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An Overview on Algae in Food

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ABSTRACT: ***Algae are primary producers that provide a diverse range of nutrients. While the high protein content of different species is one of the major reasons for considering them as an alternative source of protein, microalgae oils rich in certain PUFAs seem to be particularly beneficial for youngsters, pregnant women, vegetarians, and people with seafood allergies. Because algae are high in vitamins, minerals, antioxidants, and natural colorants, integrating the whole biomass into food and feed may help to provide color, nutritional value, texture, and oxidation resistance. Microalgae biomass may be used into conventional meals to produce novel items that are both attractive and nutritious. Even when used in small amounts in the nutrition of various animals, algae have been credited with improving the immune system, increasing weight, the number of eggs, reproductive performance, or lowering cholesterol levels, indicating the possibility of new farming methods to improve the quality of meat and eggs. They're also essential in aquaculture since they're a natural food source for these creatures. Finally, owing to its high protein content and numerous bioactive chemicals, the microalga Spirulina is nature's richest and most complete source of organic nutrition, and it has become a health food throughout the globe.***

KEYWORDS: ***Algae, Antioxidant, Colorants, Proteins, Vitamins.***

1. INTRODUCTION

Algae are by far the most numerous primary producers, despite the fact that some are mixotrophic or heterotrophic. Algae is a scientific name for a group of lower plants that have chlorophyll in their cells and are often found in aquatic biotopes, but they may also be found in other habitats. Based on their size, they are classified as macro algae (macroscopic algae) or micro algae (microscopic algae) (microscopic algae). Because of their prokaryotic cell type, blue green algae are also known as cyano bacteria. They have been recognized as one of the most promising species for the separation of new and biochemically active natural compounds[1]–[3]. Algae is produced and consumed as a food source all over the world. Vitamins, minerals, proteins, polyunsaturated fatty acids, antioxidants, and other nutrients are abundant in them. Microalgae have a lot of promise since they aren't as extensively researched as agricultural crops, they can be produced in conditions that aren't conducive to plant growth (with reduced or no seasonality), and some species produce many times as much as plants. Figure 1 shows the seaweed which involves algae.

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Figure 1: Illustrates the seaweed involving algae[4]

Because they utilize solar energy more effectively, they have the potential to produce valuable chemicals or biomass, and they may be employed to enhance the nutritional content of food and feed. Microalgae combine the biotechnological properties of microbial cells with the characteristics of higher plants. In other words, they can multiply quickly in a liquid media with low nutritional needs (unlike fungus and bacteria, they don't need an organic carbon source) and collect metabolites. However, the capacity to adjust growing conditions in order to enhance biomass or the synthesis of desirable chemicals is critical. A lack of nitrogen molecules in the medium of the microalga Chlorella, for example, may cause 85 percent fat accumulation in biomass, while mixotrophic culture of the microalga Spirulina can increase output by 5.1 times. Microalgae, due to their wide diversity and advancements in genetic engineering, are one of the most promising biological resources for new products and uses[5]–[7].

1.1 Algae as a Source of Polyunsaturated Fatty Acids (Pufas):

Some of the -3 PUFAs are of special importance, with eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) being the most significant nutritionally (DHA). Gamma linolenic acid (GLA) is also a 6 PUFA and a key precursor in the production of prostaglandins. GLA has been proven in clinical studies to help cure illnesses including arthritis, heart disease, obesity, alcoholism, depression, schizophrenia, Parkinson's disease, multiple sclerosis, zinc deficiency, and certain symptoms in the elderly. Unsaturated fatty acids decrease lipid levels (cholesterol and triglycerides) in hyperlipidemia, reducing the risk of heart disease and atherosclerosis. EPA and GLA are very effective in this regard. Although EPA and DHA are often extracted from fatty fish, there are a number of drawbacks to doing so: 1) mercury and polychlorinated biphenyl levels are frequently unacceptable for certain consumers (especially children and pregnant women; the developing nervous system of the fetus is very susceptible to even low levels of these contaminants); 2) an unpleasant odor; 3) they are not suitable for vegetarians; 4) the problem of fish sustainability as a source (many species have been fished almost to extinction); and 5) the problem of fish sustainability as a source (many species have been fished almost to extinction). Fish, on the other hand, get their omega-3 from algae, which are the first producers of PUFAs in the aquatic food chain. PUFAs from microalgae have a highly potential biotechnology market for food and feed since they may achieve considerably greater contents and productivities than other

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conceivable sources. The baby formulas business seems to be especially well-suited. DHA is a critical vitamin for the development of the prenatal brain as well as for normal retinal function in newborns[8]–[11].

1.2 Algae as a Vitamin and Mineral Source:

Algae are high in vitamins and minerals, making them ideal for nutritional supplements. Some Chlorella species have higher vitamin content than most cultivated plants. In addition, compared to any fresh plant or animal dietary source, the Spirulina genus has over tenfold more -carotene than any other food, including carrots, and more vitamin B12. This genus has the most vitamin E, thiamine, cobalamine, biotin, and inositol when compared to green algae, spinach, and liver. Several microalgal species generate large levels of α-tocopherol (α-T, the most physiologically active form of vitamin E). After 120 hours, the synthesis of α-tocopherol in heterotrophically produced microalga Euglena gracilis reached 3.70.2 mg/g, which is approximately 13, 18, 95, and 56 times greater productivity than sunflower, soybean, olive, and maize (some of the most common natural sources of vitamin E). Also, if the microalga Tetraselmis suecica's claimed high biomass yields can be achieved, it may compete with E. gracilis as a contender for commercial -T production. The quantity of folate (as folic acid) in the six seaweed (macroscopic marine algae) species studied by Rodriguez Bernaldo de Quiros et al. varied from 161.6 g/100 g dry mass. Algae has the potential to be used as mineral additions in animal feed. Some edible macroalgae have higher amounts of both macrominerals (8.083–17,875 mg/100g; Na, K, Ca, Mg) and trace elements (5.1– 15.2 mg/100g; Fe, Zn, Mn, Cu) than edible land plants, allowing them to be used as a food supplement to help meek people.

1.3 Antioxidant Source:

Antioxidants are among the most important chemicals in algae. Because of the interactions between various antioxidant components, microalgal biomass may be thought of as a multi-component antioxidant system, which is usually more effective. Polyphenols, phycobiliproteins, and vitamins are the most potent water-soluble antioxidants found in algae (Plaza et al., 2008). Algae, being photosynthetic organisms, are exposed to light and high oxygen concentrations, and oxygen concentrations in cultures with high cell density in closed photobioreactors may be very high. Under such circumstances, extremely efficient antioxidative scavenger complexes accumulate to protect cells, and the antioxidative potential of Spirulina platensis, for example, may rise by a factor of ten under oxygen stress. The radical scavenging capability of microalgal products is gaining popularity in functional food/nutraceuticals, particularly in the beverage market sector.

1.4 A Natural Colorant Foundation:

Synthetic colors used in the food business are mostly coal tar derivatives, which are favored owing to the poor yield of natural colors from plant sources, despite the fact that they are prohibited in many countries due to health concerns. Because the global trend for colorants is to replace artificial with natural, and plant extraction needs a larger quantity of biomass, algae provide a viable option. Other pigments present in algae include carotenoids and phycobiliproteins, in addition to chlorophylls. Chlorophyll is derived as a natural colorant from spinach in Brazil, with a concentration of about 0.06 mg/g, while Spirulina sp. biomass has a value of 1.15 mg/g. Using KNO3 and NH4Cl as nitrogen sources in the medium, high-quality Spirulina biomass with a

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chlorophyll content of 21.85 mg/g was produced. Incorporating the whole Spirulina sp. biomass into food, on the other hand, is especially intriguing since it will provide green color while also increasing nutritional value. Carotenoids are abundant in algae, which are utilized as natural food colorants, feed additives, vitamin supplements, and health food items.

Carotenoids must be present in the diet for broilers and/or egg yolk pigmentation, and the impact of these pigments from Chlorella vulgaris biomass on the coloration of egg yolk was similar to that of commercially manufactured pigments. Carotene is the most significant carotenoid since it is the most active form of pro-vitamin A, and it is employed as a colorant, a provitamin, a multivitamin supplement, and a health food product with an antioxidant claim.

Microalgal pigments, as well as the whole biomass, may be utilized to color food and feed while also improving textural properties. The rheological characteristics of emulsions were shown to be significantly enhanced by phycocyanin, which increased linearly with the phycocyanin content. On the other hand, natural pigments' antioxidant qualities make it feasible to enhance oil oxidation resistance, which is especially useful in high-fat goods like emulsions. The addition of microalgal biomass to emulsions produced a broad variety of attractive hues, from green to orange and pink, as well as improved oxidation resistance. The authors also examined the impacts of Haematococcus pluvialis and Chlorella vulgaris biomass, assuming that the greater oxidative stability in the presence of H. pluvialis was attributable to astaxanthin as the main carotenoid.

1.5 Algae component of functional food:

In industrialized nations, the food is rich in calories, which, when combined with a contemporary way of life, leads to obesity, heart disease, diabetes, and other health issues. As a result, there is a need for food items that may improve health by supplementing the diet with vitamins, minerals, PUFAs, and other nutrients, and utilizing natural components rather than synthetic ones has become more attractive to consumers.

Algae are a wonderful, but understudied, natural source of biologically active chemicals. Beta1, 3-glucan, an aggressive immune stimulant, free-radical scavenger, and blood lipid reduction, seems to be the most significant component in Chlorella. The antibacterial, antiviral, anticancer, and food additive properties of cyanobacteria are widely known, and effective drug development is the most promising element of microalgal biotechnology. Although the function of antioxidants present in algae has previously been addressed in the text, there has also been research on the hypocholesterolemic impact of several components, including lipoprotein lipase activity, chlorophyll content, and C phycocyanin.

Biomass from microalgae was mostly used in the health food industry. However, since incorporating natural-source components with functional characteristics into conventional meals is a method to create appealing and nutritious new goods, there are a plethora of microalgae or microalgae-based mixes available all over the globe.

1.6 Involvement of Algae in Human Nutrition:

The rise in the world's population in recent decades has prompted a quest for new sources of alternative food, and algal biomass has emerged as a potential candidate. In 1978, a research was conducted with a malnourished baby who was fed an algae-enriched diet. The scientists found that

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therapeutic factors, as well as algal proteins, were responsible for the substantial improvement in health.

Seaweeds are extensively grown algal crops in coastal regions of all continents because they are utilized in human and animal nutrition. Consumers and the food business are interested in species like Porphyra sp., Chondrus crispus, Himanthalia elongate, and Undaria pinnatifida because of their low calorie content and high vitamin, mineral, and dietetic fibre content. Microalgal biomass, on the other hand, is often accessible in the form of powder, pills, capsules, liquids, and may even be included into a variety of food items. However, only a few taxa use microalgal biomass, with the Spirulina and Chlorella species being the most significant in human nutrition.

Spirulina is nature's richest and most complete source of organic nutrition, and it's quickly gaining popularity as a health food due to its high protein content and many bioactive components. Since ancient times, indigenous people in Mexico and Africa have utilized it as food, and it is now employed as a human nutritional supplement as well as a feed additive in the aquaculture, aquarium, and poultry sectors.

1.6 Algae in Animal Nutrition:

Microalgae have a great nutritional value in the diets of pigs, cows, sheep, poultry, and other domestic animals, as well as many aquatic species, according to many nutritional studies (in aquaculture). Because large amounts of biomass are required, algae are not considered an essential feed source in most studies. However, even when used in small amounts, algae have been linked to improved immune function, lipid metabolism, gut function, stress resistance, as well as increased appetite, weight, number of eggs, reproductive performance, and cholesterol reduction. A significant number of nutritional and toxicological studies have shown that algal biomass may be used as a useful feed additive or as a replacement for traditional protein sources (soybean meal, fish meal, etc.). The poultry is the domestic animal of choice, owing to the fact that incorporating algae into poultry diets provides the best chance for commercial application in animal feed. Algae may be utilized as a partial substitute for traditional proteins in chicken, with a percentage of 5-10%. They may also serve as practically the only protein supply in laying hens, and they are legally authorized as chicken feed in many countries. Yap et al. anticipated the inclusion of even 33% in pig feed with no detrimental effects.

In the commercial production of aquatic organisms, microalgae serve as a food supply and nutritional supplement. Given that they are natural food for these species, their significance in aquaculture is unsurprising. Using certain species of microalgae in the diet of fish fry reduces their price by 50%, and a combination of two or more species is often employed to achieve a greater nutritional value of microalgal biomass. In the Japanese fish farming business, the genus Spirulina is extensively utilized as a feed supplement, with inclusion levels ranging from 0.5 to 2.5 percent. Sturgeon given a Spirulina-based diet fared even better than those fed fish meal-based diets.

2. DISCUSSION

Algae are a class of creatures that are mostly aquatic, photosynthetic, and nucleus-bearing but lack the actual roots, stalks, leaves, and specialized multicellular reproductive systems that plants have. Algae are often associated with the color green, although they may come in a variety of colors and tints, depending on the kind of algae and, in certain instances, how they are produced. Individual cells contain pigments (colored chemicals) that give them their hues. Algae are sometimes referred

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to as "plants" and other times as "protists" (a grab-bag category of generally distantly related organisms that are grouped on the basis of not being animals, plants, fungi, bacteria, or archaeans). Brown algae (Phaeophyceae), green algae (Chlorophyta), and red algae (Chlorophyta) are the three main categories of macroalgae (Rhodophyta). Because all of the groupings include chlorophyll granules, their distinctive hues are generated from pigments other than chlorophyll.

3. CONCLUSION

Algae may be found all around the world. Algae is also utilized in the food sector as a dietary supplement and a component of functional foods. Algae is also used to enhance the quality of meat products such as pasties, steaks, frankfurters, and sausages, as well as fish, fish products, and oils. Given how little is known about microalgae, their cultivation can be independent of external conditions, convert solar energy more efficiently than higher plants, do not require fertile soil, produce a wide range of substances, can be used for a variety of applications, and some species reproduce very quickly, making these organisms a truly remarkable source of food. The ability to control and define metabolism and the synthesis of the target chemical by changing the growth conditions is a significant benefit. While mixing various species or combining them with other foods offers up numerous options, utilizing them in feed may also address the problem of employing plants that are initially and mostly utilized as food. They may also be able to reduce the cost of animal feed. Manufacturers of these organisms all over the globe have identified various potentials and have therefore concentrated their efforts only on the food and feed industries.

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