless crops have been selected.

Depending on the muddy mixture prepared, the concentration of the solution of AgNPs, salicylic acid and alkaline agent (extraction means), the slurry is optionally filtered (100-120 mesh) for the preparation of liquid formulations (at alkaline pH or acidic pH), or dried using a (normally rotary) dryer and, optionally, granulated or microgranulated for precision applications on crops.
Microgranulation (0.4-1.0 mm) is recommended for solid products, since it allows a rational and precision distribution of the amounts of fertilizers actually added, a control which is required for sustainable agriculture. Microgranular formulations can be distributed with precision machines, able to administer 25-40 kg/ha of formulation at the time of seeding, compared to 250-400 kg/ha dispensed nowadays with the current crop nutrition techniques.

In the embodiment which provides a granular or microgranular product, said method of preparation comprises a first drying of the slurry carried out with a rotary dryer, leaving a residual moisture in the product of about 13-16%, preferably of about 15% which is followed by the granulation or microgranulation process, preferably with a disc granulator, -which is followed by one final drying on a fluid bed plant.

The method comprising the drying in subsequent steps advantageously allows a better microgranulation or granulation, due to the residual moisture content still present during the granulation process.

In order to promote the granulation and microgranulation process, adding a glue to the mixture, preferably of a natural origin, such as lignosulfonate or carboxymethylcellulose, has proved effective.

The formulation comprising the glue ensures a better hold of the granule and a better mechanical distribution of the granules, which is important in precision fertilization.

The production process according to the present invention may also be implemented in other industrial technologies that the process engineer will deem appropriate, depending on the specific needs, technologies allowing the introduction of the different raw materials in line while the plant is carrying out the homogenization of the whole slurry, up to obtain the titrated mixture already granulated or microgranulated.

For the preparation of solid formulations, it is suitable to
follow a working schedule which takes the cultivation needs into proper consideration. All those raw materials are therefore added according to the desired content and depending on the specific classification of the formulation to be marketed, such as for use in organic farming or in eco friendly agriculture.

For the preparation of liquid formulations, the present production process comprises the necessary separation of the liquid moiety from the insoluble moiety of the mixtures, where the liquid phase represents the plant nutraceutical composition, which can be used as is or used to prepare mixtures of nutraceuticals for plants with specific titrations.

For the production of liquid formulations according to the present invention, a very fine, almost weightless fossil material ground to 120-150 mesh should be used in order to obtain better extraction and little filtration waste. It is also very important to carry out an adequate separation of the liquid moiety from the insoluble one in the mixture through a special filtering system, for example with filter press, vacuum filter and other systems available, avoiding the natural sedimentation technique, which also eliminates moieties which are very important from the agronomic point of view. For the production of liquid formulations, at acidic pH or alkaline pH, according to the present invention, for direct use in agriculture or for use as an intermediate in the formulation of nutraceuticals for plants, a reactor should be available, provided with high speed (2000-3000 rpm) stirring system, rpm control, preferably with two independent propeller stirring columns in order to allow to stir the slurry in both directions and stir the product on the bottom to the surface, and vice versa. This allows to obtain homogeneous productions and a better and complete extraction of humic substances.

It is advantageous to use ultrasounds in the slurry as they greatly improve the extraction and allow to obtain a colloidal suspension even with an acidic pH and a significant reduction of
the extraction means (alkaline products).
In a preferred embodiment, the aqueous solution comprising AgNPs is added to the reactor, preferably of stainless steel, and then, the finely ground fossil material is added slowly under stirring. Alternately, the fossil material is introduced into the plant and the aqueous solution comprising AgNPs is added thereto. The slow addition of the ground fossil material to the water already present in the reactor has proved particularly advantageous in order to obtain a homogeneous mixture without lumps.
While the system is under stirring, salicylic acid is added slowly in the defined proportion, depending on the desired end product. It is kept under stirring for 2-3 hours. After 2-3 hours of stirring, the alkaline agent is poured slowly. The slurry is kept being worked for at least 1 hour, preferably for about 5-6 hours, after which the product is ready to be filtered and/or dried and/or stored in dedicated tanks.
The preparation process described herein, as noted hereinafter, leads to a product in which the complexing action of humic substances is maximized, so as to have a nutraceutical complex in which the bioavailability of active ingredients contained therein is maximized. This particularly advantageous effect is achieved due to the specific combination of active ingredients and to the preparation process, which allows to maximize the effectiveness thereof.
In a further aspect, compositions obtained with the process described above are described herein.
Compositions were obtained which are used in organic farming, which comprise raw materials permitted and certified for use in organic farming, and compositions suitable for eco friendly agriculture comprising mineral and/or process raw materials only in very small amounts, so as not to have a strong environmental impact.
Liquid formulations, with acidic pH and alkaline pH, produced
according to the present invention, are advantageously used as an intermediate for the preparation of specific formulations, titered according to commercial and technical requirements. Solid (granular and/or micro-granular) formulations are also obtained with an acidic or alkaline pH, so as to adapt them to the crop and soils on which they are used. Formulations with a high content of acidic pH humic acids are used in physiologically alkaline soils, in foliar applications, in hydroponics crops and in mixtures with agrochemicals. Formulations with a high content of alkaline pH humic acid are used in acidic soils. The formulations according to the present invention may further comprise one or more substances able to release macroelements, microelements and/or meso-elements. Said macro-elements comprise, for example, nitrogen, phosphorus and potassium. Said micro-elements comprise, for example, iron, zinc, manganese, copper, boron, molybdenum. Said meso-elements comprise, for example, calcium and magnesium.

Particularly effective nutraceutical compositions further comprise the addition of animal or plant protein hydrolysates. The addition of insect repellents, fungicides, fungistatic agents, bactericidal agents, bacteriostatic agents, nematode repellents, plant growth regulators, complex fertilizers, adsorbents has proved to be particularly effective. In a preferred embodiment, said plant growth regulators are selected from cytokines, auxins, gibberellins.

In a preferred embodiment, said adsorbents are of natural origin and comprise starches and derivatives thereof, or they are synthesized and comprise potassium polyacrylates. Said adsorbents are preferably added in amounts from 5 to 20% w/w.

In one embodiment, said method shall further comprises the addition of residues (cake) to said mixture from extraction processes of oils, preferably of neem (Azadirachta indica),
karanja (Pongamia glabra), castor (Ricinus communis), Jatropha (Jatropha curcas).

In a further embodiment, said compositions also comprise Sophora japonica extract.

The following table shows the results obtained in terms of average % increase in yields of productions, average % reductions of the fertilizing units administered and average reduction of the agrochemicals administered.

The results in the single cultivations were obtained by applying the cultivation protocols described in detail in examples 13 to 32, using the formulations according to the present invention, as described in examples 1 to 12. The results obtained on each of the cultivations are surprising in terms of yield increase, reduction of fertilizing units and agrochemicals administered.

On all the crops tested, the nutraceutical formulation of example 12w was used the control of pests (insects, nematodes and mites), at the foliar doses of 4-5 kg/hectare and on specialized horticultural crops, provided with drip irrigation system, also administered to the soil at doses of 10-20 kg/hectare, carrying out 2 applications, one at 7-10 days post transplantation and the other halfway of the growing cycle.

Table 1: effects obtained on the indicated crops using the cultivation protocols according to the present invention.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Average % increases in production yield</th>
<th>Average % reductions of fertilizing units administered</th>
<th>Average % reductions of agrochemicals administered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salad</td>
<td>20</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Leaf lettuce</td>
<td>15</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Arugula</td>
<td>15</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Celery</td>
<td>30</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Valerian</td>
<td>15</td>
<td>55</td>
<td>90</td>
</tr>
<tr>
<td>Tomato</td>
<td>20</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Vegetable</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>-----------------</td>
<td>------</td>
<td>--------</td>
<td>------</td>
</tr>
<tr>
<td>Pepper</td>
<td>20</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Eggplant</td>
<td>15</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Potato</td>
<td>16</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Green bean</td>
<td>20</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Bean</td>
<td>15</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Cucumber</td>
<td>20</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Radish</td>
<td>12</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Zucchini</td>
<td>20</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Carrot</td>
<td>12</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Strawberry</td>
<td>25</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Watermelon</td>
<td>18</td>
<td>55</td>
<td>90</td>
</tr>
<tr>
<td>Melon</td>
<td>20</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Wheat</td>
<td>10</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Barley</td>
<td>14</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Quinoa</td>
<td>26</td>
<td>60</td>
<td>95</td>
</tr>
<tr>
<td>Corn</td>
<td>18</td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td>Soy</td>
<td>15</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>16</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Sunflower seeds</td>
<td>15</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Beet leaves</td>
<td>16</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Rice</td>
<td>15</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Peanuts</td>
<td>18</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Tobacco</td>
<td>16</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Plum</td>
<td>18</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Kiwi</td>
<td>20</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Apple</td>
<td>15</td>
<td>55</td>
<td>90</td>
</tr>
<tr>
<td>Pear</td>
<td>15</td>
<td>55</td>
<td>90</td>
</tr>
<tr>
<td>Banana plant</td>
<td>12</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Cherry</td>
<td>10</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Peach</td>
<td>13</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>Apricot</td>
<td>10</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Papaya</td>
<td>12</td>
<td>55</td>
<td>90</td>
</tr>
<tr>
<td>Mango</td>
<td>15</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Pineapple</td>
<td>12</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>18</td>
<td>60</td>
<td>90</td>
</tr>
</tbody>
</table>
The composition according to the present invention turned out to be surprisingly advantageous, showing a synergy between the different components. A synergy made strong by the method used for the preparation of the composition, which allows the formation of a mixture of organic substances which comprises AgNPs and salicylic acid, from which the humic substance is then extracted. The alkaline extraction method proposed, possibly assisted by ultrasonic extraction, when applied to a mixture comprising the desired components, allows it to be found evenly distributed in the finished product. The humic substance, due to the chelating properties of its constituents, rich in phenolic and carboxylic groups, has a strong property as a carrier and complexing agent. The extraction method described herein allows a nutraceutical complex with unique properties to be obtained, which allows maximum bioavailability of the components present. In the formulation described herein, the AgNPs show a fungicide, bactericide and antiviral action exceeding that expected when applied with other methods. The combined presence of salicylic acid enhances the endogenous defenses of plants.

The advantage resulting from having the microgranulate formulations described herein, which allow precise control of the distribution of fertilizer, is also noted. These make the fertilization process eco-friendly, allowing the fertilizing units for the nutrition of crops to be rationalized. The surprising
activity observed in enhancing the endogenous defenses of plants
also allows the drastic reduction of agrochemicals, thus
preventing the use of substances with a very strong impact on the
ecosystem and very high permanence in the environment and in
agricultural products, as well as dangerous for the operators. The
advantages described are associates to a marked quality and
quantity improvement of agricultural productions.
The following examples are intended to better illustrate the
solution according to the present invention, are not intended to
be limiting of the same. Examples 1 to 12 describe compositions
and formulation processes, examples 13 to 32 describe cultivation
protocols which involve the use of one or more of the compositions
described in the examples above.
Examples:
Example 1: nutraceutical for plants with a high content of humic
acids and with acidic pH.
A composition is described which is formulated as follows:
- 72.5% aqueous solution containing 20 ppm-300 ppm AGNPs
- 5% salicylic acid
- 20% finely ground leonardite or other fossil material
- 2.5% potassium hydroxide in 99.8% flakes

Preparative process:
To a sealed tank provided with high speed (2000-3000 rpm) stirring
system, preferably with propellers, with two stirring columns, so
as to proceed with stirring downwards and upwards, is added the
aqueous solution containing AgNPs and salicylic acid under
stirring and stirring is continued for 10 minutes, then leonardite
is slowly added and stirred for about an hour. Finally, potassium
hydroxide is added and stirred for about one hour. In order to
obtain a perfect extraction of humic substances, it is suggested
to operate at high speeds and in both directions (upwards and
downwards). The use of ultrasounds in the slurry proved to be
particularly advantageous here.
The formulation proved surprisingly advantageous in the preparation of nutraceuticals for plants, titered for example with macro-, micro-, meso-elements, nutritional catalysts, amino acids, seaweed extracts, plant extracts, protein hydrolysates. The formulations also proved to be advantageous for use in hydroponic cultivations, for the preparation of nutrient solutions for any cultivation (flowers, vegetables, nurseries, etc...), for foliar applications and also as such for use in fertigation.

Example 2: nutraceutical for plants with a high content of humic acids and with alkaline pH.

A composition is described which is formulated as follows:

- 70.00% aqueous solution containing 20 ppm-300 ppm AgNPs
- 5% salicylic acid
- 20% finely ground ieonardite or other fossil material
- 5% potassium hydroxide in 99.8% flakes

The composition proved to be surprisingly advantageous in the preparation of basic formulations and for use in acidic soils and on basophilic plants.

Example 3: preparation of a titered (5% organic nitrogen) nutraceutical for plants in liquid formulation.

The nutraceutical is prepared ng by mixing in proportion 1:1 or a formulation according to examples 1 or 2 and an animal or plant protein hydrolysate containing 10% (w/w) of 50% organic nitrogen.

Example 4: nutraceutical for plants titered in ammonia nitrogen (14%), copper (1%), zinc (4%), and manganese (2%), in liquid formulation.

The nutraceutical comprises:

<table>
<thead>
<tr>
<th>% w/w in the starting solution</th>
<th>% w/w in the finished product</th>
</tr>
</thead>
<tbody>
<tr>
<td>28% ammonium hydroxide</td>
<td>63.3%</td>
</tr>
<tr>
<td>Component</td>
<td>Percentage</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>50% copper hydroxide</td>
<td>2.2%</td>
</tr>
<tr>
<td>35% zinc sulfate</td>
<td>11.5%</td>
</tr>
<tr>
<td>30% manganese sulfate</td>
<td>7.0%</td>
</tr>
<tr>
<td>Nutraceutical for plants with a high content of humic substances, with alkaline pH (example 2 composition)</td>
<td>16.0%</td>
</tr>
</tbody>
</table>

**Example 5:** nutraceutical for plants, microgranular formulation (% are w/w in the finished granulate/microgranulate product)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>leonardite</td>
<td>20%</td>
</tr>
<tr>
<td>ground garlic flour</td>
<td>14%</td>
</tr>
<tr>
<td>lithothamnion</td>
<td>15%</td>
</tr>
<tr>
<td>neem cake</td>
<td>27%</td>
</tr>
<tr>
<td>zinc sulfate</td>
<td>3%</td>
</tr>
<tr>
<td>Castor cake</td>
<td>13%</td>
</tr>
<tr>
<td>salicylic acid</td>
<td>3%</td>
</tr>
<tr>
<td>aqueous solution of silver nanoparticles (20 ppm - 200 ppm) as needed to provide the mixture and create a slurry (typically, 30% (w/w) with respect to the raw materials used in the process)</td>
<td>5%</td>
</tr>
<tr>
<td>potassium carbonate</td>
<td>5%</td>
</tr>
</tbody>
</table>

Production process: the aqueous solution of silver nanoparticles is poured in a mixer. Leonardite, neem cake, lithothamnion, garlic flour, castor cake, zinc sulfate, and salicylic acid are added slowly under stirring. The mass is mixed continuously until it forms a homogeneous slurry. Still under stirring, potassium carbonate is then added to allow the extraction of humic substances from leonardite and form a stable and active complex. Thereafter, the slurry is dried by means of a drying system, preferably rotary, so as to leave a residual humidity of 13-16%, ideal for granulation or, preferably, microgranulation of the product (0.4-1.0 mm). After granulation or microgranulation, the
Product is dried again by means of a fluid bed dryer, so as not to damage the granules.

It is noted that in this and in the following examples, where there is no % in finished product in relation to the aqueous solution, the aqueous solution of silver nanoparticles in the finished product is almost completely evaporated, there is no residual humidity in the finished product. For this reason, the % by weight of the aqueous solution in the finished product is irrelevant, since only the silver nanoparticles and the minerals present in said solution are found in the finished product.

Advantageously, in order to improve the granule hold, an adhesive of natural origin is added to the slurry, such as calcium lignosulfonate or carboxymethylcellulose. The formulation comprising the glue ensures a better mechanical distribution of the granules, which is important in precision fertilization.

The composition described herein has shown surprising advantages for use in organic farming, as it possesses a strong repellency activity against nematodes and soil insects, in addition to a strong rhizogenic action.

**Example 6**: nutraceutical for plants, microgranular formulation.

<table>
<thead>
<tr>
<th>% w/w in the starting solution</th>
<th>% w/w in the finished product</th>
</tr>
</thead>
<tbody>
<tr>
<td>leonardite</td>
<td>40%</td>
</tr>
<tr>
<td>12-54 monoammonium phosphate</td>
<td>38%</td>
</tr>
<tr>
<td>35% zinc sulfate</td>
<td>3%</td>
</tr>
<tr>
<td>11% boron ethanolamine</td>
<td>3%</td>
</tr>
<tr>
<td>30% manganese sulfate</td>
<td>2%</td>
</tr>
<tr>
<td>salicylic acid</td>
<td>3%</td>
</tr>
<tr>
<td>potassium hydroxide in flakes</td>
<td>5%</td>
</tr>
<tr>
<td>46% technical urea</td>
<td>6%</td>
</tr>
<tr>
<td>aqueous solution of silver nanoparticles (20 ppm - 200 ppm) as needed to provide the mixture and</td>
<td></td>
</tr>
</tbody>
</table>
create a slurry (typically, 30% w/w with respect to the raw materials used in the process)

Production process: the aqueous solution of silver nanoparticles is poured in a mixer. Leonardite, N? 12-54 monoammonium phosphate, zinc sulfate, manganese sulfate and salicylic acid are slowly added under stirring. The mixture is homogeneously mixture up to form a homogeneous slurry, thereafter boron ethanolamine, technical urea and potassium hydroxide are slowly poured under stirring, so as to allow the extraction of the humic substances from leonardite and form a stable and active complex. Thereafter, the slurry is dried by means of a drying system, preferably rotary, so as to leave a residual humidity of 13-16%, ideal for granulation or, preferably, microgranulation of the product (0.4-1.0 mm). After granular-ion or microgranulation, the product is dried again by means of a fluid bed dryer, so as not to damage the granules.

Advantageously, in order to improve the granule hold, an adhesive of natural origin is added to the slurry, such as calcium lignosulfonate or carboxymethylcellulose. The formulation comprising the glue ensures a better mechanical distribution of the granules, which is important in precision fertilization.

The formulation is eco friendly, slow-release, and has been advantageously applied with starter effect to industrial crops. 

Example 7: biological nutraceutical, WDG formulation, based on trace elements (copper, zinc and manganese)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>35% zinc sulfate</td>
<td>14.5%</td>
</tr>
<tr>
<td>30-32% manganese sulfate</td>
<td>17.0%</td>
</tr>
<tr>
<td>50% copper hydroxide</td>
<td>14.5%</td>
</tr>
<tr>
<td>glucono delta lactone</td>
<td>30%</td>
</tr>
<tr>
<td>oligosaccharides (inulin)</td>
<td>20%</td>
</tr>
<tr>
<td>nutraceutical with a high content of humic acids, acidic pH</td>
<td>20% with 4% dry matter content</td>
</tr>
</tbody>
</table>
aqueous solution of silver nanoparticles (30 ppm - 200 ppm) as required to form the slurry.

Production process: zinc sulfate, manganese sulfate, copper hydroxide, glucono delta lactone and the oligosaccharide (preferably inulin) are poured in a mixer. The mass is homogeneously mixed. The aqueous solution of silver nanoparticles is slowly poured under stirring to form a homogeneous slurry. The nutraceutical with a high content of humic acids at acidic pH is then added to form a homogeneous and doughy slurry. Thereafter, the slurry is dried by means of a drying system, preferably rotary, so as to leave a residual humidity of 13-16%, ideal for microgranulation of the product (0.4-1.0 mm). After microgranulation (WDG), the product is dried again by means of a fluid bed dryer, so as not to damage the granules.

Advantageously, in order to improve the granule hold, an adhesive of natural origin is added to the slurry, such as calcium lignosulfonate. The formulation comprising the adhesive ensures the hold in the packaging and prevents the formation of powders during the handling by the operator.

Example 8: nutraceutical for plants, microgranular formulation.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>leonardite</td>
<td>11%</td>
</tr>
<tr>
<td>16% magnesium sulfate heptahydrate (MgO)</td>
<td>13%</td>
</tr>
<tr>
<td>35% zinc sulfate</td>
<td>3%</td>
</tr>
<tr>
<td>11% boron ethanolamine</td>
<td>3%</td>
</tr>
<tr>
<td>30% manganese sulfate</td>
<td>1%</td>
</tr>
<tr>
<td>salicylic acid</td>
<td>3%</td>
</tr>
<tr>
<td>potassium carbonate</td>
<td>7%</td>
</tr>
<tr>
<td>neem cake</td>
<td>20%</td>
</tr>
<tr>
<td>glucono delta lactone</td>
<td>4%</td>
</tr>
<tr>
<td>aqueous solution of silver nanoparticles (20 ppm - 200 ppm) as needed to provide the</td>
<td></td>
</tr>
</tbody>
</table>
Production process: the aqueous solution of silver nanoparticles is poured in a mixer and leonardite, glucono delta lactone, zinc sulfate, manganese sulfate, magnesium sulfate, ferrous sulfate, neem cake, guano and salicylic acid are slowly added under stirring. The mixture is homogeneously mixture up to form a homogeneous slurry, thereafter boron ethanolamine, and potassium carbonate are slowly poured under stirring, so as to allow the extraction of the humic substances from leonardite and form a stable and active complex.

Thereafter, the slurry is dried by means of a drying system, preferably rotary, so as to leave a residual humidity of 13-16%, ideal for granulation or, preferably, microgranulation of the product (0.4-1.0 mm). After granulation or microgranulation, the product is dried again by means of a fluid bed dryer, so as not to damage the granules.

Advantageously, an adhesive of natural origin is added to the slurry, such as calcium lignosulfonate or carboxymethylcellulose. The formulation is advantageously used in viticulture and horticulture and organic nursery.

Example 9: nutraceutical for plants characterized by high bio-stimulating action on the underground and off-ground apparatus. The use of spirulina (Arthospira platensis), a cyanobacterium very well known in the field of food supplements, characterized by a high protein content (60-70%) and, therefore, of organic nitrogen (10-11%), allows to obtain a formulation characterized by a marked biostimulant action enhancing the endogenous plant defenses, even in periods when the plant is subjected to strong biotic and abiotic stresses.
A composition is described which is formulated as follows:

47.5% aqueous solution containing active silver nanoparticles (20 ppm-300 ppm)
3% salicylic acid
15% finely ground leonardite or other fossil material
30% finely ground spirulina
4.5% potassium bicarbonate

The preparation of this formulation is carried out as follows:
To a sealed tank provided with high speed (2000-3000 rpm) stirring system, preferably with propellers, with two stirring columns, so as to proceed with stirring downwards and upwards, is added the aqueous solution containing active silver nanoparticles and salicylic acid under stirring and stirring is continued for 10 minutes, then leonardite and spirulina are slowly added together and stirred for about an hour. Finally, potassium bicarbonate is added and stirred for about one hour. In order to obtain a perfect extraction of humic substances, it is suggested to operate at high speeds and in both directions (upwards and downwards). It may be very advantageous to use ultrasounds in the slurry as they greatly improve the extraction and allow to obtain a much more homogeneous and stable colloidal suspension.

After the processing cycle, the product must be filtered to remove all insoluble substances. This can be done either with a vacuum filter or a filter press, with 100-120 mesh filter. Sedimentation filtration is not recommended as it also removes small useful fractions contained in the fossil material. This filtration method successfully applies also to the formulations described in examples 1 and 2.

Example 10: nutraceutical with a high content of urea nitrogen for eco friendly agriculture, for foliar and root application.

Composition:
28% aqueous solution of AgNPs (20 ppm-300 ppm)
3% glucono delta lactone
44% technical urea with low content of biuret with a urea nitrogen content of 46% w/w
10% 10% protein hydrolysate org. no.
15% nutraceutical with a high content of humic acids, acidic pH

Production process:
To a reactor provided with high-speed stirring system, preferably with two propeller stirring columns and running direction switch is poured the aqueous solution of active silver nanoparticles and, with the system under stirring, glucono delta lactone is slowly added followed by technical urea. As soon as the technical urea has completely dissolved, the nutraceutical with a high content of humic acids of example n. 1 and the animal or plant protein hydrolyzate are added. The slurry is kept under stirring for about one hour, after which the product is ready to be packaged or stored in dedicated tanks.

Preparative example 11:
60% potassium bicarbonate
18% oligosaccharide (preferably inulin)
18% glucono delta lactone
20% nutraceutical with a high content of humic and acidic pH, where the dried substance present therein is found in the finished product, equal to 4% by weight of the finished product weight.

Method:
Potassium bicarbonate, glucono delta lactone and the oligosaccharide are poured in a mixer. The whole mass is homogenized and, while the system is under stirring, the nutraceutical with a high content of humic acids at acidic pH is slowly poured so as to form a semi-hard muddy mixture (slurry).
Said slurry is dried in a rotary dryer to maintain a humidity of 12-13% to allow a regular microgranulation (0.4-0.6 mm). Microgranulation is carried out with the aid of natural adhesive
substances, such as calcium lignosulfonate so as to obtain an intact granule during the agricultural operator's manipulation and already before, during the industrial packaging process. Said formulation allows to bring a high content of potassium to the plants and make them more resistant to fungal infections, such as Botrytis, sclerotinia and powdery mildew.

Preparative example 12:

Composition:
- 15% hydrolyzed garlic extract
- 30% karanja extract (Pongamia glabra)
- 10% neem extract (Azadirachta indica)
- 2% Sophora japonica extract
- 20% plant protein hydrolyzate
- 3% oligosaccharide (preferably inulin)
- 20% nutraceutical with a high content of humic acids at acidic pH.

Production process:
All the extracts are gradually poured, one at a time, a zirconium microsphere mill provided with speed variator leaving the system under stirring for at least 20 minutes, for every single raw material. An operating speed of 500 rpm is preferable.
The nutraceutical with a high content of humic acids and the oligosaccharide are added in the end, leaving the entire slurry under stirring for about 60 minutes at a speed of 500 rpm.

Preparative example 12b: nutraceutical for plants containing complexed phosphites, characterized by high performance on plants, for applications on the foliar apparatus and soil fertigation.
A composition is described which is formulated as follows:
- 23.5% aqueous solution containing 20 ppm-300 ppm AGNPs
- 5% salicylic acid
- 23% of 98-99% phosphorous acid
- 29% of 28 Bé ammonium hydroxide
- 4.5% of 50% Cu copper hydroxide
15% nutraceutical with a high content of humic acids and acidic pH.
Preparative process:
To a sealed reactor provided with high speed (2000-3000 rpm) stirring system, preferably with propellers, with two stirring columns, so as to proceed with stirring downwards and upwards, is added the aqueous solution containing AgNPs, salicylic acid and phosphorous acid under stirring and stirring is continued for 30 minutes, then ammonium hydrate is slowly added and stirred for about three hours. Copper hydroxide is added and stirred for about one hour. Finally, the nutraceutical with a high content of humic acids, acidic pH, is slowly added and kept under stirring for 5-6 hours.
After the stirring process, the processed product is allowed to cool and then it is filtered at 120 mesh and packaged or stored in special tanks provided with pre-picking stirring system.
This nutraceutical formulation has proved surprisingly advantageous to bring phosphorus to plants in a particularly bioavailable and fast formula (P$_{03}$), in addition to nitrogen in ammonia form and copper as trace element, especially useful in numerous biochemical activities of plants. Moreover, said nutraceutical preparation is a potent inducer of resistance in plants, particularly effective for the prevention of fungal diseases, particularly those induced by Oomycetes such as Peronospora spp. and Bremia spp. for bacterial diseases. The effectiveness of the nutraceutical preparation is due to the synergistic action of the salicylic acid with the phosphorous acid and the silver nanoparticles, complexed by the humic substances present in the nutraceutical with a high content of humic acids, in which the carboxylic and phenol acids are present, characterized by a strong complexing and carrier action. Said nutraceutical preparation represents an important innovation in the sector of phosphites, since it allows to have a highly
bioavailable and effective preparation and at the same time with a low content of phosphites and phosphorous acid, with respect to the formulations currently available on the international market.

**Example 13:** cultivation protocol of salad, leaf lettuce, arugula, celery and valerian, in protected cultivation.
An application to the soil of a product of example 8 is carried out prior to seeding or transplantation at the dose of 500 kg/hectare.
Immediately after seeding and/or transplantation, an application is carried, by sprinkling or by means of localized fertigation, of the product of example 4, at the dose of 20-30 kg/hectare (the highest dose is applied for the distribution by sprinkling ever the entire surface).
During the cultivation cycle, at intervals of 7 days, foliar application by spraying of the product of example 7, at a dose of 4 kg/hectare, diluted in 1000 liters of water.
Around half of the cultivation cycle, an application of the formulation of example 10 is carried out in localized fertigation or sprinkling.
Healthy plants, high quality of production and a low content of nitrate in the leaves were obtained following this cultivation protocol.

**Example 14:** cultivation protocol of tomato, pepper and eggplant, in protected cultivation.
The formulation of example 8 at the dose of 300 kg/hectare was applied pre-transplantation, localized on the rows. This is a slow-release formulation, which allows to obtain a balanced plant with a strong and expanded root system.
Immediately after transplantation, the formulation of example 1 was distributed in localized fertigation at doses of 25 kg/hectare.
The formulation of example 7, at a dose of 4 kg/hectare, was used 7 days after the transplantation, for the entire cultivation cycle
at intervals of 7 days.
The formulation of example 4 was used in localized fertigation at a dose of 25 kg/hectare 21 days and 45 days post transplantation. Said formulation allows to enhance the endogenous defenses of plants against fungi and bacteria, in addition to having a rhizogenic and nutritional action.
In the growth phase of the berries, 3 applications of the formulation of example 10 were carried out in localized fertigation, at intervals of 12 days, at a dose of 40 kg/hectare. In the phenclogical phase of growth end and beginning of veraison, the formulation of example 11 was used at a dose of 5 kg/hectare for 2 applications, at 14-day intervals.
The protocol can significantly reduce the nitrogen units used and thus the permanence thereof in vegetables and aquifers.
Example 15: cultivation protocol for potatoes
The formulation of example 6 at the dose of 100 kg/hectare was applied upon seeding, localized on the rows.
Since the early vegetative stages and for the entire cultivation cycle, the formulation of example 7 was applied at a dose of 5 kg/hectare by foliar spraying, at intervals of 10 days.
A foliar application was carried out halfway of the cultivation cycle with the formulation of example 4, at a dose of 5 kg/hectare.
The formulation of example 11 at the dose of 5 kg/hectare was applied post-blooming by foliar spraying.
Example 16: Cultivation protocol for bean and string bean
The formulation of example 6 at the dose of 100 kg/hectare was applied upon seeding localized on the rows.
Since the early vegetative stages and for the entire cultivation cycle, the product of example 7 was applied at a dose of 4 kg/hectare by foliar spraying, at intervals of 8 days.
Example 17: Cultivation protocol for Cannabis sativa in organic farming
A treatment with 200-300 kg/hectare of the nutraceutical of example 8 is carried out upon transplantation of the cultivation. After the transplantation, the nutraceutical of example 12 is administered at 10-14 day intervals, with foliar applications, at a dose of 5 kg/hectare, mixed with the nutraceutical of example 12, at a dose of 5 kg/hectare.

The nutraceutical of example 9 is administered at the dose of 5 kg/hectare pre-blooming and post-fruiting by foliar applications.

After post-fruiting, the nutraceutical formulation of example 3 is applied in localized fertigation, at the dose of 25 kg/hectare, admixed with 10 kg/hectare of the nutraceutical of example 11.

The nutraceutical of example 11 is administered in foliar applications in the last 45 days of the cultivation cycle, at a dose of 5 kg/hectare, in three applications at 14-day intervals.

The protocol allows to prevent fungal and bacterial diseases on cannabis, avoid damage by pests and, very importantly, obtain an increase in the content of cannabinoids, especially THC (delta-9-tetrahydrocannabinol) even with peaks up to 35%.

**Example 18:** Cultivation protocol for cucumber, watermelon and melon

The formulation of example 8 at the dose of 150 kg/hectare was applied upon transplantation localized on the rows.

Since the early vegetative stages and for the entire cultivation-cycle, the formulation of example 7 was applied at a dose of 5 kg/hectare by foliar spraying, at intervals of 7 days.

In the fruit growing phase, the formulation of example 10 was used at a dose of 30 kg/hectare for 4 applications, at 10-day intervals.

The formulation of example 4 was used in localized fertigation at a dose of 20 kg/hectare 15 days and 45 days post transplantation. During the cultivation (about halfway of the cultivation cycle), the formulation of example 11 was applied three times at a dose of 5 kg/hectare, at intervals of 12 days.
Example 19: Cultivation protocol for radish
Prior to seeding, the formulation of example 8 was administered by broadcast seeding over the entire surface, at the dose of 200 kg/hectare.
Immediately after seeding, the formulation of example 4 at the dose of 30 kg/hectare was applied over the entire surface by sprinkling.
The formulation of example 7, at a dose of 5 kg/hectare, was used since the early vegetative stages and for the entire cultivation cycle at intervals of 7 days.
One week prior to seeding, the formulation of example 11 was applied on the cultivation by foliar spraying at the dose of 5 kg/hectare.

Example 20: Cultivation protocol for carrot
The formulation of example 8 at the dose of 200 kg/hectare was applied upon seeding, localized on the rows.
Since the early vegetative stages and for the entire cultivation cycle, the formulation of example 7 was applied at a dose of 5 kg/hectare by foliar applications, at weekly intervals.
The formulation of example 10 was used in spraying fertigation at a dose of 35 kg/hectare halfway of the cultivation cycle.
The formulation of example 11 was applied in the last month of the cultivation cycle by foliar spraying at the dose of 5 kg/hectare, with two applications at intervals of 12 days.

Example 21: Cultivation protocol for strawberry
The formulation of example 8 at the dose of 200 kg/hectare was applied upon transplantation, localized on the convexing.
Immediately after transplantation, the formulation of example 1 was administered by localized fertigation at doses of 30 kg/hectare.
The formulation of example 4, at a dose of 20 kg/hectare, was administered every 30 days for the entire cultivation cycle by localized fertigation.
Since the early vegetative stages, the formulation of example 7 was administered at a dose of 5 kg/hectare by foliar spraying, at intervals of 10 days, for the entire vegetative cycle.

In the fruit growing stage, the formulation of example 10 was administered by localized fertigation at a dose of 30 kg/hectare at 12 day intervals.

In the post-growth and pre-veraison phase of the strawberries, 3 applications of the formulation of example 11 were carried out at intervals of 10 days, at a dose of 5 kg/hectare.

**Example 22:** Cultivation protocol for wheat, corn, barley, sunflower seeds, quinoa, soy, rapeseeds, peanuts.

Upon seeding, the formulation of example 6 was administered close to seeds at the dose of 40 kg/hectare.

100 units of nitrogen in urea form were administered as coverage.

During the growth of the culture, 2 foliar treatments with the formulation of example 10, at a dose of 7 kg/hectare and 2 foliar treatments with the formulation of example 4, at a dose of 5 kg/hectare, were carried out.

**Example 23:** Cultivation protocol for beet leaves

The formulation of example 6 at the dose of 40 kg/hectare was administered upon seeding, localized on the rows.

During the vegetation, 3 treatments were carried out with the formulation of example 7, at a dose of 5 kg/hectare, admixed with 2.3 kg of the formulation of example 10.

The formulation of example 11 at the dose of 6 kg/hectare was applied to the cultivation one month prior to harvesting.

**Example 24:** Cultivation protocol for rice

The formulation of example 6 was applied pre-seeding, localized on the rows, at the dose of 200 kg/hectare.

During the cultivation cycle, 3 treatments were carried out by foliar application with the formulation of example 7, at a dose of 4 kg/hectare, admixed with 3 kg of the formulation of example 10.

**Example 25:** Cultivation protocol for tobacco
The formulation of example 3 was applied upon transplantation, localized on the rows, at the dose of 80 kg/hectare. Foliar applications of the formulation of example 7 were carried out since the early vegetative stages at intervals of 10 days. The formulation of example 11 was administered one month prior to harvesting the leaves, at a dose of 5 kg/hectare for 2 applications, at 12-day intervals.

**Example 26:** Cultivation protocol for plum, peach, cherry, apricot and kiwi

Immediately after the fall of the leaves and immediately after pruning, foliar application of 7 kg/hectare of the formulation of example 4, preferably diluted in 1000 litres of water.

One month prior to the vegetative growth, soil application, along the cultivation rows, of the formulation of example 8, 150 kg/hectare.

During the vegetative stage, foliar applications in pre-blooming, post-fruiting and three weeks later, treatment with the formulation of example 7, at a dose of 4 kg/hectare, preferably in 800-1000 liters of water/hectare.

In the growth phase of the fruits, 2 treatments were carried out with the formulation of example 10, at intervals of 12 days, at a dose of 5 kg/hectare.

Since mid-cultivation cycle, with fruit size of about 50%, the formulation of example 11 was administered 3 times, at the dose of 5 kg/hectare.

**Example 27:** Cultivation protocol for apple and pear

Immediately after the fall of the leaves, after pruning and growth of the buds, foliar treatment with the formulation of example 4, at a dose of 8 kg/hectare, preferably in 1000 liters of water/hectare.

One month prior to the vegetative growth, root application, along the cultivation rows, of 150 kg/hectare of the formulation of example 8.
Since the early vegetative stages, excluding the blooming period, foliar treatments at intervals of 7-8 days with the formulation of example 7, at a dose of 5 kg/hectare.

In the fruit growth stage, 2 foliar treatments with the formulation of example 10 at the dose of 5 kg/hectare.

Two foliar treatments with the formulation of example 11 at the dose of 5 kg/hectare were carried out one month prior to harvesting.

Example 28: Cultivation protocol for banana and and plantain.

At the beginning of the vegetative activity, root administration of 1.5 kg/plant of the formulation of example 8.

During the cultivation, foliar treatments with the formulation of example 4, at a dose of 4 kg/hectare, also with aerial means, at intervals of 12-14 days.

Example 29: Cultivation program for papaya, mango, pineapple, coffee and cocoa.

At the beginning of the vegetative activity, root administration of 100-150 kg/hectare of the formulation of example 8.

During the cultivation cycle, excluding the blooming period, foliar applications at intervals of 10-12 days with the formulation of example 4, at a dose of 5 kg/hectare.

Example 30: Cultivation program for pomegranate, blackberry, raspberry, blueberry.

At the beginning of the vegetative activity, root administration along the cultivation rows of 100-150 kg/hectare of the formulation of example 8.

During the cultivation cycle, excluding the blooming period, foliar applications at intervals of 15 days with the formulation of example 7, at a dose of 5 kg/hectare.

In the fruit growing phase, foliar application of the formulation of example 10, at a dose of 6 kg/hectare, with 3 applications at 12-day intervals.

Example 31: Cultivation protocol for grapevine.
Upon the fall of the leaves, after pruning and swelling buds, foliar treatment with the formulation of example 7, at a dose of 6 kg/hectare.

One month prior to the vegetative growth, soil administration, along the cultivation rows, of the formulation of example 8, at a dose of 100 kg/hectare.

During the vegetative period, foliar applications at intervals of 7-8 days with the formulation of example 7, at a dose of 4-5 kg/hectare.

In the pre-veraison stage, 2 treatments were carried out with the formulation of example 11 at the dose of 5 kg/hectare, at 12-day intervals.

**Example 32:** Cultivation protocol of tea.

Localized soil application, along the cultivation rows, of the formulation of example 8, 200 kg/hectare.

Foliar applications, at 10 day intervals, with the formulation of example 10, at a dose of 6 kg/hectare, alternated with the application of the formulation containing spirulina of example 9 at a dose of 4 kg/hectare.

Monthly applications of the formulation of example 7, at a dose of 5 kg/hectare.
CLAIMS

1. A method for preparing a nutraceutical composition for plants, comprising:
   a) providing a fossil material, an aqueous solution comprising silver nanoparticles (AgNPs) and salicylic acid;
   b) introducing said fossil material, aqueous solution comprising AgNPs and salicylic acid into a reactor, stirring until a slurry is obtained;
   c) extracting the humic substances from said slurry by alkaline extraction.

2. A method according to claim 1, wherein in said step b) the aqueous solution is introduced into the reactor and said fossil material is slowly added thereto, under stirring, and when the slurry is formed, said salicylic acid is added.

3. A method according to claim 1 or 2, wherein said stirring is obtained in a reactor comprising two independent propeller stirring columns.

4. A method according to one of claims 1 to 3, wherein said stirring is high speed, between 2000 - 3000 rpm, upwards and downwards.

5. A method according to one of claims 1 to 4, wherein in said step b), the stirring is maintained for 2-3 hours to obtain said slurry.

6. A method according to one of claims 1 to 5, wherein in said step c), said extraction takes place by slowly adding an alkaline agent to the slurry under stirring and the slurry is kept under stirring for at least 1 hour, preferably for about 5-6 hours.

7. A method according to one of claims 1 to 6, wherein said fossil material is characterized by at least 80% (w/w) of total organic substance, at least 80% (w/w) of extractable organic substance and at least 80% (w/w) of humified organic substance.
substance, preferably at least 90% (w/w) of total organic substance, at least 90% (w/w) of extractable organic substance and at least 90% (w/w) of humified organic substance.

8. A method according to one of claims 1 to 7, wherein said fossil material is selected from the group comprising: leonardite, lignite, peat coaleat, xylite, peat or mixtures thereof.

9. A method according to claim 8, wherein said fossil material is leonardite.

10. A method according to one of the preceding claims, wherein in said step c) the slurry is exposed to high power ultrasound, preferably at about 80 kHz.

11. A method according to one of the preceding claims, wherein said fossil material is finely ground, characterized by a grain size from 100 to 200 mesh, preferably from 120 to 150 mesh.

12. A method according to one of the preceding claims, wherein in said step b), said fossil material and said aqueous solution are mixed in a ratio from about 1:0.1 to about 1:10.

13. A method according to one of the preceding claims, wherein in said step b), said fossil material and said aqueous solution are mixed in a ratio from about 1:0.2 to about 1:8.

14. A method according to one of the preceding claims, wherein in said step b), said fossil material and said aqueous solution are mixed in a ratio from about 1:0.3 to about 1:6.

15. A method according to one of the preceding claims, wherein said salicylic acid is added in an amount from 1% to 10%, preferably from 3 to 7% w/w of said slurry.

16. A method according to one of the preceding claims, wherein
said salicylic acid is added in an amount of about 5% or of about 3% w/w of said slurry.

17. A method according to one of the preceding claims, wherein said alkaline extraction is carried out using an alkaline agent selected from the group comprising potassium hydroxide, potassium carbonate, potassium bicarbonate, ammonium hydroxide or a mixture thereof.

18. A method according to one of the preceding claims, wherein said alkaline extraction is carried out by adding an alkaline agent to the slurry in a % from 3 to 7% w/w of said slurry.

19. A method according to one of the preceding claims, wherein said nutraceutical composition is in liquid form and said method comprises, after said step c), filtering the resulting slurry at 100-120 mesh.

20. A method according to one of claims 1 to 18, wherein said nutraceutical composition is in solid form and said method also comprises, after said step c), drying the resulting slurry.

21. A method according to claim 20, wherein said nutraceutical composition is in granular or microgranular form and said drying is obtained in at least two steps: a first step with a rotary dryer which leaves a residual humidity of 13%-16% in the slurry, preferably of 15% and a second step on fluid bed, wherein said second step is carried out after the microgranulation or granulation of the product obtained in said first step.

22. A method according to claim 21, wherein said granulation or microgranulation is obtained with a disc granulator.

23. A method according to one of claims 1 to 22, wherein the final nutraceutical composition has a pH from 5.5 to 6.

24. A method according to one of claims 1 to 22, wherein the final nutraceutical composition has a pH from 9.5 to 12.

25. A method according to one of the preceding claims, which
further comprises the addition of one or more substances able
to release macroelements, microelements and/or meso-elements.

26. A method according to one of the preceding claims, which
further comprises the addition of animal and plant protein
hydrolysates.

27. A method according to one of the preceding claims, which
further comprises the addition of insect repellents,
fungicides, fungistatic agents, bactericidal agents,
bacteriostatic agents, nematode repellents, plant growth
regulators, complex fertilizers, adsorbents, seaweed
extracts, plant extracts.

28. A method according to claim 27, wherein said plant
growth regulators are selected from cytokines, auxins,
gibberellins.

29. A method according to one of the preceding claims, which
further comprises the addition of residues from oil
extraction processes.

30. A method according to claim 29, wherein said oils are
selected from the group comprising neem oil (Azadirachta
indica), karanja (Pongamia glabra), castor oil (Ricinus
communis) and Jatropha oil (Jatropha curcas).

31. A process according to claim 27, wherein said adsorbents
are of natural origin and comprise starches and derivatives
thereof.

32. A process according to claim 27, wherein said adsorbents
are synthetic and comprise potassium polyacrylates.

33. A process according to claim 27, wherein said adsorbents
are added in amounts from 5 to 20% w/w.

34. A process according to one of claims 1 to 33, wherein
said method comprises a granulation or microgranulation step
and a glue, preferably of natural origin, is added to said
slurry.

35. A nutraceutical composition for plants obtained
36. A composition according to claim 35, which is in solid form, preferably granular or microgranular, or liquid.

37. A composition according to claim 35 or 36, which has a particle size from 0.4 to 1.00 mm.

38. A composition according to one of claims 34 to 36, wherein in said steps a) to c), the following % by weight are used:
- 72.5% aqueous solution containing 20 ppm-300 ppm AgNPs;
- 5% salicylic acid;
- 20% finely ground leonardite or other fossil material;
- 2.5% potassium hydroxide in 99.8% flakes as alkaline agent.

39. A composition according to one of claims 35 to 37, wherein in said steps a) to c), the following % by weight are used:
- 70.00% aqueous solution containing 20 ppm-300 ppm AgNPs;
- 5% salicylic acid;
- 20% finely ground leonardite or other fossil material;
- 5% potassium hydroxide in 99.8% flakes.

40. A composition according to one of claims 35 to 39, wherein said composition is mixed in the ratio of 1:1 with an animal or plant protein hydrolysate containing 10% (w/w) of 50% organic nitrogen.

41. A composition according to one of claims 35 to 40, which has an alkaline pH and further comprises 14% ammonia nitrogen, 1% copper, 4% zinc, and 2% manganese w/w in the finished product.

42. A composition according to claim 41, which is in liquid form.

43. A composition according to one of claims 35 to 39, comprising the aqueous solution containing AgNPs in the amounts needed to form said slurry, 20% leonardite, 14% ground garlic flour, 15% lithotharttnium, 27% neem cake, 3%
zinc sulfate, 13% castor cake, 3% salicylic acid, 5% potassium carbonate w/w in the finished product.

44. A composition according to one of claims 35 to 39, comprising 40% leonardite%, 38% monoamionium phosphate 12-54, 3% zinc sulfate, 3% boron ethanolamine, 2% manganese sulfate, 3% salicylic acid, 5% potassium hydroxide in flakes, 6% technical urea and the aqueous solution containing AgNPs, in the amounts needed to form said slurry.

45. A composition according to one of claims 35 to 39, comprising, in addition to said aqueous solution comprising AgNPs, 14.5% zinc sulfate, 17% manganese sulfate, 14.5% copper hydroxide, 30% glucono delta lactone, 20% oligosaccharides.

46. A composition according to one of claims 35 to 39, comprising, in addition to said aqueous solution comprising AgNPs, 11% leonardite, 13% magnesium sulfate, 3% zinc sulfate, 3% boron ethanolamine, 1% manganese sulfate, 3% salicylic acid, 7% potassium carbonate, 20% neem cake, 4% glucono delta lactone.

47. A composition according to one of claims 35 to 39, which in said steps a) to c), comprises the use of the following components:

47.5% aqueous solution comprising 20 ppm-300 ppm AgNPs; 3% salicylic acid; 15% finely ground leonardite or other fossil material; 30% finely ground spirulina; 4.5% potassium bicarbonate.

48. A composition according to one of claims 35 to 39, which in said steps a) to c), comprises the use of the following components:

28% aqueous solution comprising AgNPs (20 ppm-300 ppm); 3% glucono delta lactone 44% 46% technical urea low in biuret content.
10% protein hydrolysate org. no.
15% nutraceutical with a high content of humic acids, acidic pH

49. A composition according to one of claims 35 to 39, comprising: 60% potassium bicarbonate, 18% oligosaccharide, preferably inulin, 18% glucono delta lactone 20% nutraceutical with a high content of humic and acidic pH, wherein the dried substance present therein is found in the finished product, equal to 4% by weight of the finished product weight.

50. A composition according to one of claims 35 to 39, comprising (% w/w): 15% hydrolyzed garlic extract, 30% karanja extract (Pongamia glabra), 10% neem extract (Azadirachta indica), 2% Sophora japonica extract, 20% plant protein hydrolyzate, 3% oligosaccharides, preferably inulin, 20% nutraceutical with a high content of humic acids at acidic pH.

51. A composition according to one of claims 35 to 39, which includes steps a) to c), comprises the use of the following components:
23.5% aqueous solution containing 20 ppm-300 ppm AgNPs, 5% salicylic acid 23% of 98-99% phosphorous acid 29% of 28 Bé ammonium hydroxide 4.5% of 50% Cu copper hydroxide 15% nutraceutical with a high content of humic acids and acidic pH.

52. A method for preparing a nutraceutical fertilizing composition comprising the step of combining the nutraceutical composition according to one of claims 35 to 51 with one or more fertilizing, pesticide, fungicide composition or which comprises other active components used in agriculture.
A method for increasing crop productivity which comprises the step of using the nutraceutical compositions according to one of claims 35 to 51.

A method according to claim 53, wherein said nutraceutical composition provides the combination of the following components (% w/w):

- 72.5% aqueous solution containing 20 ppm-300 ppm AgNPs;
- 5% salicylic acid;
- 20% finely ground leonardite or other fossil material;
- 2.5% potassium hydroxide in 99.8% flakes

or

- 70.00% aqueous solution containing 20 ppm-300 ppm AgNPs
- 5% salicylic acid
- 20% finely ground leonardite or other fossil material
- 5% potassium hydroxide in 99.8% flakes.

A method according to one of claims 52 or 54, wherein said compositions are used for treating crops at one or more of the following steps: before transplantation, after transplantation, after thinning, before the ripening of the fruit, during the entire lifecycle of the plant.

A method according to one of claims 52 to 54, wherein said crops are selected from the group comprising: crops for feeding, crops for industrial production, crops for the production of biofuel, ornamental plants, fruit trees.

A method according to one of claims 52 to 54, wherein said crops are selected from the group comprising: salad, leaf lettuce, arugula, celery, valerian, tomato, pepper, eggplant, potato, green bean, bean, cucumber, radish, pumpkin, carrot, strawberry, watermelon, melon, wheat, barley, quinoa, corn, soy, canola, sunflower, beet leaves, rice, peanuts, tobacco, plums, kiwi, apple, pear, banana, cherry, peach, apricot, papaya, mango, pineapple, pomegranate, berries, grape vine, citrus fruits, tea, coffee, cocoa.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. C05F11/02 C05G3/02

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)

C05F C05G

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

* Special categories of cited documents:

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Date of the actual completion of the international search: 13 October 2017

Date of mailing of the international search report: 23/10/2017

Name and mailing address of the ISA:
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040; Fax: (+31-70) 340-3016

Authorized officer: Schut, Robert

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