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An overview of the applications of Spirulina platensis algae in improving the nutritional and functional properties of dairy products and its use in the recycling of dairy industry waste.

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ABSTRACT

Spirulina (Spirulina) is the general name of filamentous, multicellular and blue-green microalgae, of which the two genera Arthrospira and spirulina are important edible spirulina. This algae is the most common and widely used species that has been studied and investigated in many fields, especially food and medical industries. Chemical analysis of spirulina microalgae shows that it is an excellent source of some macronutrients and micronutrients. Spirulina is rich in protein, vitamins, essential amino acids, minerals and essential fatty acids that are important for health. The cell cover of spirulina is made of a thin hydrocarbon membrane that is very quickly digested by gastric juice, for this reason spirulina is completely digestible and one of the richest food sources available.By adding spirulina instead of stabilizer, the nutritional properties of dairy products will improve and they will have a better texture, appearance and color than before because spirulina can be used as a stabilizer. Adding 1 to 1.5% of spirulina powder to dairy products such as cheese reduces water and moisture in it, which makes it softer and is directly related to increasing its shelf life. Dairy industry is one of the most polluting industries that contain high content of elements such as phosphorus, nitrogen and carbon. Microalgae can be used to completely remove pollutants such as phosphorus and nitrogen. Spirulina blue-green algae are known to have the ability to utilize the nutrients of dairy wastewater and reduce the organic load to lower concentrations so that the treated water can be reused.In general, the addition of spirulina will increase the nutritional properties and improve the physical characteristics, and in various industries, especially the dairy industry, it can create many benefits

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1. Introduction

With the increase in public awareness of the importance of nutrition in health, the demand for superfoods has received more attention than in the past. Among the known species of algae, the blue-green spirulina microalgae has unique and extraordinary properties in the field of health promotion and nutrition, for this reason, this microalgae has always been the focus of researchers and industrialists in the field of superfoods (1).

*Spirulina platensis*Cyanobacterium is a microscopic filamentous cyanobacteria and its name is derived from its spiral and filamentous shape, which is the best known genus of cyanobacteria due to its stunning nutritional properties and is the most promising microalgae. Due to its chemical composition, which includes compounds such as all essential amino acids, vitamins, natural pigments, and essential omega-3 and especially omega-6 fatty acids such as linolenic acid and prostaglandin precursors in the body, numerous studies have shown that spirulina It is very useful for health. The dried biomass of spirulina contains about 1-20% carbohydrate, 3-7% moisture, 8-6% lipid, 10-7% ash, 60-55% protein and 10-8% fiber, spirulina contains high amounts of protein. (60-70% of its dry weight) (2).

The protein content of spirulina is 50% higher than meat, eggs, milk powder, cereals and soybeans, it contains all essential amino acids, especially leucine, valine and isoleucine. However, it is somewhat lacking in methionine, cysteine, and lysine compared to standard dietary proteins (milk, eggs, and meat), while it is superior to all plant proteins, including legume proteins. Spirulina has high amounts of many micronutrients, especially minerals (iron 0.58-1.8, calcium 1.3-14, phosphorus 0.9-7.6 and potassium 4.6-15.4 g/kg). This has made it known as a suitable food supplement for vegetarians. The mineral content of spirulina depends on the source and cultivation conditions. Spirulina is known as an iron-rich food, its iron content is ten times higher than that of ordinary iron-rich foods. Spirulina iron absorption is 60% more than iron sulfate (found in iron supplements) (3).

Spirulina microalgae is one of the nutritionally valuable foods that the World Health Organization also mentions as a valuable food, but it is better to be sterilized during heat processes when they want to use it for human consumption (4). This algae is also of interest in the treatment of diseases. In Africa, spirulina is used to fight AIDS and children with immune system defects and nutrient deficiencies. Also, its consumption is always recommended for other humans, for this reason, the production of products free from any contamination and risk is very important. Some of the studied biological effects of spirulina microalgae are listed in Table 1. To ensure the exact quality of production and final products from spirulina, risk analysis, critical control and other methods of good product production should be implemented (5).

Spirulina has many and potential applications, for example, as food ingredients to improve the health properties of products such as nutritional supplements, beverages and fermented milks, cereals and bakery products, desserts, cakes and confectionery products, biscuits, snacks, soups, sauces. Salads and dairy products such as ice cream, yogurt, dairy-based drinks, etc. are used (6); Also, in dairy products, promising results have been reported on the enrichment of yogurt (7), ultra-refined cheese (8) and buttermilk (9) with spirulina microalgae. The abundance of important biological compounds in algae provides new opportunities in the production

of useful dairy products. Dairy products include milk, cheese, butter, ice cream and buttermilk, etc., which form a major part of people's diet. Yogurt alone is a healthy food because it contains healthy ingredients, especially high calcium, vitamins and beneficial microbial flora. But cultivation is our beginning,*Lactobacillus bulgaricus* And*Streptococcus thermophilus*, they often do not have a high survival rate in the stomach (10), therefore, adding probiotic strains that have the ability to pass and survive in the digestive tract is an effective approach in the production of practical yogurt. Also, the microbial flora of yogurt along with probiotic bacteria that have low proteolytic activity are used in order to reduce fermentation time in these products. Spirulina microalgae creates antioxidant properties and improves the growth of probiotic bacteria*Lactobacillus paracasei* The antioxidant property of spirulina is mainly attributed to phycocyanin, beta-carotene and phenolic compounds, dairy products contain*Lactobacius paracasei* They are considered a probiotic and consumption of probiotic products that contain spirulina can increase the health benefits of yogurt. Lactobacillus and Bifidobacterium genera are the most common probiotic bacteria used in dairy products (11).

One of the by-products of the dairy industry in Brazil that has environmental effects is whey, which is the residue of cheese production through various processes. It has been shown that the production of microalgal biomass in mixed trophic cultures with whey is possible because these wastes provide important substrates such as sugars as a source of organic carbon for microalgal species (12). Cheese is one of the foods whose protein is high quality and rich in essential amino acids. Compared to other fermented dairy products, such as yogurt and fermented milks, due to having some characteristics such as high fat, dense and cohesive texture, cheese is a food that carries probiotics, in order to preserve their biological activity in all stages of passing through the device. digestion is very suitable; It also has a higher pH than fermented milks. This feature can help the survival of more probiotics. Adding algae and probiotics to cheese at the same time will double the nutritional value (13). Ice cream is one of the popular dairy products in the world and in Iran, which has many fans in most age groups. For this reason, ice cream seems to be a good target product for adding spirulina to the general food chain. It also seems that the blue-green color of spirulina will give the ice cream a more attractive appearance. In addition, spirulina can be used as a thickening and stabilizing agent for ice cream because it has properties such as emulsifying and absorbing water (14). Buttermilk is known as a popular and acceptable national drink of Iran, which is a healthy fermented drink that can have desirable sensory characteristics and is very important in terms of health. The amount of buttermilk produced.

In Iran and some other countries, including Turkey with the name of Ayran, India with the name of Lasi, Azerbaijan, Armenia, Afghanistan, etc., as a nutritious and strengthening drink compared to other types of drinks, it is significant to add different concentrations.*Spirulina platensis* While preventing specific changes in pH, it increases the acidity of buttermilk and has a positive effect on the iron and protein content of the treatments, therefore, due to the amount of vitamins, proteins, essential fatty acids and rare elements of natural origin, it provides new opportunities in the production of beneficial products. (15).

Another dairy product is curd, which can be prepared by boiling, concentrating, or drying the buttermilk that remains after buttering, or from fat-free yogurt (16). In the processing of this traditional product, a fundamental problem that exists is the persistence of some pathogenic bacteria such as Escherichia coli during the preparation and fermentation of liquid curd and even during its storage, which reduces the shelf life of curd and causes danger and damage to The health of the consumer will be that one of the ways to increase the nutritional value and health benefits of curd is to enrich it with spirulina algae, which is used in the production of curd due to its favorable color and essential nutrients of the body (17).

Table 1- of some studied biological effects of spirulina microalgae

Biological properties	Special effects	Bioactive components	Reference
Anticancer	Damaged DNA repair, selective inhibition of cyclooxygenase-2	Polysaccharides, C. phycocyani	18
anti Virus	inhibition of DNA polymerase activity, Blocking virus uptake and penetration into vero cells	Sulfolipids, calcium spirulina (sulfated polysaccharide)	19
antibacterial		Fatty acids such as G	20
Metal protector	Inhibiting lipid peroxidation, eliminating free radicals, increasing the activity of GSH-peroxidase and superoxide dismutase.	Antioxidant components	21
Antioxidants	Free radical scavenging activity	Carotenoids, phycocyanin and chlorophyll	22

2- The use of spirulina in dairy products

2-1- Milk

Spirulina contains more than a hundred types of nutrients and is a rich and inexpensive source of protein, essential amino acids, omega 3 and 6 fatty acids, minerals and essential vitamins, which is approved by various national and international organizations in charge of food. And it is health. However, due to the unpleasant organoleptic characteristics of

spirulina, the introduction of this algae alone as a food is likely to be unpopular with the consumer. One of the appropriate ways to introduce these food components to the consumer's food basket is to use them in the formulation of well-known food products.

So far, spirulina has been used to enrich many food products such as drinks, meat products, pasta products, etc. In the use of this algae in the dairy industry, promising results have been obtained regarding the enrichment of milk, yogurt, ultra-refined cheese and buttermilk..

Vaega and Sziget (2012) enriched milk with spirulina and stored them at 4 degrees Celsius and did not observe coliform contamination in them, but when they stored them at 15 degrees Celsius, the amount of coliforms increased from 10 to10^5 It changed in 15 days (23).

When spirulina powder and fresh spirulina sample are cultured for counting coliforms in blood agar culture medium according to standard culture methods, it is observed that the amount of coliforms counted in spirulina powder is less than fresh sample (24). According to food standards, the amount of coliforms in spirulina powder is suitable for livestock, poultry and aquatic food, but it is not suitable for human nutrition. Spirulina is clearly richer than soybean meal in terms of content of protein, even when spirulina-specific nitrogen is used. In studies that were conducted with the aim of replacing soybean meal with spirulina in the diet, the effects on feed consumption, milk production, milk fat, protein or lactose content were investigated. The milk of cows fed with spirulina had a higher beta-carotene content (0.207 vs. 0.135 μg/ml) and was yellower. Milk fat from cows fed spirulina, similar to spirulina lipids, had a higher proportion of γ-linolenic acid (0.057% vs. 0.038% fatty acid methyl esters) compared to milk fat obtained from soybean meal. Fed cows also have increased trans-11 C18:1 (vaccinic acid) and other trans-C18:1 isomers. There is no sensory difference between the milk of the two experimental groups in the diet control. In addition, there is no effect of replacing soybean meal with spirulina on total antioxidant capacity, alpha-tocopherol and total phenol of blood and milk. Spirulina appears to be a promising protein source for dairy cows with significant improvement in the optimal nutritional composition of milk and no adverse effects on livestock performance in the short term (25).

The higher yellowness of milk from cows fed spirulina could be related to the higher content of beta-carotene in the milk. However, carotenes such as beta-carotene are not the main carrot enoids in spirulina, where 83% of the total carrot enoids are from xanthophylls (myxoxanthophyll, zeaxanthin, lutein, betacryptoxanthin). Composed. Xanthophylls are also transferred to cow's milk and thus may contribute to the milk's yellow color (26).

In the study of Chiristaki et al., who in 2012 studied the effect*Spirulina platensis* The diet was based on the milk fatty acid profile of dairy cows, 20 healthy Holstein breeds with an average age of 4.3 years in the second month of lactation were divided into 2 groups. This experiment lasted for 7 weeks and every 15 days the milk fatty acid profile was evaluated. The results showed that dietary spirulina reduces saturated fatty acids, while increasing monounsaturated and polyunsaturated fatty acids. As a result, it can be said that spirulina is a promising food supplement for fortifying cow's milk with health-related unsaturated fatty acids (27).

Today, one of the most important topics in the field of dairy is the survival of probiotic bacteria during the production and storage of fermented milk. Spirulina and Chlorella are the most common microalgae for fermented

milks. In addition to the survival of probiotics in the final product, they also affect their sensory characteristics. Incorporation of microalgae into probiotic fermented milks along with increasing the viability of probiotics increases their functional characteristics. They are called "functional food."[1]" are known because they contain a wide range of nutrients and are considered as "functional food" (28).

In a study conducted by Limanen et al. in 2019, the effects of rapeseed meal (RSM)[2] or beans (FB)[3] As the only protein feed or as the protein feed that was partially replaced by the microalgae Spirulina platensis (Spirulina) on milk production, nitrogen utilization and AA metabolism of dairy cows were investigated. The inclusion of spirulina in the diet depends on the source of protein in the basal diet, and this study confirmed a lower protein yield response with FB than with canola, and the results show the AA profiles of FB and spirulina supplementation. This suggestion suggests the potential to improve the milk production response of FB-containing diets with methionine-rich dietary supplements such as spirulina (29).

In a study conducted by Lloydharto et al. in 2022, the effect of adding high concentration*Spirulina platensis* In fermented milk, the growth of microbial cells, acid production and antioxidant activity were investigated. The results of this study showed that increasing the concentration*Spirulina platensis* In fermented milk, it increases the growth of microbial cells, acid production and antioxidant activity, during milk fermentation by adding 0.3%*Spirulina platensis*The cells multiplied and the total number of lactic acid bacteria and probiotic cells after 24 hours reached 8.73, 9.19 and 8.92, respectively, and titratable acidity reached 1.08% and pH decreased to 4.41. Found. The results showed that the viscosity after 12 hours of fermentation increases significantly compared to the control group and the fermented milks with the addition of*Spirulina platensis* By*Lactobacillus plantarum* And*Streptococcus thermophilus* can be developed as alternative functional fermented milk products (30).

[1] -functional food
[2]- rapeseed meal
[3]- faba beans

Spirulina powder contains vitamins A, E and all B vitamins, high-quality proteins, 18 of the 20 known amino acids, calcium and potassium, as well as many essential minerals and enzymes. A study by Abid et al. in 2022 to prepare a healthy probiotic spirulina milk (SPL).[4] By investigating the effect of adding spirulina powder on the physicochemical, microbiological properties, antioxidant activity and sensory characteristics in addition to the nutritional value compared to the control, SPL by *Lactobacillus acidophilus* And *Streptococcus thermophilus* inoculated Then, microalgae were added to buffalo milk fermented by spirulina (0, 0.2, 0.4, 0.7 and 1% w/v) separately. Spirulina probiotic milk samples significantly ($p \leq 0.05$) increased probiotic viability, higher levels of protein, dietary fiber and antioxidant activity, while it had less synergism than the control milk. Vitamins B1, B9 and B12 as well as minerals such as iron, zinc, potassium and magnesium were higher in SPL samples than in the control group. Phytopigments increased with increasing levels of spirulina with values from 0.16 to 0.61 for chlorophyll a and from 3.10 to 4.89 for phycocyanin. (chlorophyll a, carotenoids) increased with increasing levels of added spirulina compared to the control. After that, the production of probiotic milk with phorphycate by spirulina is recommended as a potential source of phenolic and flavonoid compounds, phytopigments, vitamins, fiber and high mineral content, as shown in Figure 1. Technological aspects of adding microalgae in probiotic fermented milks in general. is given (31).

[4]- Spirulina probiotic labneh

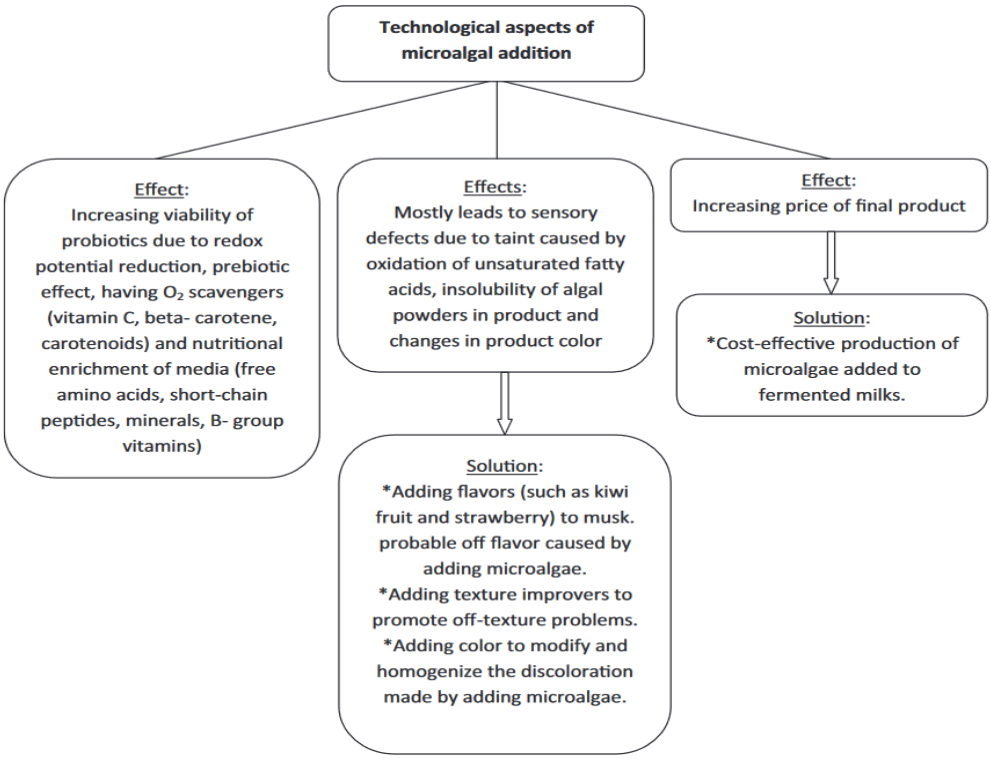

Figure 1- Technological aspects of microalgl addition in probiotic fermented milks [3]

2-2- Yogurt

Yogurt is one of the popular and widely consumed foods among fermented products, which has many health benefits and nutritional value due to the functional characteristics of its microorganisms, and this is the reason for its increasing acceptance. By changing the yogurt processing conditions, the growth of starter bacteria and acid production by them during the fermentation and storage period, the texture and taste of yogurt can be changed (7).

Increasing biomass*Spirulina platensis* It can cause several effects, for example, on the one hand, it increases the nutritional value and creates a green color in yogurt, and on the other hand, due to its complex chemical composition, it causes changes in the sensory and microbial physicochemical characteristics of yogurt. Previous studies have shown that spirulina biomass powder enhances the growth of lactic acid bacteria in synthetic culture medium, milk and yogurt (33). Spirulina powder added to yogurt is a good environment for lactic acid bacteria during refrigeration. If we use fresh spirulina in the yogurt formulation, it will lead to the production of a richer food that will satisfy consumers and will provide more health benefits due to its excellent nutritional content compared to dry spirulina. In general, the fortification of yogurt by spirulina improves functional and nutritional quality as well as health benefits without significant changes in textural properties. Textural parameters of yogurt enriched with fresh and dry spirulina are slightly different. Due to the high carbohydrate and protein content of spirulina, many authors have investigated and the results always show that high dietary fiber and milk fat globules in yogurt are correlated with lower syneresis (34). Dry or fresh spirulina can be used as a stabilizer in yogurt to reduce serum separation and improve texture. According to studies, yogurt enriched with fresh spirulina has a

higher synergism value than other formulations. This could be due to the different functional technical characteristics of different forms of spirulina (35). Total solids, protein, fat and ash are the highest in spirulina-enriched yogurts (23). Adding spirulina powder to yogurt treatments has a significant difference in terms of protein, but in terms of moisture, ash, carbohydrate, fat and pH, this difference is less than the control (36).

A study by Goldas et al. in 2010 to investigate the effect*Cyanobacterium Spirulina platensis* Powdered into plain yogurt and yogurt containing*Lactobacillus acidophilus* on the survival of microbiota during storage in the refrigerator. Yogurts were prepared in laboratory hygienic conditions and their pH and acidity were controlled during the process. Yogurt samples were kept at 4 degrees Celsius and were analyzed on days 1, 5, 10, 15, 20, 25 and 30. Examining the results showed that the control yogurt samples contained fewer lactic acid bacteria at the end of the period; Also, investigations showed that adding 1% powder*Spirulina platensis* to yogurts, it does not make a significant difference on live lactic acid bacteria (p. 0.05).≤); Also, the results show the positive effect of bulk powder*Spirulina platensis* It was on the survival of lactic acid bacteria during the storage of yogurt, and in this study, properties were also analyzed and the results indicated that the sensory scores of yogurt samples added to spirulina powder were 0.5% better than samples added to powder. Spirulina is 1% (37).

In fact, the addition of spirulina can improve the nutritional properties of yogurt and fermented dairy products, and as mentioned, recent studies have shown that spirulina can cause the growth of lactic acid bacteria (LAB).[5] be in yogurt This is the reason why Deb Babi and colleagues conducted a study in 2018 with the aim of investigating the effect of storage on the physicochemical quality of yogurt enriched with spirulina. During this study, Spirulina platensis mass biomass was produced from Gatrana SA Sidi Bouzid, which contained 21% carbohydrates, 9.41% ash, 1.5% lipid and 58% protein. Yogurt was produced by fermenting standardized pasteurized milk with thermophilic starter cultures (Streptococcus salivarius subsp. thermophilus and Lactobacillus delbrueckii subsp bulgaricus) and 0.24 grams of spirulina powder per 100 ml of milk was added to the standardized milk before the fermentation stage. The products were kept at a temperature of 4 ± 1 °C for 28 days according to the shelf life of the product. The results of this study showed that the addition of spirulina due to its biochemical properties leads to an increase in titratable acidity, total solids, proteins and ash of yogurts, and the addition of spirulina in fermented dairy products increases the growth and survival of LAB, which in turn probably causes Lactose is converted into lactic acid. Although, proteins in both control and enriched yogurts decreased during storage, probably due to milk quality and proteolytic activity, but protein and ash levels in enriched yogurts were compared

[5] Lactic acid bacteria

It remained higher with control yogurts during the storage period. Also, the results showed that total solids in control yogurts increased during storage, which is probably due to LAB synergism, but in enriched yogurts, the amount of solids was stable, which may be due to the capacity of proteins to retain water in spirulina-enriched yogurts. , limiting the phenomenon of syneresis and as a result improving the gel network and the stability of the related tissue (38).

Since the addition of spirulina can increase nutritional and physical properties in foods, in a study conducted by Arslan et al. in 2022, spirulina with different amounts (0.5%, 1% and 1.5% and control without spirulina) to Milk was added and the sensory and physicochemical properties of yogurts were analyzed for yogurt coloring. Based on the obtained results, the amount of total dry matter, protein and ash of yogurts increased due to the addition of spirulina, and on the other hand, the amount of lipids decreased, and the carbohydrate content in other yogurts, except for yogurt with 1.5% spirulina, did not differ significantly (0.05). >p) and as the amount of added spirulina increases the color decomposition, the proportion of phycocyanin increases and thus the blue color value of yogurt increases. In addition, a small amount of chlorophyll is lost. As a result of sensory analysis, the highest overall acceptance score was obtained by colored yogurt added with 0.5% spirulina. In general, it can be concluded that spirulina can be used as a natural ingredient in yogurt enrichment due to its high nutrients and pigments (39).

In a study conducted by Priyanka et al. in 2013, the enrichment of yogurt with spirulina was investigated by adding it in concentrations of 0.1, 0.2, 0.3 and 0.5%, the results showed that with increasing levels of spirulina , the amount of protein, fat and iron increases, and better quality curd is observed with an increase in the percentage of spirulina. An increase in acidity was also observed with an increase in the concentration of spirulina. It was also observed that yogurt enriched with spirulina has a natural green color. Yogurt prepared with 0.3% spirulina had better overall results than other percentages and control in terms of sensory parameters such as color and appearance, body and texture, separation of whey, taste and overall acceptability. Also, in this study, it was observed that by reducing the viability of yogurt cultures during storage, the viability of yogurt cultures in yogurt prepared with 0.3% spirulina increases compared to the control during storage at 4 degrees Celsius (40). .

In a research conducted by Lahijani et al. in 2015, the effect of adding different levels of microalgae biomass*Spirulina platensis* (zero, 0.5, 1 and 2%), in two stages of addition (before pasteurization and simultaneously with the addition of starter bacteria) on the microstructural characteristics and the development of acidity during the yogurt fermentation period, and the results showed that different levels The addition of spirulina biomass has a great effect on the parameters of acid development of yogurt and also on the time to reach the maximum acidification speed ($p<0.05$) and also the study of the microstructure of the gel network of yogurt using a vegetative electronic microscope, the positive effects of values of 0.5% and 1% percentage of spirulina biomass showed to strengthen the protein network density of yogurt (7).

In a study conducted by Bechir et al. in 2019, the effect of adding dry spirulina in yogurt was investigated in three different concentrations (0.1, 0.3 and 0.5%). Samples to determine physicochemical, rheological and sensory properties and viability*Streptococcus thermophilus* were

analyzed during storage. Interrelationships between parameters were investigated using principal component analysis. Yogurt supplementation with both forms of spirulina was able to increase the content of acidity and apparent viscosity and protein and reduce the speed of syneresis. The results showed that the supplement of fresh spirulina will slightly reduce the viability of the bacteria during storage. Yogurts enriched with fresh spirulina had different color parameters, low amount of protein, ash and viscosity compared to yogurt supplemented with dry spirulina. The grouping of variables in the principal component analysis diagram showed that each yogurt has certain characteristics. In general, it can be concluded that spirulina can be used as a natural substance to produce new yogurt with high nutritional properties (41).

The viability of probiotic bacteria or during the fermentation process and subsequent storage in the cellar is a major concern in the production of probiotic yogurt or other dairy products. Adding microalgae such as chlorella can increase the viability of probiotics in fermented dairy products such as yogurt. However, it negatively affects the sensory properties of the final product. The co-cultivation of microalgae and probiotics due to their alkaline properties and the presence of effective compounds such as adenine, hypoxanthine, etc., can stimulate growth and increase the viability and production of probiotics in products as well as in the digestive system (3).

2-3- Cheese

Cheese is one of the foods rich in essential amino acids, which contains high-quality proteins. Compared to other fermented dairy products, such as yogurt and fermented milks, due to having some characteristics such as high fat, dense and cohesive texture, cheese is a food that carries probiotics, in order to preserve their biological activity in all stages of passing through the device. Digestion is very suitable. It also has a higher pH than fermented milk. Today, there is a tendency to develop approaches such as adding microalgae to cheese to maintain or increase the amount of probiotics in some food products (42).

Since spirulina can play a role in the growth of probiotic bacteria, the effects of spirulina on lactic acid bacteria (LAB) in vitro indicate that spirulina acts as a growth promoter of LAB. Spirulina can crowd*Lactobacillus acidophilus* And*Bifidobacteria* increase (8).

One of the good carriers that can be introduced for this microalgae with ultra-refining method is Iranian white cheese. The enrichment of this product with the aforementioned microalgae leads to an increase in the amount of protein. Unlike other microorganisms that are used as a source of protein, such as yeast, these cells do not have a cellulose wall, so they have a high digestibility, and there is no need to cook and heat them to make their proteins accessible. The digestibility of this microalgae is 53-61%, which is comparable to casein, whose digestibility is 85-92% (43).

One of the most important nutritional problems in the world is iron deficiency. Hence, there has always been an interest in finding iron-rich foods. The results show that the addition of spirulina cyanobacteria powder, in addition to increasing protein, increases the iron level in cheeses, this microalgae is used as a new source of nutrients to produce a functional food (44).

Although the use of spirulina in food products can be very important in producing functional food and improving nutritional value, some of the bioactive compounds in spirulina are sensitive to heat, so processing techniques should be taken into consideration. The use of spirulina powder in various ice cream and soft cheese products in which the application of spirulina is at a relatively low temperature is necessary to protect its bioactive compounds from damage. In the study of Augustini et al. in 2016, which was conducted to determine the maximum concentration of spirulina that can be added to the product and acceptable in terms of sensory and physical properties, the results showed that the addition of 1% and 1.2% of spirulina was the best concentration for soft cheese, respectively. and ice cream, and also the addition of spirulina has a significant effect on protein, water, fat, beta-carotene and texture (soft cheese) and total sugar, excess, melting point and sensory (ice cream) (45).

In Bosnea et al.'s study in 2020, which was done to enrich cheese with this microalgae, powdered spirulina was added to cheese at different concentrations (0.25, 0.5 and 1%) and its effect on physicochemical, microbiological and Sensory was evaluated. Cheese samples were analyzed in terms of pH, fat (Gerber van Gulik method), salt (Volhard method), protein (Kjeldahl) and moisture content by drying to constant weight at 102 ± 1 Celsius. The cheeses were also evaluated by five panels. In general, the addition of spirulina slightly increased the protein content, affected the color of the cheeses, and improved the microbiological characteristics of the cheese, all of which were acceptable for consumption by the panels. However, cheeses with 0.25% and 0.5% spirulina were more preferred by the evaluation panel due to the less characteristic smell and taste of spirulina. We conclude that acceptable cheese spreads can be produced with the addition of spirulina without significant changes in the cheese production line (46).

In another study conducted by Ratio et al. in 2022, the effects of adding spirulina to processed cheese as a source of nutrients and color were evaluated. In this study, milk was processed to obtain semi-pasteurized cheese and three batches were The following description was made: control group cheese (Lc) without adding spirulina, experimental group 1 (Lexp-1) in which 0.25% was added and experimental group 2 (Lexp-2) in which 0.50% spirulina was added. After the cheese was kept for 30 days during maturation under specific conditions, to determine the main physicochemical parameters. The obtained results show an increase in the protein level, from 19.47% in Lc to 19.87% in Lexp-1 and 20.27% in Lexp-2. Differences can also be observed in terms of total mineral content (ash), the value obtained for Lexp-2 being 3.32 higher than the value obtained for Lc. Therefore, the results of this study indicate the fact that we can increase the nutritional value of the product with this method (47).

1-3-2- BAF cheese[6]

Spirulina can have several effects on BAF cheese. In general, the protein and beta-carotene content of cheese increases in the

[6]- bacteriologically acidified feta-type

presence of spirulina, while spirulina does not affect the ash content. Spirulina can also increase the protein content, dry matter and titratable acidity of BAF cheese containing spirulina. So, in general, spirulina can be suggested as a valuable food ingredient with unique properties to add to BAF cheese (33).

2-3-2- feta cheese

The addition of spirulina microalgae in feta cheese causes the growth and survival of lactobacilli and lactococci. By adding spirulina, the starter culture (lactic acid bacteria culture) used in the production of feta cheese is not disturbed and can even be increased by its presence. The composition of spirulina significantly affects the color and mouthfeel of the produced cheeses, while with the increase of spirulina content, higher moisture content is observed in these cheeses. As a result, spirulina has a high potential for industrialization because it is used as an additive in dairy products, especially those produced by lactobacilli as a starter culture, and in parallel increases the nutritional value of the products. Spirulina can be used as a performance enhancer, and in a study conducted by Terpo et al. in 2021, the use of spirulina as a supplement was investigated and moisture, salt, microbiological stability and consumer acceptance after The production of cheese containing spirulina powder (0.25%) was tested and compared with the traditional feta cheese that was used as a control. The new cheese achieved exceptional organoleptic, physicochemical and microbiological characteristics. As a result, spirulina is a substance with great industrialization potential (40).

3-3-2- Mozzarella cheese

Mozzarella cheese is a general name for a variety of semi-soft Italian cheeses that originate from southern Italy and are obtained from buffalo or cow milk. The presence of spirulina can have many effects on mozzarella cheese and significantly affect its color and taste and increase its moisture content. A study conducted by Wesgan et al. in 2021 showed that by adding spirulina to this cheese, an antibacterial effect is observed in it, and the total number of microbes, coliforms, yeast, and molds decreases, and this inhibitory effect increases with the addition of salt. It has generally been shown that*Spirulina platensis* It has antimicrobial activity against many pathogenic agents (bacteria and fungi) and at the same time increases the nutritional value of that food. Like other microalgae, spirulina can greatly affect the sensory properties of food due to its special smell (44). In fact, scientific researchers have investigated several odor reduction methods that have been proven to be effective, and as a result, the addition of appropriate concentrations of spirulina does not affect the sensory quality of products.

Since spirulina has very good nutritional, functional and healthy properties to be used as a nutritious food, it can be used in mozzarella cheese made from cow's milk.

which is of local origin was also used and its addition makes it become a significant functional product (51).

4-2- Ice cream

Ice cream is one of the most popular dairy products that has many fans. By adding the appropriate amount of spirulina microalgae to the ice cream formulation, a product with suitable physical and organoleptic characteristics can be produced. Also, this algae creates a natural light green color in ice cream.

Stabilizers are one of the main components of ice cream formulations, and a large number of physical characteristics and desirability of ice cream depend on them, for example, physical characteristics of ice creams such as viscosity, melting resistance, and generally the texture of ice creams depend on the type of stabilizers and their presence in the ice cream formulation. (46) Of course, it should be noted that spirulina cannot be used as the only stabilizing agent in the formulation of an ice cream and it must be used with other stabilizers in the formulation of ice cream because spirulina, unlike the usual stabilizers used in the ice cream industry, does not contain Color, aroma and taste are special, these have special organoleptic characteristics that may not be very pleasing to the taste of the consumer, so it is necessary to use spirulina in combination with other stabilizers in ice cream formulation.

Spirulina can be used to improve the food quality and performance characteristics of ice cream. Due to the rich chemical composition with beneficial nutritional properties and functional properties of spirulina, it can be used to partially or completely replace the stabilizer in the preparation of ice cream with natural sources. Ice cream leads to an increase in protein, minerals, essential fatty acids and trace elements of natural origin. The effect of replacing the stabilizer with spirulina on the gross composition of ice cream according to the study of Malik et al. in 2013, which is shown in Table 2. Milk is a poor source of iron, replacing the stabilizer with spirulina also has a beneficial effect in increasing the iron content of ice cream. In addition to acting as a stabilizer, spirulina also contributes to better whipping speed. This is due to the higher foaming and emulsifying capacity of spirulina's fat and protein content, which helps in the formation and stabilization of dispersed gas i.e. air (54).

Table 2: Effect of replacement of stabilizer with spirulina on gross composition of ice cream

Level Stabilizer Replaced (%)	Total Solids	Protein	carbohydrate	fat	ash	Iron (mg/100ml)
0	35/73	4/26	20/95	10/11	0/47	0/03
25	35/87	4/31	20/89	10/11	0/49	0/07
50	35/91	4/36	20/83	10/12	0/49	0/11
75	35/96	4/41	20/77	10/12	0/50	0/16
100	36/01	4/45	20/72	10/13	0/51	0/20

Spirulina enriches ice cream due to its rich chemical composition. In addition to enrichment, the addition of spirulina replaces stabilizers in the preparation of ice cream because its composition is only 60% protein. The study by Robinson et al. in 2000 showed that spirulina powder can be used with a concentration of 0.15% as a 50% stabilizer substitute in the preparation of ice cream without affecting the sensory characteristics of the product. The addition of spirulina powder also gives a natural light

green (pistachio) color to ice cream and yogurt enriched with it. Therefore, it can be concluded that spirulina powder offers great potential in the dairy industry to enrich dairy products and replace artificial additives such as colors, stabilizers and emulsifiers, etc. in various dairy products (53).

Considering that ice cream, which is a tasty food, has a high content of fat and sugar in its composition, which makes it an interesting product to study alternatives that increase changes in formulation. Reducing or replacing fat and sugar content, increasing protein content, in addition to using bioactive compounds, can improve the functional and nutritional properties of ice cream. According to the US Food and Drug Administration (FDA), fat replacers can be food additives or substances with a GRAS statement. [7] ("generally recognized as safe"). Spirulina is classified as GRAS due to its nutritional and safety properties, phycocyanin is an antioxidant protein extracted from spirulina microalgae whose biomass has a high protein content (on average 65%) and antioxidant potential. Phycocyanin is an antioxidant protein from microalgae*Spirulina platensis* It is extracted that its biomass has high protein content and antioxidant potential. In this regard, a study by Farizin et al. in 2022 to investigate whether*Spirulina platensis*, phycocyanin extract obtained from spirulina biomass and inulin can act as emulsifiers and texture agents in ice cream and reduce the amount of fat and sugar, and this work was done with the aim of investigating the effects of replacing sugar and fat on the physico-chemical composition of ice cream formulation and sensory acceptance and sensory descriptors using a descriptive sensory method assessed for consumers (CATA).[8] It was done and the results showed that ice creams with phycocyanin extract and without industrial emulsifier (9, 12 and 8) have softer and softer texture and have high amounts of pods (35.8, 34.9 and 32.9%, respectively). . The formulation showed sensory acceptance indices up to 74%. The soft, creamy/smooth and creamy appearance characteristics of all formulations are related to the texture and appearance which indicates the quality in the product formulation. Overall up to 50% fat reduction and 25% sugar reduction with the addition of inulin (2%) and Spirulina (1%) will be observed. These types of ice creams are very important for consumers who care about their health due to the effect they have on fat and sugar and reduce them (55).

In the 2021 study of Teepo et al., which was conducted with the aim of microencapsulating spirulina in maltodextrin and gum arabic and evaluating the effect on the physical and sensory characteristics of handmade ice cream, the results showed that ice cream with spirulina had 35% to 53% more protein than the standard formula. and also all ice creams have an acceptance index higher than 70% (56).

[7]- Generally Recognized As Safe

[8] -check-all-that-apply

Since most microalgae have an unpleasant smell. Scientific researchers have investigated methods to reduce the odor associated with spirulina algae by using activated carbon adsorption, heating, enzymatic hydrolysis of lysozyme, inclusion in beta-cyclodextrin, fermentation and solvent extraction, among which fermentation and ethanol extraction are the best and most practical methods. Algae like spirulina have been shown to reduce odor (51).

Considering that until now, the performance of many stabilizers in the formulation of different ice creams has been investigated and studied, and among them, carboxymethyl cellulose has been among the most efficient thickeners and stabilizers. In 2017, Rasouli et al conducted a study with the aim of achieving the optimal formulation of traditional ice cream containing spirulina, including the appropriate concentration of spirulina and carboxymethyl cellulose in order to produce a useful product with favorable physical and organoleptic characteristics. The results of this research indicated that the optimal sample was more viscous than the control sample. The percentage of resistance to melting and the percentage of increase in the volume of the optimal sample were also higher than the control sample, which can be considered as a result of the greater viscosity of this sample. In addition, the optimal sample has better microbiological properties than the control sample due to the antimicrobial properties of spirulina. had In general, the results of this study showed that the use of suitable concentrations of spirulina and carboxymethylsols leads to the production of a healthy product that has pleasant physical and organoleptic characteristics compared to the commercial sample of traditional Iranian ice cream, while the use of high concentrations of spirulina In the formulation of traditional Iranian ice cream, it negatively affects the physical and organoleptic characteristics of the product (57).

In the food industry, spirulina phycocyanin is used as a natural colorant and stabilizer. The effect of three different concentrations of Spirulina platensis (0.5%, 1% and 1.5%) on the physicochemical, textural, antioxidant and sensory parameters of ice cream was investigated in the study of Boyanova et al. in 2022. The analysis of the texture characteristics (hardness, stickiness, stickiness, gumminess) of the samples showed a statistically significant difference ($p<0.05$) between the values reported for the control sample and the samples with spirulina. Ice cream samples supplemented with spirulina with a significant increase ($p<0.05$) in antioxidant activity from 2.8±2.8 mM TE/100 g DW[9] (control sample) were different to 4.1±1.9 mM TE/100 g (sample with spirulina) (58).

The study of Sezmejda et al. in 2018 was conducted with the aim of designing an ice cream production line, which showed that adding algae extract to ice cream increases its antioxidant activity and differentiates it from ordinary ice creams. Studies conducted so far all show that ice cream can be very important as a carrier of health-promoting probiotic bacteria, which in turn utilizes other microorganisms, especially certain strains of algae (e.g.*Spirulina platensis*) as an ice cream supplement. In the presented research, the level of polyphenols and antioxidant activity expressed as the degree of inhibition of cationic free radical production from DPPH solution were analyzed. Preliminary results based on antioxidant activity tests measured with the potential to quench free radicals have shown that ice cream formulas enriched with algae extract have a higher potential to achieve an

[9] -dry weight

inhibition level of 39.7% in mint ice cream samples compared to a sample without algae with an inhibition level. They show 32.8% for control. In addition, each of the examined (dairy, pistachio, mint) versions of ice cream supplemented with spirulina were found to have enhanced antioxidant activities such as free radical quenching potential and carotenoid content (59).

In a 2020 study by Norancia et al., the stability and shelf life of ice cream*Spirulina platensis* Checked during maintenance. The samples were kept at -15 for the first month and 10 degrees Celsius for the next month. DPPH percentage and emulsion stability during storage were investigated in two replicates, and the results showed that the emulsion stability decreases slightly during the storage period. At the beginning of storage at -15 degrees Celsius, the emulsion stability was 98% and at the end of storage was 93%. At -10 degrees Celsius, emulsion stability decreased from 91% to 86%. At -5 degrees Celsius, the emulsion stability decreased from 86% to 82%. Longer storage reduces the quality of ice cream texture and antioxidant content. The obtained results showed that increasing the storage temperature has a greater effect on reducing the texture quality of ice cream*Spirulina platensis* has it. ASLT analysis on the selected parameters shows that the shelf life of spirulina ice cream is 25, 24 and 21 days respectively at -15, -10 and -5 degrees Celsius (60).

2-5- Buttermilk

One of the drinks made from yogurt is buttermilk, which was first prepared by Indians under the name of lassi, which had both salty and sweet flavors, which, in addition to its nutritional benefits, was very important for the health of the digestive system because it can contain bacteria. be useful, so that its continuous consumption can prevent the growth of harmful microorganisms. In the research conducted by Meshkanani et al. in 2013, when different concentrations of spirulina cyanobacterium powder were added to buttermilk, the acidity of buttermilk increased while preventing specific changes in pH. In general, the addition of algae cannot reduce the biphasing of buttermilk to the desired extent, but the addition of spirulina has a positive effect on the iron and protein content of the treatments.

The survival of probiotic bacteria by increasing the storage time and increasing the amount of royal jelly*Spirulina platensis* It decreases significantly. The results show that by adding 0.05% by weight*Spirulina platensis* Contains probiotic buttermilk*Lactobacillus acidophilus* And*Bifidobacterium lactis* It is possible to achieve desirable physicochemical, microbial and sensory characteristics (9).

2-6- Curd

Another fermented dairy product that is known as a traditional product and has a special acceptance among consumers is curd. The abundance of important biological compounds in algae provides new opportunities in the production of useful dairy products. A study was conducted by Alikhani in 2013 that in order to produce useful curd with spirulina algae, the extract of spirulina algae was powdered with different methods such as using a spray dryer and the particle size was reduced to nano size, and the results showed that the increase in the percentage of spirulina algae It causes an increase in the pH value, resulting in a decrease

brings acidity; Also, by adding algae powder, the amount of moisture generally increases and the density of the mass increases (16).

2-7- kefir

Kefir is a yellowish fermented beverage produced by adding kefir fruits and grains to a solution of water and sucrose. which has compounds such as: carbon dioxide, lactic and acetic acids, ethanol and microorganisms useful for health that metabolize sugars. Among the microorganisms in kefir, bifidobacteria, lactic acid bacteria (LAB)[10] and acetic acid bacteria (AAB)[11] are more prominent. In the investigations, they concluded that pineapple and spirulina residues have a high carbohydrate content and are considered good substrates for the water-based kefir fermentation process. During the fermentation process, it was observed that the formulation with the addition of pineapple and spirulina residual extract compared to the control drink had a higher content of soluble solids and a lower acidity, indicating that the drinks probably have a sweeter taste that contributes to the acceptability of the product. Among the formulations, the addition of pineapple and spirulina residual extract and the relationship with more stable physico-chemical parameters were not present, therefore, it was a suitable alternative to natural fermented drink, without additives, rich in nutrients and with prebiotic and probiotic potential (61).

[10]- Lactic acid bacteria

[11] -Acetic acid bacteria

3- Purification and recycling of dairy industry waste using*Spirulina platensis*

Dairy industry is one of the most polluting industries. Dairy effluent contains high organic load. If semi-treated or untreated wastewater is discharged into natural water bodies, there is a possibility of eutrophication due to the high content of elements such as phosphorus, nitrogen and carbon, etc. Dairy waste is a rich source of proteins such as casein and sugars such as lactose. *Spirulina platensis* Due to its combined nature, it has the potential to reduce the BOD of high carbon wastewater. In the study of Kulkarni et al. in 2016, which aimed to investigate the bioremediation of dairy wastewater using*Spirulina platensis* It was observed that*Spirulina platensis*which was cultivated in different concentrations of dairy effluent has a better performance than the control group and is very efficient in removing COD/phosphate/EC in all concentrations and also the study showed that the amount of chlorophyll, protein and carbohydrates in spirulina using different concentrations of dairy effluent It increases as an alternative feed (62).

Microalgae are used to completely remove impurities such as phosphorus, nitrogen, etc., studies show that microalgae such as*Spirulina platensis* They have the ability to use the nutrients of the dairy wastewater and reduce the organic load to lower concentrations so that the treated water can be reused. Recycling purified water helps conserve water (63). Since the cultivation of microalgae in dairy wastewater is of major interest for the removal of nutrients and the production of sustainable microalgae biomass. In the study of Zapata et al. in 2021, the comparison of biomass production, morphology and phytohormone levels in*Spirulina platensis* (UTEX LB1926) grown on dairy effluents was investigated in

comparison with Zaruk culture medium. The concentration of phytohormones varied widely with the culture medium and light conditions. Low light intensity significantly caused filaments*Spirulina platensis* In wastewater, especially in whey, they become longer and thicker, increasing biomass yield. killed*Spirulina platensis* In dairy wastewaters, it provides the possibility of producing biomass and phytohormones at a low cost and at the same time purifying these waters (64).

In a 2013 study by Tang Chang et al., the ability to systematically removeCO_2 through wet washing using diluted wastewater as washing liquid and biomass growth potential in wastewater enriched withCO_2 It was shown, in fact, that dilution of raw dairy wastewater (milk processing) was necessary because the high chemical oxygen demand (COD) loading would inhibit the growth of Spirulina maxima. However, with sufficient dilution, since the COD was less than 300 mg/L, COD was effectively (79%) removed during the microalgae culture period, asNH_4^+ (51%) and$AFTER_4$ (35%) were removed to a lesser extent. Organic carbon absorption showed that spirulina grows as a mixture in wastewater. In addition, due to the reaction of hydroxide withCO_2 that form aqueous carbonates (decreasing pH) and photosynthetic activity that consumes carbonates (increasing pH), solution pH can effectively be used as a controlling parameter in system performance (65).

In general, cyanobacterial culture can be used to treat various industrial effluents such as dairy effluents and reduce the cause of pollution. Whey is an aqueous by-product in the dairy industry. Annual production worldwide is more than 80 million tons, which contains more than 1 million tons of lactose and 0.2 million tons of milk protein. These materials are expensive to store and transport. Therefore, we can use whey for mass cultivation of Spirulina and Oscillatoria. In recent years, due to the importance and diverse applications of algae, there has been a great interest in the use of microalgae metabolites. that in order to benefit from this algae, several researches and studies should always be done for value-added products of blue-green algae in a cost-effective way. In a study conducted by Calandaval et al. in 2007, protein, various pigments (chlorophyll a, carotenoids, phycobilins) of blue-green algae*Spirulina platensis* And*oscillatory*were investigated in artificial environment and dairy effluent. Protein concentration and pigment production from*Spirulina platensis* And*oscillatory* grown in artificial medium and dairy effluent are shown in Figure 2. Protein concentration*Spirulina platensis* And*oscillatory*Cultivated in artificial environment, 0.19 mg/ml and 0.36 mg/ml, while in dairy effluent, it was 0.20 mg/ml and 0.38 mg/ml, respectively. The results of this study showed that the protein content in the dairy effluent has increased compared to the artificial environment. Chlorophyll, carotenoid and phycobilin pigment concentration*Spirulina platensis* And*oscillatory* They also show a relative increase in pigments when grown in dairy effluent. The significant increase in all the observed parameters shows that the dairy effluent increases the growth and will have a great effect on changing or increasing the physical parameters of cyanobacteria. Kanikasharma et al. (2003) also found a significant increase in protein and chlorophyll a content of cyanobacteria grown in wastewater.

reported dairy and also suggested the importance of cyanobacteria in wastewater treatment (66).

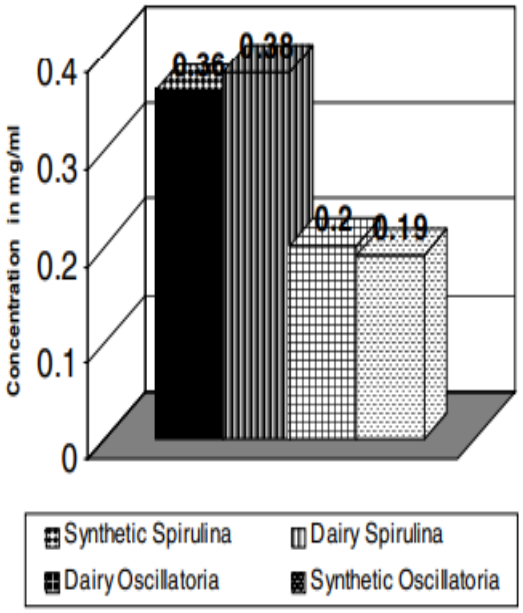

Figure 2- Protein concentration in Synthetic medium and Diary effluent

A study by Chali et al. was conducted in 2014 for one year with the aim of investigating monthly water analysis for various physicochemical factors for dairy wastewater treatment using microalgae in the city of Karbala - Iraq. Since spirulina algae is one of the blue-green algae that is very important for biological treatment, the results of this study also showed that these algae can reduce the concentration of wastewater nutrients such as nitrate, phosphorus and sulfate. In addition, the ability of these algae to reduce total hardness, alkalinity, chloride, C.O.D, T.D.S, calcium and magnesium hardness can be seen. According to the obtained results, it was observed that on the tenth day, this algae has the ability to remove 80% nitrate, 72% active phosphorus and 61% sulfate, while total hardness is 56%, alkalinity is 71%, chloride is 56%, C.O.D is 77%, T.D.S is 54%. It will have 9% calcium and 5% hardness (67).

4 - Conclusion

Adding biomass*Spirulina platensis* Dairy fermentation products have a positive effect on the viability of the initiator bacteria, improves the content of amino acids, fatty acids and vitamins, enhances the sensory and nutritional properties of the product, and also includes the enrichment of the product in terms of iron and protein. This microalgae stimulates the production of acid and prevents the growth of unwanted microorganisms; It also inhibits the growth of other pathogens and has anti-viral and anti-cancer properties.*Spirulina platensis* It strengthens the body's immune system and is effective in preventing diabetes, anemia, arteriosclerosis and obesity. Spirulina can grow and develop gram-positive bacteria, including*Staphylococcus aureus* and also inhibit Gram-negative bacteria. The use of bio-algae in dairy products has been growing in recent decades. The design and development of these products require more basic investigations. The biological effect of microalgae mass in food systems depends on the operating conditions, the type and intensity of the process (thermal, mechanical) and the interaction with other food compounds (protein, polysaccharide, lipid, salt, sugar) that the study in this field improves the design process. and the development of products enriched with microalgae.

5- Resources

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مقاله علمی_پژوهشی

مروری بر کاربردهای جلبک *اسپیرولینا پلاتنسیس* در بهبود خواص تغذیه‌ای و عملکردی محصولات لبنی و استفاده در بازیافت ضایعات صنعت لبنی

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چکیده

اسپیرولینا(Spirulina) نام کلی ریزجلبک‌های رشته‌ای، چندسلولی و سبز آبی می‌باشد که دو جنس Arthrospira و spirulina اسپیرولینا های مهم خوراکی هستند. این جلبک رایج‌ترین و پرمصرف‌ترین جنس است که در زمینه‌های متعددی به ویژه صنایع غذایی و پزشکی مورد مطالعه و بررسی قرار گرفته است. تجزیه و تحلیل شیمیایی ریزجلبک اسپیرولینا نشان می‌دهد که منبع بسیار خوبی از برخی مواد مغذی درشت و ریز مغذی است. اسپیرولینا سرشار از پروتئین، ویتامین‌ها، اسیدهای آمینه ضروری، مواد معدنی و اسیدهای چرب ضروری می باشد که برای سلامتی حائز اهمیت هستند. پوشش سلولی اسپیرولینا از غشا نازک هیدروکربنی است که خیلی سریع توسط شیره معده هضم می‌شود، به همین دلیل اسپیرولینا کاملاً قابل هضم است و از غنی‌ترین منابع غذایی قابل دسترس نیز می‌باشد. با افزودن اسپیرولینا به جای پایدارکننده خواص تغذیه‌ای محصولات لبنی بهتر می‌شود و بافت و ظاهر و رنگ بهتری نسبت به اول خواهند داشت زیرا اسپیرولینا قابلیت استفاده به عنوان پایدارکننده را دارد. اضافه کردن ۱ تا ۱/۵ درصد پودر اسپیرولینا به محصولات لبنی مانند پنیر باعث کاهش آب و رطوبت در آن می‌شود که این سبب نرم‌تر شدن آن خواهد شد و ارتباط مستقیم با افزایش عمر نگهداری آن دارد. صنایع لبنی از صنایع بسیار آلاینده محسوب می‌شود که حاوی محتوای بالای عناصری مانند فسفر، نیتروژن و کربن و... می باشد که ریزجلبک‌ها برای حذف کامل آلاینده‌هایی مانند فسفر و نیتروژن و... شناخته می‌شوند که جلبک سبز آبی اسپیرولینا توانایی استفاده از مواد مغذی فاضلاب صنایع لبنی و کاهش بار آلی را تا غلظت‌های پایین‌تر دارند تا آب تصفیه شده قابل استفاده مجدد باشد. به طور کلی افزودن اسپیرولینا باعث افزایش خواص تغذیه‌ای و بهبود ویژگی‌های فیزیکی خواهد شد و در صنایع مختلف مخصوصاً صنایع لبنی هم کارایی و مزایای متعددی می‌تواند ایجاد کند.