

MODERN BIOTECHNOLOGY FOR AGRICULTURE



MODERN BIOFACTORY “PHOTOBIONICA-100” FOR GROWING CHLORELLA FOR FEED

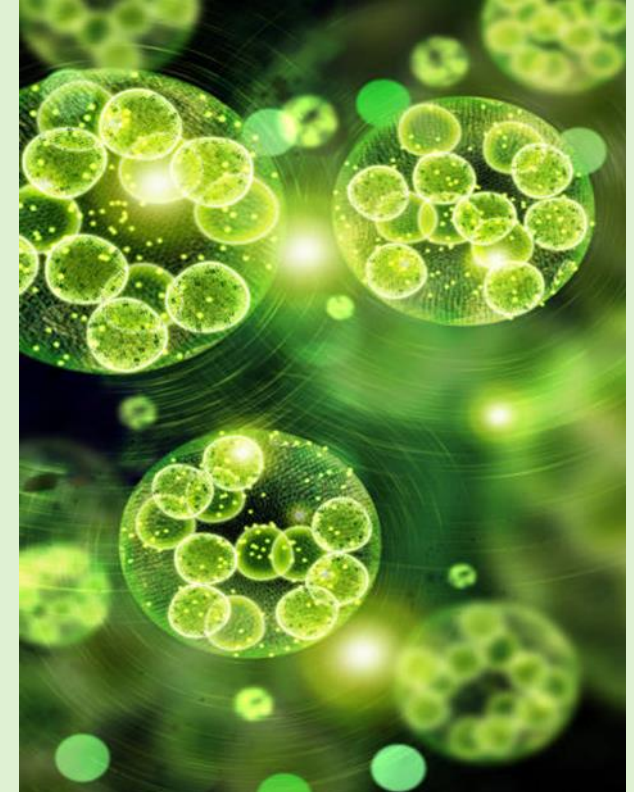
CHOLERA

Chlorella is a unicellular freshwater microalgae that has unique consumer properties.

With the help of sunlight, chlorella converts inorganic chemical elements into organic matter.

Chlorella is a natural, pure and whole food that is rich in quality protein, chlorophyll, dietary fiber, vitamins and minerals. It is rich in various enzymes, nucleic acids and phytonutrients that are beneficial to the body.

Chlorella is a natural antibiotic. It stimulates the immune system, prevents many chronic diseases and reduces the side effects of antibiotics and other medications. Its detoxifying, nourishing and restorative properties enable the body's natural defense and repair systems to function more effectively.



What can chlorella do

Chlorella is one of the most scientifically studied algae in human history. Not a single negative aspect of this organism has ever been recorded.

- *Chlorella has the ability to:*
- *improve the immune system;*
- *remove toxins and heal the body;*
- *improve digestion and excretion;*
- *improve tissue growth and repair;*
- *protect against degenerative and chronic health problems;*
- *slow down the aging process.*

Chlorella reproduces very rapidly, renewing up to four new cells every 17 to 24 hours, which makes it possible to use it on an industrial scale with a minimum payback period for capital expenditures.



Comparing chlorella and vegetables

Organic minerals contained in chlorella are easily absorbed by the body.

Chlorella is rich in potassium, magnesium, calcium and iron, which are essential for healthy heart function, blood formation and circulation.

Zinc, selenium and iodine levels are sufficient for healthy immune function.

Chlorella is rich in fatty acids, lutein, xanthophyll and other nutrients.

Component	Chlorella	Spinach	Pumpkin
<i>Protein, g/100 g</i>	63,11	3,3	1,3
<i>Lipid, g/100 g</i>	11,3	0,2	0,1
<i>Vegetable fibers, g/100 g</i>	14,3	0,8	1,0
<i>Sugar, g/100 g</i>	0,3	3,6	7,9
<i>Iron, mg/100 g</i>	52,7	3,7	0,4
<i>Calcium, mg/100 g</i>	94	55	17
<i>Potash, mg/100 g</i>	1360	740	330
<i>Phosphorus, mg/100 g</i>	1680	60	35
<i>Natrium, mg/100 g</i>	50	21	1
<i>Carotene, mg/100 g</i>	110	3,1	0,62
<i>Vitamin B1, mg/100 g</i>	2,32	0,13	0,07
<i>Vitamin B2, mg/100 g</i>	5,02	0,23	0,06
<i>Vitamin C, mg/100 g</i>	70	65	15

Energy value of chlorella

The energy value of chlorella is 441 kcal/100 g. At the same time, the energy value of chicken feed does not exceed 325 - 350 kcal/100 g.

Chlorella is rich in amino acids, complex carbohydrates, vitamins, minerals, fats (up to 85% unsaturated fat), RNA (up to 10%), DNA (up to 3%), chlorophyll, many phytonutrients and carotenoids, enzymes (including pepsin for digestion), polysaccharides and has a unique growth factor - CGF.

Ingredients	Mass., g/100 g	Мінерал	Mass., mg/100 g
Minerals	5 – 7	Iron	53
Carbohydrates	10 – 20	Calcium	94
Chlorophyll	3 – 7	Potash	1360
Lipids	5 – 15	Magnesium	264
Protein	1 – 6	Sodium	50
Proteins	60 – 69	Phosphorus	1680



Nutritional value of chlorella

Chlorella is a complete protein that contains all eight essential amino acids needed by the body. The protein contained in chlorella is much better than that found in meat because the amino acids it contains can be easily absorbed by the body. At the same time, the protein content is higher than in many different food sources.

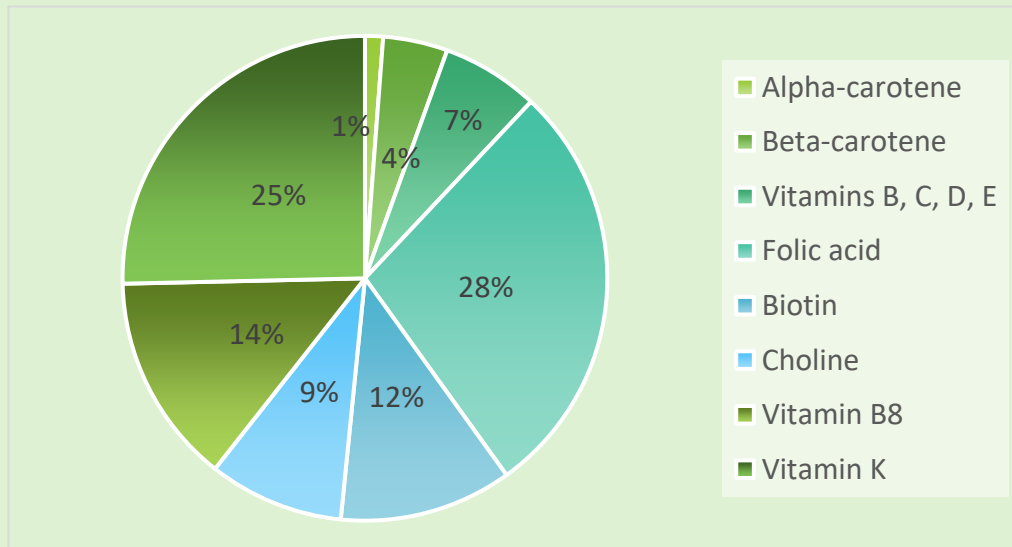
Essential amino acids, mg/100 g		Essential amino acids, mg/100 g	
<i>Isoleucine</i>	2230	<i>Alanine</i>	4550
<i>Lecithin</i>	5070	<i>Arginine</i>	3670
<i>Lysine</i>	4900	<i>Aspartic acid</i>	5210
<i>Methionine</i>	1300	<i>Cysteine</i>	790
<i>Phenylalanine</i>	2910	<i>Histidine</i>	1200
<i>Threonine</i>	2800	<i>Glutamic acid</i>	6670
<i>Tryptophan</i>	1180	<i>Glycine</i>	3360
<i>Valine</i>	3230	<i>Serine</i>	2370
		<i>Tyrosine</i>	2400

Protein, g/100 g	
<i>Chlorella</i>	60 - 69
<i>Spirulina</i>	70
<i>Soybeans</i>	32
<i>Grain</i>	13
<i>Chicken</i>	24
<i>Fish</i>	18 - 29
<i>Pork meat</i>	24 – 27
<i>Eggs</i>	13
<i>Rice, Potatoes</i>	3

The chlorophyll content of chlorella can reach 7% of the total weight, and it contains 5-10 times more chlorophyll than spirulina and 10 times more chlorophyll than alfalfa.

Vitamin bomb

Chlorella contains the full spectrum of B-complex vitamins, twice as much folic acid and more vitamin B12 than raw beef liver. It is also one of the richest natural sources of vitamin B3 and is rich in vitamin A, which acts as an antioxidant to scavenge free radicals and slow down the aging process.



Найменування	мг/100г	Найменування	мг/100г
Alpha-carotene	24	Vitamin B12	8
Beta-carotene	86	Biotin	230
Vitamin B1	2,32	Choline	180
Vitamin B2	5,02	Vitamin B8	281
Vitamin B3	24,5	Vitamin C	70
Vitamin B5	1,92	Vitamin D	0,94
Vitamin B6	2,52	Vitamin E	14,5
Folic acid	560	Vitamin K	506

RAISING CHICKENS

The use of chlorella suspension in the feed rations of poultry farms allows to achieve the following key economic indicators:

- *5% reduction in poultry mortality;*
- *increase of 10 - 11% of carcass weight;*
- *reduction of feed conversion;*
- *reduction or avoidance of costs for medicines and vitamins.*

Chlorella suspension provides:

- *improvement by 15 - 25% of biochemical parameters of blood, liver, muscles and bones of poultry;*
- *reduction in the level of morbidity;*
- *complete or partial rejection of the use of antibiotics and vitamin preparations;*
- *Increased productivity and reproductive performance of poultry.*



Chlorella provides

Effect of chlorella suspension on hatching properties (yield) of eggs

<i>Group of chickens</i>	<i>Number of eggs, pcs.</i>	<i>Exit of chickens</i>	
		<i>pcs.</i>	<i>%</i>
<i>Research</i>	2783	2310	83,0
<i>Control</i>	3625	2410	66,5



Вплив суспензії хлорели на показники росту курчат

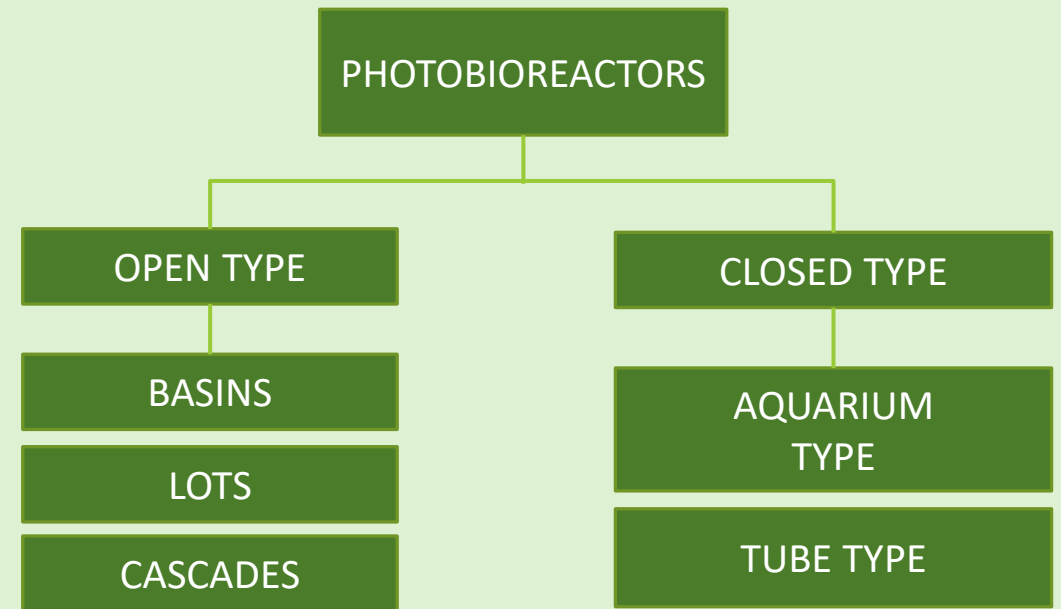
<i>Group of chickens</i>	<i>Live weight, g</i>		<i>Preservation, %.</i>	
	<i>7 day</i>	<i>42 day</i>	<i>7 day</i>	<i>42 day</i>
<i>Research</i>	127	1747	99,95	98,05
<i>Control</i>	114	1578	99,89	92,97

PHOTOBIOREACTORS

A photobioreactor is a complex reproductive system in which photosynthetic organisms are grown using light and various nutrients.

The bioproductivity of chlorella and its lipid composition depends on many factors, primarily on the intensity of irradiation (illumination) of water in the photobioreactor, the duration of irradiation, the transparency of water in the photobioreactor (which changes intensively during the process of growing algae), the biochemical composition of water in the photobioreactor, and other physical and chemical factors.

There are two types of photobioreactors: one is open and the other is closed.



The diagram shows the main types of photobioreactors used for growing chlorella.

Open-type photobioreactors

- *The advantage of an open system is its ease of construction. An open system can be in the form of a lake, pond, or large open container.*
- *The disadvantage of this design is its susceptibility to evaporation, as well as to contamination by invasive species of microorganisms.*
- *In addition, water bloom becomes a serious problem, which prevents the maximum amount of light needed to grow chlorella, as the pools are deep enough and effective circulation is problematic.*
- *The choice of photobioreactor design is determined by the task to be solved with its help. For example, open-type photobioreactors are best used to produce biofertilizers.*



Closed-type photobioreactors

- *The cultivation of chlorella for the food industry or livestock is most appropriate in closed-type photobioreactors, where it is easy enough to ensure the required level of sterility of water, nutrient solution and finished product, as well as to maintain the necessary conditions for its cultivation (temperature, light level, acid-base balance, etc.).*
- *The specific design of the photobioreactor is chosen taking into account many factors, such as: performance, conditions of the photobioreactor at the place of its operation, availability of water, heat, electricity, etc.*
- *In addition, it is necessary to have qualified service personnel who are able to maintain the photobioreactors and ensure compliance with the technological process of chlorella cultivation.*



Technical requirements for a photobioreactor for the production of a feed additive

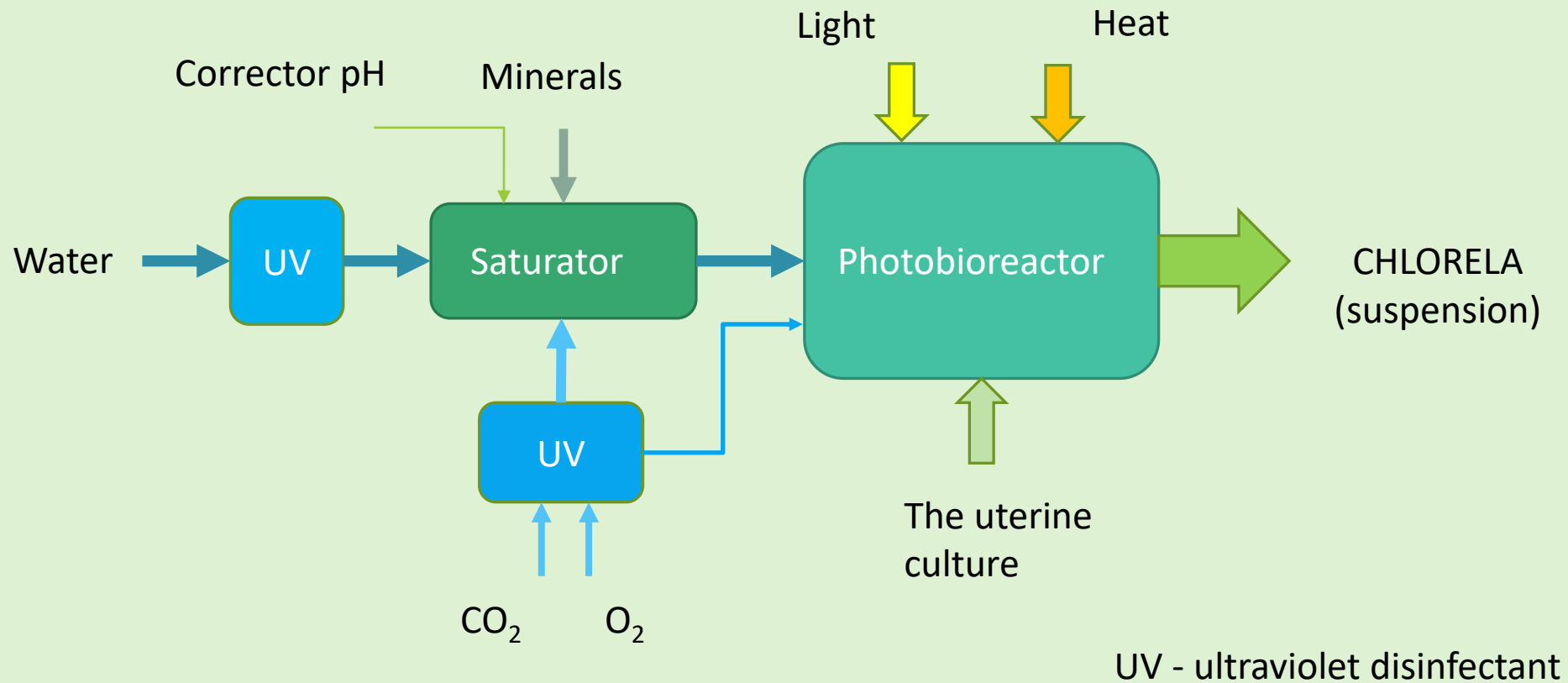
The main requirements of a photobioreactor designed to grow chlorella as a feed additive include:

- *High productivity;*
- *High quality of the product;*
- *Microbiological safety of the finished product;*
- *Possibility of growing chlorella throughout the year;*
- *Minimum dimensions;*
- *Cost-effectiveness;*
- *Simplicity of design and maintenance;*
- *High level of automation.*

Closed-type photobioreactors best meet these requirements.



Technological scheme



Technical parameters

For the intensive cultivation of chlorella in a closed-type photobioreactor, the following parameters must be met:

- *Suspension flow rate up to 9 m/min;*
- *Carbon dioxide supply rate ($C = 2...5\%$) at the level of $3...5 \text{ l}/(\text{m}^2 \cdot \text{min})$;*
- *The thickness of the suspension layer is 25 ... 50 cm;*
- *Irradiation intensity (illumination) - 2200 ... 20000 Lux ($3.22 \dots 29.3 \text{ W}/\text{m}^2$);*
- *The temperature of the suspension inside the photobioreactor is 27...28 °C;*
- *Acid-base balance $\text{pH} = 6.5...7.3$.*

These requirements are best met by closed-type photobioreactors, in which chlorella is grown in a confined space of the reactor. In such photobioreactors, it is possible to control the technological parameters and carry out the cultivation process in an automatic mode.



Converting light into matter

Industrial cultivation of microalgae is an effective method of mass production. For the industrial cultivation of chlorella, it is most appropriate to use photobioreactors with mixing of raw materials using air pump technology (airlift).

Air pump technology is not new. Highly efficient biological wastewater treatment systems are based on this principle. By the way, this technology has been adopted in Germany (Subitec).

The airlift technology ensures continuous circulation of raw materials in the culture medium, which makes the irradiation process more efficient.



Airlift - technology

The air injected into the bottom of the reactor creates an upward flow that ensures constant circulation of the culture mass. This circulation not only increases the growth rate and biomass yield, but also acts as a gentle mixer, minimizing the possibility of damage to the microalgae cell.

After introducing CO₂ - enriched air into the system, the airlift mechanism uses small air bubbles to prolong the residence time of carbon dioxide in the culture medium. This significantly improves CO₂ dissolution, increases photosynthesis efficiency and optimizes nutrient utilization.



Optimal lighting to increase biomass

To increase the efficiency of biomass cultivation, special LED irradiators with adjustable spectral characteristics are used.

To ensure the optimal irradiation regime necessary for efficient photosynthesis of microalgae, the irradiators are placed on both sides of the photobioreactor.

This arrangement of irradiators ensures maximum utilization of light, which leads to an increase in biomass yield.



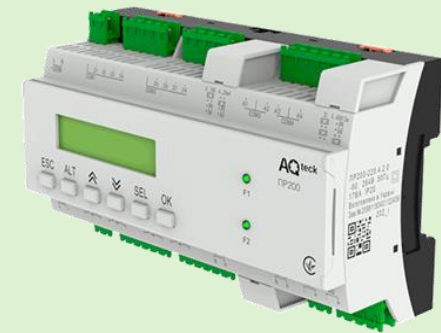
Monitoring of process parameters

To ensure optimal conditions for chlorella cultivation, the photobioreactor is equipped with an automatic control system based on modern microprocessors.

The automatic control system provides control and regulation of the main technological parameters of the photobioreactor:

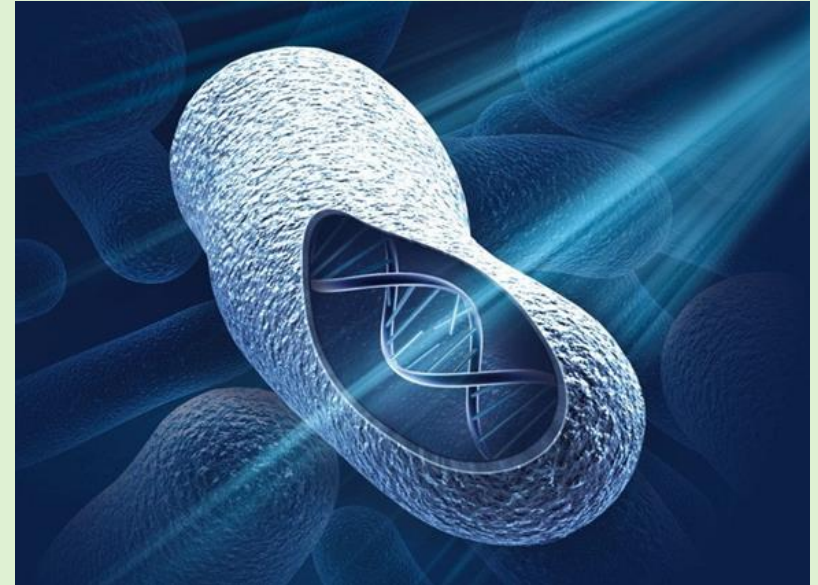
- water and substrate temperature;*
- the value of the acid-base balance;*
- irradiation intensity and dose (the amount of light energy absorbed by chlorella);*
- optimizes the spectral characteristics of the irradiation depending on the phase of development of chlorella cells.*

In other words, the automatic control system provides and maintains optimal conditions for the development of microalgae cells.



Ensuring sterility

- *The photobioreactor has a closed design that protects the culture being grown from microbiological contamination.*
- *The presence of a system for disinfecting water and gases with ultraviolet (UV) radiation ensures a high level of purity of the culture substrate and makes it impossible to contaminate it with extraneous microflora. This is crucial for the cultivation of chlorella and the production of high quality and safe feed.*



About us

PHOTOBIONICA Research and Engineering Group was founded to develop modern biotechnologies for the needs of Ukrainian agriculture, food and pharmaceutical industry and environmental protection.

The PHOTOBIONICA group includes:

- The Institute of Climate Oriented Agriculture of the National Academy of Agrarian Sciences of Ukraine - developer of the technology;*
- Kharkiv Engineering Company LLC, a developer and manufacturer of modern disinfection systems based on ultraviolet irradiation and ozonation technology.*

We have a rich (more than 30 years) experience in the development of modern high-tech technologies in various industries and agriculture.

Among our developments are the latest biotechnologies for agriculture; photo-activation seed treatment plants "PHOTOZONE"; disinfection plants for grain, spices, nuts, dried fruits "BOZONE"; UV disinfection systems for drinking water "VODOGRAY" and waste water "WATERLIGHT", a drinking water treatment plant for antibiotics (Slovakia), a modern farm for growing clarius catfish and many other developments.



Institute of
Climate-Smart
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NAAS

WHAT WE DO TODAY DETERMINES OUR FUTURE



We are confident that our developments will help solve many issues related to poultry farming. And will provide a new level of quality and profit for your company.



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