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**H. V. Chvaliuk, graduate student of the department of general biology and teaching methods of natural sciences**

**A. Y. Korniienko, graduate student of the department of general biology and teaching methods of natural sciences**

**V. V. Hrubinko, doctor of biological sciences, Prof.**

**Ternopil Volodymyr Hnatiuk National Pedagogical University, Ukraine**

## **PROMISING AND SCIENTIFICALLY BASED USE OF ALGAE AS A FOOD ADDITIVE**

### **Introduction**

In the current search for alternative sources of nutrients, algae are gaining increasing importance. Their biochemical composition, ecological availability, and functional properties make them promising as food additives. Algae contain vitamins, minerals, antioxidants, proteins, and bioactive compounds that positively affect human health. There is a global trend of increasing algae production, confirmed by numerous scientific studies [1, 6].

Algae are a source of essential nutrients: iodine (I), calcium (Ca), iron (Fe), magnesium (Mg), vitamins B, C, E, and K, as well as polysaccharides such as agar, alginates, and carrageenan, which act as thickeners, stabilizers, and prebiotics [2]. These substances possess antioxidant, anti-inflammatory, and immunomodulatory properties [3]. Microalgae (genera *Spirulina*, *Chlorella*) contain up to 70% protein in dry mass, making them an alternative to animal protein [6]. Among marine algae, those popular in the food industry include kelp (genus *Laminaria*), nori (genus *Porphyra*), and wakame (*Undaria pinnatifida*) [1]. According to a study conducted in 2025, algae are actively used as ingredients in functional foods — in the form of powders, extracts, gels, and stabilizers [6].

Algae exhibit a number of functional effects:

- Antioxidant activity: fucoxanthin and fucoidan neutralize free radicals, reducing the risk of cancer and cardiovascular diseases [5].
- Immunomodulatory action: they stimulate macrophage activity and increase interferon levels.
- Detoxification: they can bind heavy metals, pesticides, and radionuclides.
- Metabolic regulation: they help reduce blood cholesterol and glucose levels [1].

Algae are actively used in various segments of the food industry. They are added to bakery products, beverages, meat, and dairy products to enhance nutritional value [4].

- In bakery products — as a source of protein and minerals.
- In meat products — as a natural colorant, antioxidant, and stabilizer.
- In functional beverages — algal extracts are added to increase energy value.
- In vegan alternatives — algae form the basis for plant-based meat, cheese, and mayonnaise [7].

Global algae production has increased several-fold over the past 20 years, particularly in Asia, where they are a traditional part of the diet (China, Indonesia, and South Korea are industry leaders) [5]. In addition, the EU funds programs to integrate algae into the food industry as part of the “Green Deal” initiative.

In 2025, a study on the use of algae in space missions and extreme conditions was published [6]. Furthermore, algae are considered a sustainable source of protein that can replace animal products in the face of climate challenges [7].

The application of marine algae in the food industry offers wide opportunities — from their use as natural additives and preservatives to their integration into modern food products to increase the intake of beneficial substances [6].

Algae cultivation has several advantages:

- It does not always require fresh water, as many algae used in the food industry are marine.
- It does not require fertilizers or large areas.
- It helps reduce CO<sub>2</sub> emissions and purify water.
- It is an economically accessible source of protein, especially in Asian countries [5].

In Ukraine, algae-based products and additives are not yet widely used; however, scientific studies confirm their potential. In particular, domestic researchers are exploring the possibilities of using kelp and spirulina as sources of biologically active substances [1, 2].

### **Conclusions**

Algae have significant potential as a food additive due to their rich composition, functional properties, and environmental sustainability. Their use contributes to the creation of healthy products, reduces environmental impact, and fosters new directions in the food industry. Their application opens new prospects for the food industry, medicine, and for achieving sustainable development goals in the future. Ukrainian science has all the prerequisites for integrating global practices into the national context.

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