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АДАМ АНАТОМИЯСЫ ЖӘНЕ ФИЗИОЛОГИЯСЫ

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--	---	---

БИОТЕХНОЛОГИЯ

К.М. Аубакирова М.С. Култаева Т.Ж. Сатқанов З.А. Аликулов	<i>Экологиялық таза аквакультура өнімдерін ұтымды пайдалану</i>	15
--	---	----

ЗООЛОГИЯ

Ж.Р. Кабдолов К.М. Турсунханов Б.С. Аубакиров О.И. Кириченко А.М. Касымханов И.В. Притыкин А.С. Нукенов	<i>Ертіс өзені бекіре популяциясының күйі мен оны көбейту мақсатында табиғи ортадан оңтайлы алу жөніндегі ұсынымдар</i>	22
---	---	----

Д.Г. Белый В.Г. Мека-Меченко К.К. Ниязалиев К.Т. Нурбаев В.П. Садовская З.З. Саякова	<i>Мойынқұм шөлді оба ошағындағы кеміргіштер фаунасының қазіргі жағдайы</i>	30
---	---	----

ПАРАЗИТОЛОГИЯ

А.Э. Кучубоев Б.Б. Соатов	<i>Зарафиан өзенінің төменгі ағысындағы балықтардың гельминттері</i>	42
------------------------------	--	----

БИОЛОГИЯЛЫҚ БІЛІМ

Ж.А. Шамшатова Б.А. Байдалинова Б.Ж. Баймурзина Б.С. Кенжебаева Т.Е. Жақыпова	<i>Инновациялық технологияларды биология сабағында қолдануды зерттеу</i>	52
---	--	----

Э.О. Кожаметова А.А. Чармухаметова	<i>Креативтілікке арналған тапсырмаларды қолдану арқылы оқушылардың синтез дағдыларын дамыту жолдары</i>	58
---------------------------------------	--	----

Е.Е. Кирик В.Н. Алиясова Т.А. Граф	<i>«Қазіргі заманғы мектеп өміріндегі жаратылыстану мұражайы» авторлық бағдарламасы жаратылыстану музейлерінің мәдениетті және педагогикалық әлеуетін іске асыру тәсілі ретінде</i>	66
--	---	----

Т.Ж. Шакенова Ш.Ш. Хамзина	<i>Жаратылыстану-ғылыми бағыттағы пәндерді оқыту процесіндегі оқушылардың функционалдық сауаттылығы</i>	73
-------------------------------	---	----

АВТОРЛАР ТУРАЛЫ МӘЛІМЕТТЕР		80
----------------------------	--	----

МАҚАЛАНЫ РӘСІМДЕУ БОЙЫНША «ҚАЗАҚСТАННЫҢ БИОЛОГИЯЛЫҚ ҒЫЛЫМДАРЫ» ЖУРНАЛЫНЫҢ АВТОРЛАРЫНА АРНАЛҒАН НҰСҚАУЛЫҚ		88
--	--	----

СОДЕРЖАНИЕ

АНАТОМИЯ И

ФИЗИОЛОГИЯ ЧЕЛОВЕКА

А.Ш. Кыдырмолдина Б.А. Жетписбаев А.М. Утегенова Э.К. Омарханова М.М. Малик С.С. Тыржанова Л.А. Оберкулова	<i>Изменение иммунологической резистентности и биохимических процессов в лимфоцитах периферической крови при действии стресса</i>	8
--	---	---

БИОТЕХНОЛОГИЯ

К.М. Аубакирова М.С. Култаева Т.Ж. Сатканов З.А. Аликулов	<i>Рациональное использование экологически чистых продуктов аквакультуры</i>	15
--	--	----

ЗООЛОГИЯ

Ж.Р. Кабдолов К.М. Турсунханов Б.С. Аубакиров О.И. Кириченко А.М. Касымханов И.В. Притыкин А.С. Нукенов	<i>Рекомендации по оптимальному извлечению из природной среды осетровой популяции реки Иртыш с целью ее воспроизводства</i>	22
---	---	----

Д.Г. Белый В.Г. Мека-Меченко К.К. Ниязалиев К.Т. Нурбаев В.П. Садовская З.З. Саякова	<i>Современное состояние фауны грызунов в Мойынкумском пустынном очаге чумы</i>	30
---	---	----

ПАРАЗИТОЛОГИЯ

А.Э. Кучбоев Б.Б. Соатов	<i>Гельминты рыб водоемов низовьев реки Зарафшан</i>	42
-----------------------------	--	----

БИОЛОГИЧЕСКОЕ ОБРАЗОВАНИЕ

Ж.А. Шамшатова Б.А. Байдалинова Б.Ж. Баймурзина Б.С. Кенжебаева Т.Е. Жақыпова	<i>Изучение применения инновационных технологий на уроках биологии</i>	52
---	--	----

Э.О. Кожахметова А.А. Чармухаметова	<i>Пути развития у учащихся навыков синтеза с использованием заданий на креативность</i>	58
--	--	----

Е.Е. Кирик В.Н. Алиясова Т.А. Граф	<i>Авторская программа «Естественно-научный музей в жизни современной школы» как способ реализации культуро-созидающего и педагогического потенциала естественно-научных музеев</i>	66
--	---	----

Т.Ж. Шакенова Ш.Ш. Хамзина	<i>Функциональная грамотность учащихся в процессе преподавания предметов естественно-научного направления</i>	73
-------------------------------	---	----

СВЕДЕНИЯ ОБ АВТОРАХ		83
---------------------	--	----

РУКОВОДСТВО ДЛЯ АВТОРОВ ЖУРНАЛА «БИОЛОГИЧЕСКИЕ НАУКИ КАЗАХСТАНА» ПО ОФОРМЛЕНИЮ СТАТЬИ		94
---	--	----

CONTENT

HUMAN ANATOMY AND PHYSIOLOGY

A.Sh. Kydyrmoldina B.A. Zhetpisbayev A.M. Utegenova E.K. Omarkhanova M.M. Malik S.S. Tyrzhanova L.A. Oberkulova	<i>Change of immunological resistance and biochemical processes in peripheral blood lymphocytes in action stress</i>	8
--	--	---

BIOTECHNOLOGY

K.M. Aubakirova M.S. Kulataeva M.Zh. Satkanov Z.A. Alikulov	<i>Rational use environmentally friendly products of aquaculture</i>	15
--	--	----

ZOOLOGY

Zh.R. Kabdolov K.M. Tursunkhanov B.S. Aubakirov O.I. Kirichenko A.M. Kasymkhanov I.V. Pritykin A.S. Nukenov	<i>Recommendations on the state of the sturgeon population of the Irtysh river and its optimal extraction from the natural environment for reproduction</i>	22
--	---	----

D.G. Belyy V.G. Meka-Mechenko K.K. Niyazaliyev K.T. Nurbayev V.P. Sadovskaya Z.Z. Sayakova	<i>The current state of the rodental fauna in the Moyinkumdesert plague focus</i>	30
---	---	----

PARASITOLOGY

A.E. Kuchboev B.B. Soatov	<i>Fish helminths in reservoirs of the Zarafshan river</i>	42
--	--	----

BIOLOGICAL EDUCATION

Zh.A. Shamshatova B.A. Baidalinova B.Zh. Baymurzina B.S. Kenzhebaeva T.E. Zhakypova	<i>Studying the use of innovative technologies in biology lessons</i>	52
--	---	----

E.O. Kozhakhmetova A.A. Charmukhametova	<i>Ways to develop students' synthesis skills using creative tasks</i>	58
--	--	----

E.E. Kirik V.N. Aliyasova T.A. Graf	<i>The author's program «Natural Science Museum in the Life of a Modern School» as a way of realizing the culture-creating and pedagogical potential of natural science museums</i>	66
--	---	----

T.Zh. Shakenova Sh.Sh. Khamzina	<i>Functional literacy of students in the process of teaching natural science subjects</i>	73
--	--	----

INFORMATION ABOUT AUTHORS		86
----------------------------------	--	----

GUIDELINES FOR AUTHORS OF THE JOURNAL «BIOLOGICAL SCIENCES OF KAZAKHSTAN» FOR MANUSCRIPT PREPARATION		100
---	--	-----

RATIONAL USE ENVIRONMENTALLY FRIENDLY PRODUCTS OF AQUACULTURE

K.M. Aubakirova, M.S. Kulataeva, M.Zh. Satkanov, Z.A. Alikulov
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Summary

Aquaponics is a new agricultural industry with potential in Kazakhstan. It is the combined culture of fish and plants in a recycling aquaculture system. The plants use the nutrients from fish effluent for growth. Through environmentally sustainable technology, locally grown high value products can be produced and marketed year round. Aquaponics operations are inherently diversified operations as they offer two profit centres: fish and plants.

Aquaponics facilities contain contains plant and fish components together in one recirculation system. The fish water, rich in nutrients, is used for plant growth, while the plants are used as biofilters for water regeneration.

Key words: *aquaponics installation, aquaculture, hydroponics, recycling ecosystem*

Aquaponics is a new high-tech agricultural technology that combines both the cultivation of plant products and the production of fish products. The main purpose of the method is the organic production of meat and vegetable products for food purposes.

Aquaponics is a combined method of growing fish and plants together in a recycling ecosystem using natural bacterial cycles to convert fish waste into plant nutrients.

It is an environmentally friendly method that uses the best attributes of aquaculture and hydroponics without the need to add

chemical fertilizers, throw water or filtrate. Aquaponics can be called a combination of two other methods of cultivation: hydroponics and aquaculture. Aquaculture needs to be provided with permanent waste disposal, not permitting achievements toxic to fish level. Hydroponics requires constant replenishment and manual balancing of chemicals. Aquaponics is a system where plants and fish are grown together in symbiosis. Fish products provide food plants, and plants, in turn, filter the water, which returns to the fish. Advantages:

- more intensive aeration of water as a basis for the development of plants,
- easy supply of all minerals and trace elements necessary for the growth and reproduction of plants, freshwater inhabitants and bacteria,
- double the result of activities: crop and product from fishing,
- rejection of harmful herbicides, pesticides, etc. chemicals that indicates the ecological purity of the harvest
- savings on fish nutrition by feeding them parts of the plant
- savings on plant nutrition due to symbiosis with fish and recovery of wastes of the past, the maximum water recycling allows to economize on this resource, reduces or neutralizes the wastewater.

Aquaponics is a high-tech way of farming, combining aquaculture (growing aquatic animals) and hydroponics (growing plants without soil). The first mention of the joint cultivation of fish and plants is the Aztec civilization (XIV—XVI

centuries), then the ancient Chinese. In the XXI century, this technology is entering a new stage of development. Aquaponics is an artificially created ecosystem in which three types of living organisms are key: This technology is environmentally safe. It works on the principle of an ecosystem of fish and plants: fish provide food to plants, and plants purify water. The essence of the method — the use of waste fish as a nutrient medium for plants. Fish toxic for them waste products: nitrogenous, potash, phosphorus compounds, carbon dioxide. These same substances are absolutely necessary for plants and are an excellent natural fertilizer for vegetables or flowers. In aquaponics, this problem is solved by itself: the waste products of fish are disposed of by bacteria and plants. The system is fully consistent with the natural cycle of reproduction of fish and plants in nature, therefore excludes the use of chemical fertilizers and other additives. With the use of natural nutrients secreted by fish significantly increases productivity and accelerates fruit ripening. nitrates in plants grown on aquaponics, about 10 times less than in grown on earth.

To date, the problem of ecology has become a very topical issue, but there is a product of integration of hydroponics and aquaculture – aquaponics, which does not have a negative impact on the environment. Aquaponics involves the combined cultivation of plants and various species of freshwater fish in an environment caused by symbiosis. The technology is based on the creation of a natural cycle of useful substances: substances obtained as a result of the processes of life of fish are absorbed by plants, while cleaning the environment and contributing to their growth. Fish are periodically fed with worms, which are grown in the remains of vegetation and the cycle is repeated. As a result – almost cost-free process of complex cultivation of plants and fish [1].

Finally, this technology can dramatically accelerate the growth of plants and increase their productivity, as physiological processes occur in this case much faster.

Materials and methods. The structure of this unique method of growing crops using natural ingredients: flora and fauna in a single system. The essence of aquaponics is to create a single system, each element of which is in symbiotic relationship with others. Thus, the system interacts three groups of flora and fauna: actually grown plants, bacteria and freshwater fish or shrimp. A characteristic feature of aquaponics is the lack of a solid substrate or soil as a basis for the growth of seedlings. The role of soil in this system is assigned to water enriched with waste products of the fish or shrimp living in it. In addition to useful elements, fish waste contains harmful substances that in pure form the root system of the plant could not be converted into harmless. However, the presence of bacteria as a full-fledged component of the aquaponics solves this problem: the microorganisms are contributing to dissolution of harmful substances and their more rapid and complete processing plants. Of course, maintaining the natural balance in the system is impossible without the use of high-tech equipment.

The waste products of fish contain many solid elements. Thanks to filters and sedimentation tanks, the water in which fish live is purified from large and suspended particles and in this form is fed to the roots of crops without losing its useful chemical elements. Pumps and self-strings in aquaponics create the difference between the levels of the flows, resulting in lower energy consumption for liquid circulation in the system. Neutralization of nitrates contained in the waste products of freshwater organisms is carried out with the help of bacteria and plants themselves.

Each representative of the flora is more or less sensitive to changes in temperature.

In turn, fish, which are one of the links of the system, also need a certain temperature regime of the aquatic environment. For this reason, the symbiosis of certain plants and fish is the result of a preliminary analysis of the requirements of flora and fauna to the temperature regime. Oxygen enrichment of water is a prerequisite for the normal functioning of both fish and plants. Aeration and oxygenation of the water tank are produced naturally and mechanically. Equally important is the control of pH in water. The supply of liquid to fish is carried out only after the analysis of its acidity. In turn, the water in which the freshwater lived is supplied to the root systems also after checking the pH level and making appropriate changes [2].

Thus, there are many advantages of aquaponics in comparison with traditional methods of growing crops: more intensive aeration of water as a basis for planting plants; easy supply of all minerals and trace elements necessary for the growth and reproduction of plants, freshwater inhabitants and bacteria; harvesting twice in one period; double the result of activities: crop and product from fishing; rejection of harmful herbicides and pesticides, which means ecological purity of the crop; no need for the maintenance of large warehouses for storage of chemicals; saving money on the purchase of phosphorus and nitrogen fertilizers; saving money on fish nutrition by feeding them part of the plants; maximum water recycling saves on this resource, reduces or neutralizes wastewater discharges. The performance of aquaponics is no less than aquaculture and hydroponics. The special microbiological environment of the system is suitable for growing even tropical and exotic aquatic inhabitants.

An exceptional feature of this installation is the actual non-waste production, when the products of the exchange of one biological cluster are used in the subsequent stages of biotechnology before their complete

utilization within a closed system. Non-waste of this technology ensures its high environmental safety.

Aquaponics can significantly save water resources, especially - in systems with maximum water recirculation; significantly reduces and reduces to zero wastewater discharge. The possibility of recycling up to 90% of the used water.

There is a high probability that over time aquaponics systems will be widely used and will serve the development of agriculture around the world. Fish production is carried out without the use of synthetic mineral fertilizers, growth regulators, artificial food additives, as well as without the use of genetically modified products.

The main advantage of the production can also be called environmentally friendly. Fish is contained in purified water with filters from all harmful impurities. Human waste (garbage, polyethylene, oil products) does not get into the water. In addition, the absence of mud in the water eliminates the appearance of herbaceous smell in the meat.

Aquaponics is a part of industrial agricultural production and is a simulation combined ecosystem of automatic and semi-automatic control over the state of the aquatic environment, temperature and lighting, with an auto mechanical hydroponic method of growing plants. The symbiotic component of aquaponics is a symbiosis of the existence of artificially bred freshwater animals, hydroponic crops of agricultural plants and colonies processing organic residues of bacteria. In other words, aquaponics is an interconnected hybrid system of pond farming and hydroponics. Vegetables and herbs are grown in containers that do not contain soil, and plants receive their nutrition from wastewater discharged from ponds. Plants feed on bacteria from fish waste products, and then this water is returned back to the pond in purified form [3,4].

The concept of aquaponics involves changing not only the way of farming – at least in the development of small farms, but also, perhaps, ways of harvesting and its further consumption.

The creation of the symbiotic method of aquaponics became possible thanks to the observation and study of natural ecosystems, the rapid development of aquaculture in pond farms, swimming pools and aquariums, as well as, and especially, hydroponics of the 20th century, and the scientific understanding of an integrated approach to agricultural production in the combination of different directions

The basis of production is the use of natural processes of life of freshwater animals (fish, shrimp) as a nutrient medium for industrial plants. During the process, plants consume the necessary products of secretions of living organisms — chemicals (nitrogen, potassium, phosphorus compounds, carbon dioxide, etc.), dissolved in water, and — at the same time, naturally purify and enrich it with oxygen. In the production process eliminates the need for the use of various chemical fertilizers, with a complex system of dosing and storage: the process of chemicalization, processing and purification occurs naturally and in a closed cycle. Thus, aquaponics simulates a natural whirlpool in nature. Unusual farms of the future, which are already trying to get rid of the waste of water and other resources, soil pollution and the use of insecticides, are already appearing in different places on our planet. They are balanced ecosystems capable of producing organics that do not contain toxic substances, often found in vegetable crops grown by traditional methods.

Results and discussion. In its original form, systems based on hydroponics and aquaculture produce some hazardous waste that pollutes the environment. In aquaculture, such wastes are natural wastes containing ammonium and, as a result,

contaminated water has to be removed from the system to prevent a negative impact on fish. And in systems that use hydroponics, solutions that feed plants lose their quality over time, and they also have to be removed from the zone of growing plants. The disadvantage of traditional hydroponic systems is also that the formulations of nutrient solutions are based on synthetic elements. In comparison with a hydroponic system aquaponics has certain advantages: multi-purpose installation usage, diversity of products, low level of nitrates. In the conditions of aquaponics installation there is an additional water purification due to direct absorption and assimilation of nitrogen ions by plant roots. The same types of plants are used for aquaponics cultivation as for hydroponic cultivation: vegetables, greens, strawberries, etc. the Experience of foreign research in the field of aquaponics confirms that these plants are used, and are environmentally appropriate. For example, they are particularly beneficial when water and soil are scarce for traditional agriculture [5].

In the conditions of instability and shaky economy to replace weak agricultural methods, come the latest innovative technologies. These are progressive ways of conducting economic activity, which amaze with their high results.

Thus, the main advantage of the method, based on the combination of the two technologies, is that aquaculture and hydroponics can «nullify» the waste of both systems, forming a closed – or, in the language of physics, closed – ecosystem, in which fish emissions are absorbed by plants, feeding them, and water, where fish live, is purified by plants. In ecosystems using aquaponics, you can set specific for the nature of equilibrium, while sustainable farms are efficient in terms of cost of production and volumes of harvest and it can compete with traditional agricultural objects, relying on proven

technology, the traditional design (for example, polycarbonate greenhouses) and conventional fertilizer. Aquaponics systems are not inferior in performance or hydroponics or aquaculture.

Developing a system of aquaponics, the British look to the not so distant future. In 40 years, 70 percent more food will have to be produced to feed the world's growing population. Given the rapid depletion of soil and water bodies, those countries that learn to use the earth's resources more carefully will avoid hunger.

Specific development restriction aquaponics is the lack of generalists, combining the same high competence as in the Botanical Sciences agricultural hydroponic plants, and the Zoological — with the peculiarities of fish-farming, aquarium and fish farming. The main problem of aquaponics is the exact observance of the fragile balance of an artificially created ecosystem, combining the difference, but the interdependence of the characteristics of water — a vital environment in the symbiosis of animals, plants and protozoa.

To implement the task of active implementation of highly effective methods of industrial fish farming and, above all, closed-cycle technologies, it is necessary to increase scientific, applied and implementation work.

The funds will be used for the introduction of the aquaponics module into the educational programs of Nur-Sultan, where the skills and knowledge of world and domestic experts will be used, the production of aquaponics will be carried out in an experimental volume.

Biotechnical standards for the joint cultivation of various aquaculture facilities by intensive methods and testing of new standards for the joint cultivation of facilities in a modular installation will be prepared. Methods of intensive cultivation of hydrobionts for obtaining food

products from closed water supply units in specialized modular systems with technical characteristics close to world analogues will be proposed. The new integrated approach will contribute to the formation of modern national industry, fish farming and farming of fisheries, the implementation of the educational process will make the transition to a new biotechnology at the world level and the establishment of a new structure of innovation education cluster in the country.

The project provides for the creation of conditions for the development of research competence of students, for practical research and project activities of students in accordance with the modern demands of the participants of the educational process. With a positive examination of the research results will be used as a commercial product in the educational and agri-industrial sectors.

Conclusion. The results of the study can be used in the following areas: biology, hydrobiology, ichthyology, ecology, biotechnology, water technology, aquaculture, agriculture and fisheries, as well as in the real sector of the economy, in the agro-industrial complex and its component fisheries complex of the country. The development will correspond to the world level, and in some respects as an additional increase in production per unit area will exceed the world analogues.

The project will have an impact on the preparation of the theoretical basis of the sequence of processes of cultivation of aquatic organisms intensive methods and hydrochemical mode in the closed loop system (experimental model) to ensure optimal limits of the parameters for all the cultivated fish.

The potential of aquaponics for organic production is high. There is a number of retailers supplying organically certified minerals. The aquaponics project offered a new opportunity to develop a whole new

industry based on supplies for organic hydroponics.

This project can stimulate a new industry of soluble organically certified supplements replacing conventional mineral fertilizers. For example, these supplements may include soluble kelp powder containing biologically active components besides potassium. These components were shown to have a positive effect on crop production and development. The emerging aquaponic industry may have a considerable impact on supplying industry.

The other approach is a development of plant-based fish feed. This feed will have more potassium and will be more balanced for growing plants. The existing fish feed is based on fish meal, byproduct from the fish industry. The limited supply of fish meal hampers the development of fish farming in all over the world. Thus, new products based in plants are the key factor for the expansion of the fish farming. In the last case, the aquaponics production will be an imperative for future aquaculture industry.

Aquaponics is cutting-edge technology based on recycling nutrients produced by fish and growing high value organic vegetables without synthetic fertilizers. The water is filtered by the plants and returned pure to the fish tanks. Organic food production is a rapidly growing industry in Kazakhstan and this operation plans to tie into those markets

Organic greenhouse operations are higher risk because of the greater potential for yield loss from diseases and various nutrient disorders. Aquaponics may reduce this risk because it is a soil-free technology and is an example of sustainable agriculture.

The complexity and uniqueness of growing fish and plants in a closed system require strong involvement from experts from many areas including crop and fish production, economics and marketing.

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Экологиялық таза аквакультура өнімдерін ұтымды пайдалану

Аңдатпа

Аквапоника-бұл Қазақстандағы әлеуеті бар жаңа ауылшаруашылық саласы. Бұл қайталама аквакультура жүйесіндегі балық пен өсімдіктердің аралас мәдениеті. Өсімдіктер өсу үшін балық ағындарынан қоректік заттарды пайдаланады. Экологиялық таза технологияның арқасында қосылған құны жоғары жергілікті өнімдер жыл бойы өндіріліп, сатыла алады. Аквапоника операциялары негізінен

әртараптандырылған операциялар болып табылады, өйткені олар екі пайда орталығын ұсынады: балық және өсімдіктер.

Аквапоника қондырғыларында бір рециркуляция жүйесінде өсімдіктер мен балық компоненттері бар. Қоректік заттарға бай балық суы өсімдіктердің өсуі үшін қолданылады, ал өсімдіктер суды қалпына келтіру үшін биофилтр ретінде қолданылады.

Түйінді сөздер: аквапоника қондырғысы, аквакультура, гидропоника, қалдықтарды қайта өңдеу экожүйесі

Рациональное использование экологически чистых продуктов аквакультуры

Аннотация

Аквапоника - это новая сельскохозяйственная отрасль с потенциалом в Казахстане. Это комбинированная

культура рыбы и растений в системе вторичной аквакультуры. Растения используют питательные вещества из рыбных стоков для роста. Благодаря экологически устойчивой технологии местные продукты с высокой добавленной стоимостью могут производиться и продаваться круглый год. Операции по аквапонике по своей сути являются диверсифицированными операциями, поскольку они предлагают два центра прибыли: рыбу и растения.

Установки аквапоники содержат растительные и рыбные компоненты вместе в одной системе рециркуляции. Вода для рыбы, богатая питательными веществами, используется для роста растений, в то время как растения используются в качестве биофилтров для регенерации воды.

Ключевые слова: установка аквапоники, аквакультура, гидропоника, экосистема переработки отходов.