International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

http://ijpsat.ijsht-journals.org
Vol. 24 No. 2 January 2021, pp. 400-405

The Usage Of The Green Chlorella Raised In The Organo-Mineral Environment As Foodstuff In The Fish Aquaculture

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Abstract – In the following article the modern techniques of the usage of green chlorella as a foodstuff in the fishing industry based on the recent data obtained in the organo-mineral environment is analysed. Also, the problem of tutoring the experts in Uzbekistan in this sphere are revealed.

Keywords – Algae, Sustainable Aquaculture, Chlorella, food chain, Volvox, animal feed, plankton, fishery, ichthyology, Chlorella, Chlamydomonas, Amphora, Chlorophyta.

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I. INTRODUCTION

The main research on fish breeding development is conducted under the umbrella of the Coordination Committee on Science and Technologies Development, under the Cabinet of Ministers of the Republic of Uzbekistan. There is one research institute in the field of aquaculture and fisheries: the Uzbek Research Centre for Fishery Development at Uzbek Scientific Production Centre for Agriculture of Ministry of Agriculture. There are four research institutions with departments conducting research in the field of ichthyology, hydrobiology, and aquaculture: Laboratory of Hydroecology at the Institute of Water Problems of Uzbek Academy of Sciences; Laboratory of Ichthyology and Hydrobiology at the Institute of Zoology of UzAS; Institute of Bioecology of Karakalpak Branch of UzAS; and the Department of Ecology at the National University.

On-farm participatory research in aquaculture is not practised in Uzbekistan. There are no technical schools offering training in aquaculture. In 2006–2007 in the frame of a research grant named “Sustainable Aquaculture in Recirculating Systems – Feasibility Study for the Catchment Area of the Aral Sea”, funded by German Federal Foundation for Environment, new sustainable aquaculture concepts were developed for Uzbekistan. The research in this topic recently has become intensified.

II. METHODS

A eutrophic waterbody has naturally or artificially elevated nutrient levels, especial nitrogen and phosphorus. Elevated levels of phosphorus can lead to a proliferation, or ‘bloom’ of blue-green algae in a waterbody. Such algae blooms can create ecosystem dynamics in which the oxygen concentration in the lake is too low to sustain fish and other aquatic organisms.

The project was a cooperative effort involving various fisheries research institutes and enterprises in Germany and Uzbekistan. A multi-disciplinary approach was chosen to consider the biological, ecological, technological and economic criteria for aquaculture development.

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In the past, specialists in aquaculture and fisheries at graduate level studied in the Department of Hydrobiology and Ichthyology in the Biology Faculty of the National University of Uzbekistan), graduating 8 to 20 students annually. In 2003, that department became the Department of Ecology, and now there is no centre for high education for the fishery sector in the country. At one time, opportunities for fisheries higher education were available in the Russian Federation but it is now too expensive. Today, highly educated people from the State University (biologists), the Agro University (agriculture), and the Technical University (engineers, food industry) can become fisheries specialists. But nowadays Uzbekistan needs the experts in this level.

Green algae are the most numerous representatives of algae and belong to the plant kingdom. Among green algae, there are unicellular and multicellular organisms that live both in water and in humid places. The life cycles of different representatives differ from each other. Representatives of green algae are chlorella, ulva, chlamydomonas, ulotrix.

The word “Algae” is Latin for ‘seaweed’ and today refers to a wide ranging group of water plants. Some, like chlorella are tiny microscopic organisms, whist some kelps can measure more than 50 m long.

- There are more than 25,000 known species of algae
- Algae is said to be responsible for 90% of the photosynthesis on earth
- Algae is the first link in the food chain
- Fossilized algae can be dated back to more than 1.5 billion years [1].

Figure: Green algae: 1 - chlamydomonas; 2 - chlorella; 3 - closterium; 4 - ulotrix; 5 - spirogyra; 6 – cladofora.

Chlorella (from the Greek χλωρός, “green” and Latin -ella - a diminutive suffix) is a genus of unicellular green algae belonging to the Chlorophyta division. It has a spherical shape, from 2 to 10 microns in diameter, without flagella. Chlorella chloroplasts contain chlorophyll a and chlorophyll. Chlorella only needs water, carbon dioxide, light, and a small amount of minerals to reproduce for the photosynthesis process. Chlorella vulgaris is very common, constantly occurring in masses in the water and in the

mud of puddles, ditches and ponds. It often develops, as well as a related form, Chlorella infusionum, in laboratories and at home in vessels with water or with solutions of pepsin and sugar, covering the inner surface of the glass with a greenish coating.

Chlorella is a genus of unicellular plants from the department of green algae. This genus unites about 20 species, and in the CIS countries there are about 10 species. The most famous and widespread Chlorella vulgaris forms huge accumulations of mud puddles, ditches and ponds in the water[1].

Representatives of this genus are ubiquitous, as they are undemanding to environmental conditions and multiply intensively. They develop rapidly in both saline and fresh water bodies, as well as in abundantly moist soil.

III. Structure

Chlorella cells are single, spherical or ellipsoidal, with a diameter not exceeding 15 microns. This immobile microorganism has a thin, smooth cellulose membrane. The cell contains one nucleus and only one chloroplast, located parietally. The cytoplasm stores foods such as fats and starch.

Chlorella, like other green algae, is capable of synthesizing organic matter through photosynthesis. This requires only water, carbon dioxide and sufficient light. Also, algae of this group need a small amount of minerals for reproduction.

IV. Reproduction

Exceptionally asexual reproduction is characteristic, which is carried out by cell division into 4-8-16 equal parts - autospores. These newly formed cells, after the disappearance of the maternal membrane, turn out to be free, quickly increase in size and after a short period of time divide again.

Chlorella is capable of extremely fast accumulation of biomass during cultivation, due to which this microorganism has become the most demanded object of cultivation and research. Representatives of this genus of green algae are used for experimental research in closed ecological life support systems. During the life of chlorella, a large amount of oxygen is released during the process of photosynthesis, which has found application for air regeneration in confined spaces, for example, in spaceships, submarines. Research is underway to use chlorella as a likely food source, but the difficulty lies in the fact that all algae nutrients are covered with a strong membrane that cannot be destroyed by human digestive enzymes. It should also be noted the importance of these algae for biological wastewater treatment.

Unlike its relatives, Chlamydomonas, Chlorella is a typical autotroph. To maintain its existence, it only needs water, light, carbon dioxide and a few minerals. Later research has shown that chlorella also needs some carbohydrates, such as sugar. Even at the dawn of the discovery of chlorella (and this was at the end of the 19th century), scientists discovered special formations in the cells of protozoa and other animals. It was soon established that these were not some organs of these animals, but chlorella living with them in symbiosis. Chlorella feeds on the host's body, but does not harm it. This cohabitation is called commensalism, or “lodging”.

Sometimes you can observe how chlorella suddenly dies in the host's body. This happens if it has entered the area of the cell responsible for digestion; then the cell perceives it as food and absorbs it.

Little Chlorella has proven to be a very beneficial organism in various fields. Here are just a few ways to use it: Scientific research; Cleaning of reservoirs; Eating as well as animal feed. The nutritional value of chlorella has now entered the culinary fashion. Vegetarians are especially addicted to it. Chlorella is said to be superior to many other foods in terms of nutrient content. So, in terms of protein content, it is much superior to wheat and is close to meat.

Chlorella is taken in tablets, powders, pastes, suspensions and concentrates. Such a late fascination with chlorella as food is explained by the fact that for a long time scientists did not know how to split its extremely dense shell. All useful substances are contained inside the cell; the thickness of the shell is such that the human stomach is not able to digest and break it down. Only in recent years has an effective way of “preparing” chlorella been found. The Japanese were among the first to eat chlorella.

In terms of nutritional value, chlorella competes with its more popular cousin, spirulina. Chlorella has both advantages and disadvantages (for example, lack of essential fatty acids).

Algae are grown mainly in Asia, the USA, while in Uzbekistan the technology has not yet been introduced everywhere. Gradually, domestic companies are creating pilot plants: for example, Amphora grows chlorella in a photobioreactor and plans to use algae to support the environment. The company plans to expand the use of chlorella and add it to animal feed, cosmetics, medicines and even create biofuels using green algae [2].

Chlorella shell is dense, it contains cellulose. The cytoplasm contains a nucleus and a chromatophore with chlorophyll. Photosynthesis is very intense, so chlorella releases a lot of oxygen and produces a lot of organic matter. Just like chlamydomonas, chlorella is able to assimilate ready-made organic substances present in water. Chlorella is characterized by asexual reproduction by division[3].

Chlorella is used to produce oxygen in closed ecosystems. In 1967-1978, the use of chlorella in food was not successful in the BIOS-1, BIOS-2 and BIOS-3 facilities. In terms of its nutritional value, this seaweed is not inferior to meat and is significantly superior to wheat. If wheat contains 12% protein, then chlorella contains more than 50%.

Due to its unique properties, the planktonic strain made it possible to significantly simplify the biotechnology of chlorella cultivation and the storage technology of mother culture. The new strain made it possible to introduce chlorella into the diet of cattle, pigs, birds, rabbits, bees, fish; use chlorella for wastewater treatment, algolization of water bodies.

Green algae have only a green pigment - chlorophyll. In the cell, a nucleus, protoplasm, chromatophores are distinguished. The cells are covered with a cellulose membrane. Reproduction is sexual and asexual (zoospore). The product of photosynthesis is starch.

The single-celled green organism of euglena (Euglena viridis), depending on habitat conditions, can eat like a plant, or completely switch to an animal lifestyle. Euglena does not have a cellulose casing. When placed in the dark or in an environment rich in organic matter, it loses its green color and begins to feed like an animal, absorbing ready-made organic matter, while a green euglena feeds like a plant, synthesizing starch from carbon dioxide and water. Here, the concepts of “plant” and “animal” become interchangeable and depend on the living conditions. This way of eating euglena testifies to the unity of the flora and fauna. Botanists classify euglena as algae, and zoologists as flagellate protozoa.

It is assumed that the green algae chlorella in a long space flight will absorb carbon dioxide in the cabin and release oxygen, as well as be used by astronauts for food. Algae are of great importance for increasing soil fertility. Thanks to photosynthesis, they create organic matter by assimilating carbon dioxide from the air and enrich the soil with it after they die off; also through photosynthesis, they enrich the soil with oxygen. Some types of blue-green algae absorb nitrogen from the air.

Algae are part of the plankton, where, like the protozoa, they serve as food for more organized creatures. Algae are good indicators of the degree of pollution of water bodies with organic matter. In the most polluted water bodies (sewage, sewage), blue-green algae and euglena develop in mass. With less pollution, oscillators develop from blue-greens, closterium from greens, and melozir from diatoms. In water bodies poor in organic matter, Volvox, most spirogyra, develop.

The global problem of our time is the provision of various sectors of the national economy with the required amount of proteins, as well as assimilable sources of vitamins and microelements. So, the shortage of proteins, vitamins and microelements in feed rations is experienced by livestock and poultry, which negatively affects the productivity of livestock and poultry, as well as the resistance of their organisms to a number of diseases. The diets of farm animals and poultry in a number of regions of our country are characterized by a shortage of protein, vitamins and minerals. In this regard, an urgent task of biotechnology is to study a convenient producer of the listed components, which makes it possible to obtain target products at low cost.

So, chlorella, growing in an environment rich in nitrogen sources, synthesizes mainly proteins, and with a nitrogen deficiency, mainly lipids and carbohydrates. It is known that with a change in mineral nutrition, temperature and light conditions, it is also possible to grow these algae with different content in the biomass of protein (8–58%), carbohydrates (5–38%) and lipids (4–85%). And the addition of manganese salts to the nutrient medium to a final concentration of 0.2 mg / l can increase the yield of chlorella biomass by one or two orders of magnitude. Chlorella is the richest source of protein, equal in quality to that of powdered milk or meat. Moreover, chlorella does not produce waste: all components of its cell are absorbed.

The total protein of algae is represented by more than 40 amino acids. Including for 100 g of total nitrogen of chlorella there are 6.4 g of aspartic amino acid; 6.2 g glycine, 7.7 g alanine, 7.8 g glutamic amino acid, 3.3 g serine, 2.8 g tnrosine, 5.8 g proline, 0.2

g cystine, 5.5 g valine, 15 , 8 g arginine, 3.3 g histidine, 3.5 g isoleucine, 6.1 g leucine, 10.2 g lysine, 1.4 g methionine, 2.8 g phenylalanine, 2.9 g threonine, 2.1 g tryptophan [5].

Chlorella synthesizes a significant amount of vitamins, surpassing all plant feed and agricultural crops. 1 g of dry matter of algae biomass contains: carotene (provitamin A) - 1000-1600 μg, thiamine - 2-18 μg, riboflavin - 21-28 μg, pyridoxine - 9 μg, cyanocobalamin (neither yeast nor higher plants synthesize it) - 0.025–0.1 μg, ascorbic acid - 1300–5000 μg, provitamin D - 1000 μg, phylloquinone - 6 μg, nicotinic acid - 110-180 mcg, tocopherol - 10-350 mcg, pantothenic acid - 12-17 mcg, folic acid - 485 mcg, biotin - 0.1 mcg, and leucovorin (a derivative of tetrahydrofolic acid) - 22 mcg. culture liquid, where their level is significantly higher than that in algae cells. The trace element composition of the chlorella suspension includes copper, iron, zinc, cobalt, manganese, molybdenum, iodine, and other elements.

A recently published study suggests climate change may encourage longer and more frequent blooms of toxic algae along Canada's Pacific coast. The research on the presence of algae toxins in marine mammals along the Alaska coastline holds a warning for British Columbia.

Algae eaters have long been an integral part of the aquarium-keeping hobby for balancing the natural ecosystem we are all trying to replicate.

Due to their expertise in algae removal coupled with their quirky looks and habits, they are glorious additions to your aquatic family. From fish, to shrimp, to snails; we will cover our favorites for eating algae in your tank.

Read this article to learn how to choose a new clean-up crew for your tank. Because of how important these fish are to your aquarium, it is essential that you learn how they can naturally clean up your system so you can stay away from harsh chemicals.

Take inventory of existing factors in your tank to select the right algae eater:

Besides looking at the water parameters that a given fish can survive and, hopefully, thrive in, it's necessary to consider other important facets of a tank's ecosystem and its inhabitants.

- Activity and Aggression Levels of Tank Mates: This is a very important question to ask. Do your current fish or critters mesh well with your chosen algae eater?
- Oxygenation Levels: What are the oxygenation levels in your tank? Pick an algae eater that matches the same requirements as your existing ecosystem.
- Speed of Current: Some algae eaters like lots of current but, for others, it's kind of stressful. Does your speed of current rule out any algae eating critters?
- Density of Foliage/Hardscape: What density of foliage and hardscape do you currently have in your tank? How will that affect a potential algae eater?

The highest levels of Chlorella sp. meal in the diets (40 and 50 g/kg of CM) provided the highest egg production (P = .004), hatching rate (P = .004) and larval survival (P = .009) at 6 days post-fertilization [10].

V. Results

Due to its relatively simple organization, high reproduction rate, and the possibility of cultivation under completely controlled conditions, high metabolic plasticity makes chlorella a classic object of industrial biotechnology. It has found wide application in various fields of human activity: in agriculture, medicine, food industry, perfumery, wastewater treatment, etc.

VI. Conclusion

For further optimization of biotechnological processes associated with the use of chlorella, first of all, an in-depth study of the mechanisms of regulation of the metabolism of its cells is necessary. One of the general mechanisms of this kind is the proteolysis system. The literature data on the features of its organization in chlorella is scarce, which dictates the need to expand research in this direction, as well as to reveal the role of individual proteolytic reactions in the life of cells of this alga.

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