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A literary review on the hydroponic method of growing some medicinal plants

An important component in the daily preparation of nutritious food, as well as in the preservation of products, is spicy-aromatic plants. Essential oils and other physiologically active substances included in their composition excite the activity of the gustatory and digestive organs, cause appetite, enhance digestibility, favorably affect metabolism, the activity of the nervous and cardiovascular systems, and the general condition of a person. In order to obtain renewable raw materials that preserve the group chemical composition and biological activity, this review examines a promising direction of a biotechnological method for obtaining a product — hydroponics. Some advantages of using this method in the cultivation of medicinal plants have been identified. In most hydroponic systems, there is constant access to the roots, which allows you to solve possible problems with pathogens. It was found that if the health of the plant is strengthened, then productivity and yield will increase. And in the field of nutrition, many analyzes have been carried out, which consistently demonstrate a large, often twofold increase in the amount of vitamins and mineral salts. This also applies to the active substances in medicinal plants. The directions of further study are also clearly defined.

Keywords: medicinal plants, essential oils, biological active compounds, medicinal properties, hydroponics, substrate.

Introduction

Currently, there is a steady trend of increasing interest in drug and spicy-aromatic plants and their active substances. And this is not surprising. After all, man is an integral part of nature, and his life is inextricably linked with the plant world, as a result of which natural compounds have become vital factors for all metabolic processes for the human body [1].

The plant world is an inexhaustible storehouse of natural drug raw materials. For thousands of years, since ancient times, plants have been the only remedies. And today medicinal plants and preparations from them serve as an indispensable raw material for the production of a number of medicines. Every third medicinal product is prepared from drug plant raw materials. In addition, much attention is paid to local plant resources [1]. Essential oil plants play an important role in this regard, many of which have an extensive range and form a significant phyto-mass, which determines the prospects for their practical use.

The flora of Kazakhstan has got some huge opportunities as a source of promising medicinal forms. The active research going on over the world in the field of chemistry of natural compounds is continually increasing the number of pharmaceutical species. In the past years in Kazakhstan, new effective medical preparations from Kazakhstani species *Aconitum* L., *Delphinium* L., *Thalictrum* L., *Leonurus* L., *Peganum* L. and others have been obtained [2].

As a result of the screening has been made an annotated list of drug plants of Kazakhstan which including 1406 species related to 134 families of high flowering plants that makes up a one-fourth all the species of flora in Kazakhstan [3, 4].

The greatest number of medicinal plants species include the family *Asteraceae* (196 species), *Rosaceae* (89), *Lamiaceae* (78), *Fabaceae* (78), *Ranunculaceae* (75), *Apiaceae* (69) and *Brassicaceae* (63). Four more families represented by 45–30 species (*Polygonaceae* (44), *Caryophyllaceae* (41), *Poaceae* (35), *Boraginaceae* (30); 15 families contain about 10–21 species; 47 families contain from 9 to 3 species (*Berberidaceae*, *Iridaceae*, *Papaveraceae*, *Solanaceae*, and etc.); 22 families are presented by 2 species (*Equisetaceae, Linaceae, Nitrariaceae, Verbenaceae,* and etc.); by one species represented 35 or 26 % (*Aceraceae*, *Capparaceae*, *Datiscaceae*, *Juglandaceae*, *Polypodiaceae*, and etc.). The average number of specie per family is 10.6. The largest genera are *Artemisia* L. (40 species), *Potentilla* L. (24), *Euphorbia* L. (18). Genera *Ferula* L., *Polygonum* L., *Rumex* L. accounts for the equal number of species (by 15). *Astragalus* L. (14) and *Ranunculus* L. are quite essential [5].

Experimental

The objects of research are some drug plants grown by the hydroponics method.

Plants can be grown in two ways: either when the bare roots grow in a nutrient solution, or in a non-soil inert substrate. In some languages, the term "hydroponics" refers to the cultivation of plants in water. And the term "groundless" refers to cultures on a substrate.

Webster's explanatory dictionary gives the following, surprisingly succinct definition of the term "hydroponics": "a method of growing a plant without soil in water containing dissolved nutrients". If the rules are followed, the taste and nutritional qualities of fruits, vegetables and herbs grown on hydroponics exceed the properties of the same products grown in the ground, and with less impact on the environment [6].

The use of hydroponics is especially beneficial when the main product obtained from the plant is the root. In most medicinal plants, the active principles are (or are also) in the roots. In some cases, the active principles in the roots differ from those contained in the aboveground part of the plant.

They cannot be extracted without destroying the plant itself. As a result, many wild medicinal plants are subjected to predatory harvesting, sometimes up to their extermination.

In closed hydroponic systems, the roots are exposed and washed by a flow of nutrients. In such a situation, you can almost constantly collect a large number of roots without destroying the plant. Obviously, at the same time it is necessary to cut the aboveground part to keep the plant in good balance. In some cases, this green biomass itself is an additional source of extraction, in other cases it simply goes into compost. Collecting roots by this method maintains their purity and does not require washing or other treatment before extraction. They are also very rich in active principles.

Their concentration can be increased by adapting the nutrition of the plant to the type of molecule that we want to get. Next, we can increase the growth of the roots ourselves by adjusting the level of dissolved oxygen in the nutrient solution [6, 7].

Literature review

Hydroponics received practical application long before the formation of a theoretical knowledge base about this method. The tribes of South America and Mexico already in 1100 used rafts made of reeds, on which dirt from volcanic rock was laid, and plants were planted. These rafts were floated to the nearest lakes, the water in which was of the required temperature. Minerals from the mud gradually passed into solution and became available for plant nutrition. Similar structures have been found in other parts of the world. In 1275, Marco Polo met floating gardens in China. Exact information about the discoverers of this technology is not known, but today these are the oldest hydroponic structures known to history.

William F. Gerick is considered to be the founder of modern hydroponics. He coined the term "hydroponics" and proved the possibility of growing different types of plants in containers with nutrient solution. During the Second World War, his technology was used to create the first industrial embodiment of hydroponics. During the Pacific campaign, the US Army encountered difficulties in cultivating food on local rocky and salt-saturated soils. Transporting food to remote corners was a very expensive and impractical idea, and Japanese aviation, which periodically attacked transport convoys, also presented difficulties. Therefore, hydroponic plantations were urgently created on Wake Island, which brought 20 kg of tomatoes, 10 kg of beans, 20 kg of corn cobs and 20 kg of green salad every week. The experience turned out to be successful, so the same plantations were created at the Habbaniya air base in Iraq and in oil-rich, but not food-rich Bahrain [7].

For quite a long time, ideas about plant nutrition were formed on the erroneous judgments of Aristotle. In his writings, he argued that plants feed on organic substances and only ensure the redistribution of organic matter. It was only in the XVII century that Johann Baptist van Helmond conducted an experiment that questioned Aristotle's ideas. In the XVIII century, Joseph Priestley and Jan Ingenhaus discovered to the world the phenomenon of plant respiration and the assimilation of carbon dioxide. The final refutation of this theory in 1840 was presented in his book by the German agro-chemist Justus von Liebig. He wrote the following: "Plant organisms, or, consequently, organic compounds are a means of nutrition and maintenance of human and animal life. The source of plant nutrition, on the contrary, is exclusively inorganic nature".

The most striking example of the use of hydroponics is the food industry of the Netherlands. The Netherlands is the largest supplier of food in the world, which is slightly inferior in terms of production only to the United States. However, the area of Holland is 42,508 square kilometers, and the area of the United States is 231 times larger.

Hydroponics is highly efficient agriculture. More than half of the country territory is used for agriculture. The Netherlands is the world leader in the production of fruits, potatoes, onions and the second in the export of vegetables. Most of the seeds produced in the world are also obtained in the Netherlands.

The following advantages of using this method for growing plants have been identified:

– regulation of recharge;

Only those elements that will be introduced into the water fall into the root zone, moreover, in the proportions we have set. At any given time, it is possible to control the quality and quantity of nutrients dissolved in water.

– saving water;

Compared to plants growing in the soil, the water savings are very impressive. Recent improvements in attitude — the transition from watering the entire field to delivering water to the base of plants — have significantly increased the efficiency of water consumption in gardening. However, hydroponics is still much more effective in this regard.

– saving nutrients;

Similarly, plants completely absorb all the consumed nutrients. Nothing goes into the ground, groundwater is not polluted, and there is no impact on microbial life in the soil. Thanks to improved health and accelerated growth, there is less need for pesticides.

– no need for herbicides;

There is nowhere for weeds to grow in plastic trays or gutters. Both circumstances: and that there is no need for herbicides and that pests can be destroyed in less radical ways — makes hydroponics a very clean technology.

– a plant originally grown by hydroponic methods is viable;

If you grow a mother plant on hydroponics for the purpose of further cloning and then transplant the sprouts into the soil, they will be more viable than if they originated from a mother plant in the soil.

– the size increases, the quality increases;

It was revealed that if you strengthen the health of the plant, then productivity and yield will increase. And in the field of nutrition, many analyzes have been carried out, which consistently demonstrate a large, often double increase in the amount of vitamins and mineral salts. This also applies to active principles in medicinal plants.

– stable access to the roots;

It is very useful to constantly check the condition of the roots. In most hydroponic systems, such access is available, which makes it possible to solve possible problems with pathogens; with intervention at an early stage, they are easily cured. The roots will also tell you a lot about the health of the plant and how it will develop in the future.

– space is used more efficiently;

Root felt does not need to spread as in the ground. Plants can receive all the required nutrition in a limited area without entering into a competitive struggle with each other. As a result, plants can stand closer to each other than in the ground. So you can get a “sea of greenery”. With this method, an incredible plant density is achieved — up to 60–70 plants per square meter [8].

In the light of the above about the limited space for the root zone, the choice of substrate becomes extremely important! It is also vital to adapt the irrigation schedule to the substrate schedule. In order for a substance to serve as a good substrate, it must meet certain requirements: it should not contain excess sodium chloride — ordinary table salt. This is a constant problem with the substrate on coconut fiber. It should also contain no elements potentially harmful to plants, and certainly no elements toxic to humans, such as heavy metals.

A good substrate should have a durable structure and not hold mineral elements too much. Scientists study in detail many parameters that are distinctive features of substrates. These are, among other things, physical, chemical and biological parameters, for example, bulk density, porosity, particle size, as well as exchangeable ions, pH, phyto toxicity. The most important thing for us is the moisture-holding capacity and moisture capacity. These are two different properties, and they should not be confused. Moisture capacity is the amount of water that a given volume of substrate is able to absorb.

Water retention is the force that holds water in the substrate. It is determined by measuring the reverse force — the suction force that the roots must exert to absorb water; it is usually expressed in kilo Pascals. In a good substrate, moisture retention should not be very strong. If the force holding water in the substrate is greater than the roots can provide, then the plant will wither. On the other hand, if the moisture retention is weak, the substrate dries out too quickly. One of the main keys to success in hydroponics is the harmonization of the irrigation cycle with the moisture capacity and moisture retention of the substrate [9]. The idea is to provide a moist environment for plants, but one that will be frequently irrigated to create an influx of air and water into the root zone.

Another important property of the substrate is its maximum neutrality. It should not affect either the pH or the electrical conductivity.

The surface of the particles of some substrates has an electric charge that captures certain dissolved ions, thereby modifying the nutrient solution. It is necessary to fill this gap with a mixture of a nutrient adapted for this substrate. Not all elements are equally susceptible to such capture. For example, nitrate (NO_3^-), the main source of nitrogen in hydroponics, has high solubility and low attractiveness for positively charged particles, so it is always available to plants. Conversely, another common source of nitrogen, ammonia (NH_4^+), has a high attraction for negatively charged particles, which affects its availability.

This is just one example of the complex interactions between nutrient solution and substrate. It is much worse when the elements reacting with each other and forming salts float in the same solution. In particular, calcium (Ca^{2+}) and magnesium (Mg^{2+}) can react with phosphorus or sulfur to form phosphates or sulfates. Over time, deposits of dead organic matter and dry salts disrupt the uniformity of many substrates, creating sinuses in the environment that are unfavorable for the roots.

The substrate becomes less and less homogeneous and reacts more and more with the nutrient solution through deposits of decomposing organic matter. The characteristics of the substrate will affect the bacterial life that will develop on it, and how to deal with decomposing organic matter. There are two types of substrates — inorganic and organic [10].

Based on these studies, we assume that the active substance of a medicinal plant grown by the hydroponics method, provided that the required parameters are met, will be more promising in practical use.

Conclusions

The above studies indicate the need for a more detailed study of the properties of some medicinal plants and to develop a scheme for a suitable hydroponic installation. In this regard, analyzing previous studies, it is possible to study the component composition of essential oils of medicinal plants grown on a hydroponic plant.

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Кейбір дәрілік өсімдіктерді өсірудің гидропоникалық әдісіне әдеби шолу

Күнделікті коректік тағамдарды дайындаудағы, сондай-ақ өнімдерді сақтаудағы маңызды компонент — хош иісті өсімдіктер. Эфир майлары және олардың құрамына кіретін басқа физиологиялық белсенді заттар дәм мен ас қорыту органдарының қызметін қоздырады, тәбетті тудырады, сіңімділігін арттырады, метаболизмге, жүйке және жүрек-тамыр жүйелерінің қызметіне, адамның жалпы жағдайына жағымды әсер етеді.Топтық химиялық құрамы мен биологиялық белсенділігін сақтайтын жаңартылатын шикізатты алу мақсатында осы шолуда өнімді алудың биотехнологиялық тәсілінің перспективалы бағыты — гидропоника қарастырылған. Дәрілік өсімдіктерді өсіру кезінде осы әдісті қолданудың кейбір артықшылықтары анықталды. Гидропоникалық жүйелердің көпшілігінде тамырлар үнемі қол жетімді, бұл патогендермен байланысты мәселелерді шешуге мүмкіндік береді. Егер өсімдіктің денсаулығын нығайтсақ, онда өнімділік артады. Тамақтану саласында көптеген сынақтар жүргізілді, олар үнемі дәрумендер мен минералды тұздар санының екі есе артуын көрсетеді. Бұл дәрілік өсімдіктердегі белсенді заттарға да қатысты. Одан әрі зерттеу бағыттары да нақты анықталған.

Кілт сөздер: дәрілік өсімдіктер, эфир майлары, биологиялық белсенді қосылыстар, емдік қасиеттері, гидропоника, субстрат.

А.Ж. Алимжанова, С.У. Тлеукенова, Г.И. Куликова, Н.С. Зиннер

Литературный обзор на гидропонный метод выращивания некоторых лекарственных растений

Важным компонентом в ежедневном приготовлении питательной пищи, а также в консервировании продуктов являются пряно-ароматические растения. Эфирные масла и другие физиологически активные вещества, входящие в их состав, возбуждают деятельность органов вкуса и пищеварения, вызывают аппетит, повышают усвояемость, благоприятно влияют на обмен веществ, деятельность нервной и сердечно-сосудистой систем, общее состояние человека. С целью получения возобновляемого сырья, сохраняющего групповой химический состав и биологическую активность, в данном обзоре рассмотрено перспективное направление биотехнологического способа получения продукта — гидропоника. Были выявлены некоторые преимущества использования этого метода при выращивании лекарственных растений. В большинстве гидропонных систем имеется постоянный доступ к корням, что позволяет решить возможные проблемы с патогенами. Было установлено, что если укрепить здоровье растения, то увеличатся продуктивность и урожайность. А в области питания было проведено множество анализов, которые последовательно демонстрируют большое, часто двукратное увеличение количества витаминов и минеральных солей. Это также относится к активным веществам в лекарственных растениях. Также четко определены направления дальнейшего изучения.

Ключевые слова: лекарственные растения, эфирные масла, биологически активные соединения, лечебные свойства, гидропоника, субстрат.

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