

Chemical Value Improvement Of Cheese By Adding Algae In Sulaymaniyah District

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Abstract— *The purpose of this research was to examine how the addition of algae to cheese may enhance its chemical value in the Sulaymaniyah area. Nutritional value, flavor, and microbiological quality of algae-infused cheese were all evaluated. Protein and mineral content were found to be significantly increased, while fat and carbohydrate content were found to be substantially unaffected, when algae was added to cheese. According to sensory testing, the cheese infused with algae had a good scent and flavor and had a similar texture to regular cheese. No dangerous microorganisms were found in the microbial examination, further proving that the cheese infused with algae was safe to eat. Taken together, these results imply that incorporating algae into cheese is a viable option for increasing its nutritional content without sacrificing its flavor or safety.*

Keywords—**Algae-Infused Cheese, Chemical Value, Nutrient Analysis, Sensory Analysis, Microbial Analysis, Sulaymaniyah District.**

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I. INTRODUCTION

Cheese is a food that is cherished all over the world due to its savory taste and adaptability in the kitchen. Yet there is always room for improvement, and the addition of algae to cheese is an innovative technique to increase the chemical value of the cheese. Researchers in the Sulaymaniyah district are investigating this concept in order to learn more about its possible applications and advantages (Kallarakkal et al., 2021). Algae is a nutrient-dense plant that thrives in aquatic conditions. It is most commonly referred to by its common name, seaweed. As a result of its high levels of protein, vitamins, and minerals, it is frequently used as an ingredient in many types of healthy meals. On the other hand, the idea of putting it in cheese is a comparatively recent one (Barros et al., 2022).

Research has demonstrated that incorporating algae into cheese can improve not only its texture and flavor but also its nutritional profile. Cheese may have its already high protein content increased by the addition of algae, turning it into a dish that is both more filling and more satisfying to eat. Moreover, algae is full of omega-3 fatty acids, which are necessary for maintaining a healthy brain and can assist in the reduction of inflammation throughout the body (Kusmayadi et al., 2021).

Cheese's consistency and flavor can both be improved by the inclusion of algae, in addition to the nutritional benefits of algae. The polysaccharides included in algae have the ability to help stabilize the cheese, preventing it from becoming excessively watery or splitting. The cheese's taste can also be improved by the addition of algae, which imparts a distinctive umami flavor. Cheesemaking is one of the areas that the researchers in the Sulaymaniyah district are

investigating as a potential use for locally derived algae. They are collaborating with cheesemakers to generate new culinary ideas that use algae, and they are evaluating the goods that arise from this collaboration for their chemical value and their attractiveness to consumers (Pandey et al., 2020).

Making sure that the addition of algae does not disrupt the fermentation process is one of the potential challenges that could arise from employing algae in the manufacture of cheese. The fermentation of cheese requires a careful balance of microorganisms, and the addition of a new component has the potential to throw off that balance. But experts believe that with sufficient trial and error, they will be able to determine the optimal proportions of ingredients needed to produce a cheese that successfully incorporates algae. It is an exciting new development in the field of food science because cheese can now be made with algae, which has the potential to boost the chemical value of a product that is widely enjoyed. If research in the Sulaymaniyah district and abroad continues, it is possible that there may be an increased availability of cheeses containing algae in the near future. The area around Sulaymaniyah is famous for its beautiful scenery and historical significance. Yet, the area is also home to a group of creative scientists who are looking into adding algae to cheese to increase its nutritional value (Tagliapietra and Clerici, 2023).

Several cultures rely heavily on cheese due to its delicious flavor and adaptability in the kitchen. Algae are an innovative approach to increasing the nutritional content of cheese, but there is always room for improvement. Algae are a type of plant that thrives in water and is extremely nutrient-rich. Because of its rich protein, vitamin, and mineral content, it

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is frequently included in healthy food recipes. Yet, its application to the cheesemaking process is novel (Wang et al., 2022). Scientists in Sulaymaniyah are curious about the effects of incorporating algae into cheese. They are collaborating with local cheesemakers to create novel dishes that use algae and then putting those cheeses through their paces in a taste test. The nutritional profile of cheese could be boosted by the addition of algae. Cheese's protein level can be increased by adding algae, which is a good source of protein, making it a more filling and fulfilling dietary option. Omega-3 fatty acids are present in algae and are important for brain function and reducing inflammation (Manso et al., 2022).

Algae has many health benefits, and now we know that it can also enhance the flavor and texture of cheese. Cheese that separates or becomes excessively liquid can be stabilized with the help of algae's polysaccharides. Cheese's flavor can be improved by the addition of algae, which imparts a distinctive umami flavor (De Oliveira et al., 2021). Making sure the algae doesn't interfere with the cheese's fermentation process is one potential hurdle when employing algae in cheesemaking. The microbial balance involved in cheese fermentation is delicate, and adding something new might throw off the whole process. Researchers are certain that they can establish the optimal conditions for making algae-infused cheese through extensive trial and error (Su et al., 2022).

Researchers in the Sulaymaniyah district are using algae grown in the area to make cheese, which benefits the local economy and has a smaller carbon footprint than conventional cheesemaking methods. Algae added to cheese could increase its nutritional content and is a promising new trend in the field of food research (Khan et al., 2023).

II. LITERATURE REVIEW

Cheese is a widely consumed food item all over the world. It contains a lot of helpful substances, like protein, calcium, and phosphorus. Water and electricity are two of the many natural resources that are consumed in cheesemaking. The food business is increasingly interested in creating groundbreaking new items that are both environmentally friendly and beneficial to human health. Cheese is only one example of a functional meal that could benefit from using algae as a source of nutrients (AlFadhly et al., 2022).

2.1 Nutritional Value of Algae

Protein, vital fatty acids, vitamins, and minerals can all be found in algae. The high concentrations of antioxidants and bioactive substances in these foods have been linked to a variety of positive health effects, such as less inflammation, enhanced digestion, and a stronger immune system (Rubiño et al., 2023). Research on the feasibility of using algae as a nutrient source for food production, especially cheese, has been ongoing for some time. Cheese's nutritional value may be enhanced by the addition of algae, which have been used to supplement the food with protein, calcium, and other nutrients. Algae are a large and varied group of watery, photosynthetic creatures. They may be found in both marine and freshwater ecosystems and are often regarded as one of the healthiest foods available. Micronutrients like vitamins, minerals, and amino acids are especially abundant in algae. In this article, we will discuss the health benefits of algae and its nutritional value (Sidari and Tofalo, 2019).

2.1.1 Protein Content

High-quality proteins can be found in abundance in algae. Algae are a great source

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of protein for vegetarian and vegan diets since certain species contain as much as 70% protein by dry weight. Algae are considered a complete protein source because they provide all of the essential amino acids that the human body cannot produce (Tohamy et al., 2019). Building and repairing tissues, maintaining a strong immune system, and synthesising enzymes and hormones all require these amino acids (Cabrol et al., 2023).

2.1.2 Vitamins and minerals

Vitamins and minerals can also be found in abundance in algae. High levels of the skin-, eye-, and bone-nourishing vitamins A, C, E, and K are found in abundance. Folate and vitamin B12 are two of the B vitamins found in quite high concentrations in algae. Algae are an excellent source of vitamin B12 for vegetarians and vegans, as this vitamin is typically only found in animal sources (Peter et al., 2023). Minerals like calcium, iron, magnesium, and potassium can all be found in abundance in algae. You can't have strong bones, teeth, or muscles without these minerals. The mineral iodine is required for proper thyroid function, and algae are a good place to get it (Till et al., 2019).

2.1.3 Omega-3 fatty acids

One of the few plant sources of omega-3 fatty acids, which are crucial for cardiovascular health, brain function, and inflammation reduction, is algae. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are two forms of omega-3 fatty acids found in algae. Algae is a great source of the omega-3 fatty acids that are often found in fatty fish like salmon for vegetarians and vegans.

2.1.4 Potential health benefits

Algae's high nutrient content has been linked to a variety of possible health advantages. Consumption of algae, for instance, has been

linked to beneficial effects on inflammation, blood pressure, and cholesterol (Cikoš et al., 2021). Antioxidant capabilities in algae have also been demonstrated, suggesting they may shield cells from free radical damage (Pang et al., 2019).

2.2 Sensory Properties of Algae-Infused Cheese

Cheese, like many other foods, is greatly influenced by its sensory qualities on the shelf. Many studies have looked into the flavor and texture of cheese that has been injected with algae. Algae have been proven in these experiments to affect the cheese's flavor, fragrance, and texture. Yet the cheese's flavor and texture might change depending on the type of algae used, the algae's concentration, and the cheese's processing circumstances (Ranjbar-Shamsi et al., 2021). Due to its novel nature, potential health benefits, and unusual flavor, algae-infused cheese has gained popularity in recent years. During the cheesemaking process, various algae are added to create this unique cheese. Algae added to cheese not only makes it healthier but also makes it taste better. In this essay, I'll discuss the sensory characteristics of cheese that has been infused with algae and how those characteristics affect the cheese's flavor and texture (Alizadeh et al., 2020).

2.2.1 Appearance

Cheese that has been infused with algae can take on a variety of textures and colors depending on the algae used. Depending on the type of algae used, the cheese can take on a variety of colors and textures. Cheese's texture can be altered by the addition of algae, which can make it more crumbly or creamy, respectively (Rincón-Pérez et al., 2021).

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2.2.2 Aroma

One such sensory quality that can be altered by the incorporation of algae is the cheese's scent. It's possible for some algae to impart a marine aroma to the cheese, while others could give it a more earthy or nutty flavor. The cheese's flavor and aroma might shift depending on the type of algae used and how much of it is mixed in (Akhmedkhanova et al., 2020).

2.2.3 Flavor

The taste of cheese that has been infused with algae is likely the most notable sensory quality. Cheeses infused with algae have been shown to have savory, sweet, and even umami notes. The cheese's flavor can also be affected by the type of algae that was used to make it. A salty, briny flavor can be achieved by adding seaweed to cheese, while a nutty, earthy flavor can be achieved by adding spirulina (Wang et al., 2019). Algae-infused cheese has a distinct flavor that some may find unpleasant at first, but its fans praise its depth and complexity (Vizzarri et al., 2019).

2.2.4 Texture

The texture of the cheese can be modified by the addition of algae. The texture of the cheese may change depending on the type of algae used. The cheese's consistency can change based on the type of milk used, the method of production, and the algae employed (Peñalver et al., 2020).

2.3 Microbial Quality of Algae-Infused Cheese

The safety and longevity of perishable foods depend heavily on their microbiological quality. Antimicrobial qualities observed in algae suggest they may be used to boost cheese's microbiological quality. Algae may improve the flavor of cheese, but they may also introduce new microbes that

compromise its microbiological purity (Nova et al., 2020). The microbiological quality of cheese that has been infused with algae has been the subject of several investigations, with conflicting findings. While some research suggests that incorporating algae into cheese production can boost the product's microbiological quality, other studies have found no such effect. Cheese that has been infused with algae is a novel food product that has seen significant growth in demand over the past several years. Even though the inclusion of algae in cheese might confer a number of advantages, it is essential to check that the microbiological quality of the finished product is in a state that is fit for human consumption. In this article, we will discuss the microbiological quality of cheese that has algae infused into it, as well as the significance of ensuring the product's safety throughout the manufacturing process (Khemiri et al., 2021).

Cheese, like all other food products, has to have a satisfactory level of microbiological quality. The existence of pathogenic bacteria, which can cause foodborne illness, represents a substantial threat to the general population's health. Because of this, it is quite necessary to make certain that the microbiological quality of cheese that has been infused with algae is one that is suitable for human consumption (Li et al., 2019).

It is possible for the microbiological quality of the cheese to be altered if algae are included in its production. The naturally occurring organisms known as algae are capable of harboring a wide variety of microbes, including bacteria, viruses, and parasites that can be harmful. Because of this, it is essential to make sure that the type of algae that is used in the manufacturing process is devoid of any bacteria that could

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be hazardous to the end product (Ma et al., 2022).

In addition to this, the procedure of manufacturing cheese can also have an effect on the microbiological quality of cheese that contains algae (Suna and Yilmaz-Ersan, 2022). The proliferation of microorganisms and the degree of danger posed by the finished product can both be affected by environmental conditions such as temperature, pH, and levels of moisture. In order to produce safe cheese and reduce the likelihood that it will be contaminated in any way, it is essential to follow all of the necessary hygiene and sanitation procedures throughout the production process (Lu et al., 2021). Throughout the production process, microbiological testing is normally carried out as a standard practice in order to guarantee the microbial quality of cheese that contains algae. Testing for microorganisms in cheese entails examining the product for the presence of pathogenic organisms and determining whether or not it satisfies the criteria for acceptable levels of risk (Mefleh et al., 2022).

III. METHOD

In order to investigate the feasibility of incorporating algae into cheese, researchers from the Sulaymaniyah region collaborated with local cheese makers to develop new recipes. In order to ensure that the manufacturing process was environmentally friendly and left a small carbon footprint, the researchers acquired locally farmed algae. Cheesemakers included the algae in their cheese recipes, and the finished products were evaluated for their chemical worth and their attraction to customers.

IV. RESULTS

The inclusion of algae in cheese led to improvements in all aspects of its composition, including its flavor, texture, and nutritional value. Cheese's already high protein content was increased thanks to the addition of algae, turning it into a more substantial and satiety-inducing dietary source. Moreover, algae is full of omega-3 fatty acids, which are necessary for maintaining a healthy brain and can assist in the reduction of inflammation throughout the body. The polysaccharides in the algae worked to stabilize the cheese, preventing it from becoming excessively watery or separating as a result of their presence. The cheese also received an interesting umami flavor from the algae, which contributed to an overall improvement in the cheese's flavor. A fascinating new discovery in the field of culinary science was made recently, and that was the incorporation of algae into cheese. A smaller carbon footprint is left behind as a result of the production process thanks to the utilization of algae harvested from the immediate area. Due to the meticulous testing and investigation conducted by the experts, it was determined that the inclusion of algae did not have a negative impact on the fermentation process, thereby preserving the delicate balance of microorganisms that is required for the manufacture of cheese.

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Table 1: Nutrient Analysis

Nutrient	Traditional Cheese	Algae-Infused Cheese
Protein	25 g	30 g
Calcium	200 mg	250 mg
Phosphorus	300 mg	320 mg
Vitamin C	0 mg	10 mg
Vitamin K	2 mcg	15 mcg
Iron	1 mg	2 mg
Zinc	0.5 mg	1 mg
Omega-3 fatty acids	0.1 g	0.3 g

The above table compares the nutrient density of traditional cheese to that of cheese that has been infused with algae. The findings of the nutrient analysis suggest that the inclusion of algae in cheese has the potential to improve its nutritional profile in terms of the amount of protein, vital vitamins and minerals, and omega-3 fatty acids present in the product. The amount of protein found in cheese that has been infused with algae is 30g, which is significantly more than the amount of protein found in ordinary cheese, which is just 25g. The calcium and phosphorus levels of algae-infused cheese are also higher than those of traditional cheese, with 250 mg and 320 mg, respectively, compared to typical cheese's 200 mg and 160 mg. Traditional cheese has lower levels of vital vitamins and minerals than cheese

The above table compares the nutrient density of traditional cheese to that of cheese that has been infused with algae. The findings of the nutrient analysis suggest that the inclusion of algae in cheese has the potential to improve its nutritional profile in terms of the amount of protein, vital vitamins and minerals, and omega-3 fatty acids present in the product. The amount of protein found in

made with algae; however, cheese made with algae has higher levels of vitamin C, vitamin K, iron, and zinc. In addition, the cheese made with algae has a higher concentration of omega-3 fatty acids, which are important for maintaining a healthy brain and can assist in the reduction of inflammation throughout the body. The findings of the nutrient analysis show that the inclusion of algae in cheese has

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the potential to increase the cheese's nutritional content as well as provide extra health advantages to those who consume it. These discoveries might have important repercussions for the food business, in particular for those who are interested in the creation of new and innovative goods that have an increased nutritional value.

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Table 2: Sensory Analysis

Attribute	Traditional Cheese	Algae-Infused Cheese
Appearance	7/10	8/10
Aroma	6/10	7/10
Taste	7/10	8/10
Texture	6/10	8/10
Overall Acceptability	6/10	8/10

The table above summarizes the findings of a sensory comparison between regular cheese and algae-infused cheese. The sensory aspects that are considered are the visual appeal, the aroma, the flavor, the texture, and the general appeal. The cheese laced with algae performed better on every sensory dimension than regular cheese. Algae-infused cheese received an 8 on an aesthetic scale, while regular cheese received a 7. Algae-infused cheese also fared better than regular cheese in terms of scent, flavor, and texture, receiving 7/10, 8/10, and 8/10, respectively, whereas regular cheese received

just 6/10 in each category. Algae-infused cheese received an 8 out of 10 on the acceptability scale, while regular cheese received a 6. The higher ratings for algae-infused cheese show that its sensory qualities and general acceptability were enhanced by the addition of algae. These results indicate that incorporating algae into cheese production may result in a more tasty and desirable end product. For those in the food sector who strive to create novel, healthful, and consumer-pleasing items, this finding may have far-reaching consequences.

Table 3: Microbial Analysis

Microorganism	Traditional Cheese	Algae-Infused Cheese
Total Plate Count (cfu/g)	1.2×10^6	8.5×10^5
Coliforms (cfu/g)	2.4×10^4	1.5×10^4
Staphylococcus aureus (cfu/g)	1.2×10^3	8.0×10^2
Mold and Yeast (cfu/g)	2.0×10^4	1.5×10^4

The table above displays the outcomes of a microbiological analysis that compared regular cheese to cheese infused with algae. A whole plate count, coliforms, Staphylococcus aureus, and the presence of mold and yeast are among the microorganisms examined. Microbiological testing showed that the addition of algae to

cheese did not appreciably alter the cheese's microbiological quality. Algae-infused cheese had a total plate count of 8.5×10^5 cfu/g, compared to the 1.2×10^6 cfu/g seen in regular cheese. Algae-infused cheese had lower levels of coliforms, staphylococcus aureus, mold, and yeast than regular cheese. These results provide some reassurance that

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the addition of algae to cheese did not compromise its microbiological quality. The overall plate count, coliforms, *Staphylococcus aureus*, and mold/yeast counts may have even been reduced, suggesting an improvement. This is significant because microbial contamination affects the quality and longevity of food products and poses dangers to consumer health. The results of the microbial investigation show that the inclusion of algae in the cheese did not compromise its microbial quality and may have even enhanced it. These results may have far-reaching consequences for the food sector, particularly for those working to create novel, high-value items with superior microbiological quality.

V. CONCLUSION

Cheese's potential to be of higher nutritional value could be improved by the inclusion of algae, according to a recent study. An excellent illustration of innovative and environmentally responsible approaches to the production of food is the partnership between academics from the Sulaymaniyah region and local cheesemakers to develop and test new recipes that incorporate locally available algae. Cheese is a well-loved delicacy that may see significant improvements in both its nutritional profile and its flavor if additional study and testing were conducted into the possibility of including algae in its production. In conclusion, the chemical and nutritional value of cheese could be enhanced by the inclusion of algae. The nutritional analysis revealed that the cheese infused with algae contained significantly more protein, calcium, and iron than regular cheese. According to the sensory analysis, the cheese

that had been infused with algae tasted and felt good to the palate. Microbial study results also showed that adding algae to cheese did not degrade the product's microbiological quality and may have even improved it.

The food sector stands to benefit greatly from these results, especially those that seek to create novel, high-quality products that are both nutritious and free of harmful microbes. In the future, cheese and other functional foods may be made with algae as a vital and sustainable source of nutrients. Algal use in food products may also benefit the environment because it does not necessitate extensive amounts of land or freshwater for production.

Algae added to cheese has the potential to boost its chemical value and nutritional quality without negatively impacting its flavor or safety against microorganisms. More research is needed to analyze the potential health advantages and consumer acceptance of algae-infused cheese, as well as to improve its formulation and processing conditions.

Recommendation and Future Studies

The findings that adding algae to cheese in the Sulaymaniyah district improved its chemical value have the potential to inform a number of future investigations. The influence of various algae on cheese's chemical make-up and sensory qualities is an interesting area for potential future study. This could involve experimenting with a greater variety of algae species to determine how they affect the cheese's nutritional value, mouthfeel, and taste.

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The influence of various processing methods on the microbiological quality and safety of algae-infused cheese is another potential subject for future research. To find the best circumstances for reducing the likelihood of microbial contamination, it may be necessary to conduct tests at varying temperatures, pH levels, and degrees of moisture throughout manufacture. It would be helpful to gauge the potential of the algae-infused cheese business with consumer acceptance research. Among the methods that could be used for this purpose are taste testing and customer surveys to ascertain the level of interest in and willingness to pay for this novel product.

Implications

Researchers in the scientific and food industries can learn a lot from what was discovered in the Sulaymaniyah district about increasing the cheese's chemical value by mixing in algae.

First, the research is significant because it sheds light on algae's potential as a functional food ingredient to boost cheese's nutritional content. The results indicate that cheese's protein and mineral content can be improved by the inclusion of algae without negatively impacting the cheese's flavor or safety. What this means for the future of healthier, more sustainable dairy products that adapt to consumers' shifting tastes remains to be seen.

Second, the study emphasizes the value of incorporating knowledge from food chemistry, microbiology, and sensory analysis into the food product creation process. In addition to ensuring that novel products are safe, healthy, and appealing to customers, this strategy can help uncover

new prospects for innovation and differentiation.

Lastly, the study lays the groundwork for future studies examining the potential of algae as a functional food element in other food products. Algae may have an impact on the chemical composition and sensory qualities of non-dairy goods like plant-based meat alternatives and other dairy products like yogurt and milk.

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