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Techniques for Making Cheese with Low Salt and Fat Content

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ABSTRACT

When the term "reduced fat" or "lower fat content" is used on the label of cheese products, it means that the product must contain 25% less fat than the reference amount in traditional standardized cheeses. In recent years, owing to the risks associated with excessive dietary intake of fat and sodium, there is an increased consumer demand for food products, including cheese, with reduced fat and salt content. The dairy industry in developed countries is focused on the production of various types of cheeses with low fat and salt content. As a result, much research has been conducted to study the characteristics of different types of low-fat and low-salt cheeses and to improve their characteristics compared to full-fat cheeses. Despite the mitigating effects of calcium reduction, the reduced-fat, reduced-salt, lower-calcium cheese was, nevertheless, firmer, harder, more cohesive, and chewier and flowed less than the full-fat, full-salt cheese. In this paper, special emphasis is placed on technologies for eliminating the disadvantages of cheeses with reduced fat and salt content, for their nutritional, flavor and organoleptic properties to be closer to other types of cheese and at the same time to meet the needs of consumers.

Keywords: cheese, salt, fat, additional crops, technology

INTRODUCTION

Until the early 1990s, the dairy industry mainly produced cheeses high in fat and salt. From then until today, the percentage of consumers who use cheese in their daily diet is increasing, but with a reduced amount of fat and salt. This is due to the growing awareness of consumers, initiated by numerous studies on the harmful effects of fats and salt on their health. With excessive intake of fat and salt in the body leads to enormous weight gain in humans, heart problems, high cholesterol, high blood pressure, vascular problems etc. That is why the dairy industry is starting to work intensively on the introduction of new technologies to produce cheeses with reduced amounts of milk fat and salt, to meet the need of consumers for these types of products. During the introduction of processes to produce cheese with reduced amount of fat and salt, the dairy industry faced many problems, because salt and fat are the two most important components that give the basic organoleptic and nutritional properties of cheese. Removing some of the fat from the cheese can negatively affect its taste, texture, and functionality. Many low-fat cheeses have a higher transparency, lower melting point, a rubbery and resinous texture, and an uncharacteristic taste. Reducing the sodium chloride content in cheese is a particularly significant challenge for the dairy industry because salt as an integral part of cheese is also used to maintain the taste, appearance, texture, and shelf life of cheese, while controlling the activities of enzymes and the microorganisms in it. For that purpose, his paper describes the technologies that serve to eliminate the disadvantages of low-salt and fat cheeses, to get closer to full-fat cheeses, and thus meet the needs of

consumers. In this paper, fat substitutes, stabilizers, additives, exopolysaccharides, enzymes, and additives are studied as the most important technologies used to improve the properties of low-fat cheese.

MATERIAL AND METHODS

Low-fat cheeses are often characterized by an undesirable taste and texture. . For these reasons, a number of technologies have been developed to overcome these shortcomings in order for the cheeses to acquire characteristics that are similar to whole cheeses, and to place them well on the world market. This paper describes four extensive procedures to produce low-salt and low-fat cheese, including:

- Different processing techniques,
- Use of additional crops,
- Use of fat substitutes and
- Fat removal method

Various combinations of these procedures can also be used.

Research methods

Production techniques

The fat content of milk is used to produce low-fat cheese and depends on the desired fat content of the cheese, which generally ranges from 0.5 to about 1.8% [1]. According to [2] milk can be fortified with skim milk powder or fat concentration can be reduced to 1.8. [3] suggested that milk could be directly ultra-filtered, while [4] suggested that it could be fortified with ultra-filtered or micro-filtered whey. [5] found that semi-hard low-fat cheese that is made from milk concentrated by microfiltration had sensory qualities similar to whole cheese due to its lower retention of whey protein (about 35%). The ratio of casein and fat in milk is also important. According to [6] to produce 33% reduced fat Cheddar cheese, the desired ratio should be 1.58, while [7] proposed a ratio of 2.4 for mozzarella cheese with 50% reduced fat. [8] in their studies found that other basic parameters that can be manipulated during cheese production are temperature and time of second reheating, pH and degree of salting.

The general purpose of producing low-fat cheese is to replace fat with moisture, without adversely affecting the yield and quality of the cheese. Part of this is achieved by lowering the temperature of the second reheating. [9] observed that the second reheating temperature in low-fat cheddar cheese is about 30-35^{0}C depending on the desired moisture content. [6] indicate that further moisture retention is achieved by using a higher pH. For low-fat cheddar cheese this pH can range between 5.6 and 5.8. Washing the breast with cold water also helps retain moisture, remove excess lactose, and dissolve calcium which helps soften the texture of the cheese. This step helps prevent the development of excess acid during the ripening process in the cheese. However, [8], suggest that using these methods, the taste ingredients are lost, resulting in a mildly flavored cheese as well as the development of other unsuitable flavors during its ripening. [10] proposed certain changes in the production of cheddar that include cutting the pile now when it is hardest, then higher pH during its squeezing (6.45) and higher pH during its grinding (5.9). By eliminating whey by rinsing the whey and retaining calcium phosphate, the buffer capacity is increased, and the development of a disproportionately low pH is limited. Excess calcium, on the other hand, adversely affects the functional properties of some cheeses, such as mozzarella. [11] suggested lowering the pH of milk by adding dehydrated skim milk. This lowers its pH and the colloidal calcium is converted into a soluble form, which is eventually removed from the whey as it is squeezed.

Other methods used to increase moisture include whey protein and sweet buttermilk in the cheese.

Whey proteins denatured by high heat treatment (> 80 ° C) have increased water absorption capacity and are used in the production of low fat Havarti-type cheese [12] and low fat Edam [13]. [13] suggested the

use of 0.5% of whey protein aggregates. As the moisture in the cheese increases, so does its yield**.** [14] studied the inclusion of denatured whey proteins in the production of low-fat mozzarella cheese and concluded that their use did not adversely affect its physical and sensory properties.

The inclusion of sweet buttermilk in the production of low-fat cheese also helps retain moisture in it. According to [15] this is achieved by directly adding sweet buttermilk to milk, while**)** [16] noted that this process requires the addition of relatively large amounts of buttermilk, up to 30%. As an alternative method, sweet buttermilk concentrated by ultra-filtration can be used. [17] applied this method to the production of low-calorie cheddar and low-fat mozzarella cheese, and concluded that the addition of 5% ultrafiltrated buttermilk helps retain moisture and improve the shape (appearance) and texture of cheeses. This may be due to the inclusion of a milk-fat globular membrane in the buttermilk that releases free fat into the cheese produced.

Processes involving homogenization have been developed with a specific goal, which is to improve the shape, appearance, and texture of low-fat cheese. [16] reported that milk homogenized at 10,300 and 17,200 kPa could be used to produce low-fat mozzarella cheese. Some improvements in the texture and melting of the cheese have been reported after this treatment. Some improvements in the texture and melting of the cheese have been reported after this treatment. According to [19], by homogenizing milk, milk fat globules are reduced and interfacial forces on the surface of new fat globules are increased, which can disrupt casein mycelium and lead to the loss of large amounts of whey, and thus loss of yield. [20] developed a procedure in which 40% of sour cream is homogenized and mixed with skim milk to obtain the desired fat content in the production of low-fat cheddar cheese. Homogenization in this way has a minimal effect on milk proteins, while providing the necessary reduction in the size of fat globules and, consequently, increases their area and number. The resulting low-fat cheddar cheese is characterized by excellent firmness and texture, lower free fat content during its melting and improved yield due to increased fat and protein recovery.

Additional crops

Additional crops not only play an important role in the development of mature cheese flavors, but they can also be used to improve the functionality of low-fat cheeses. [21] indicated that the proteolytic activity of Lactobacillus casei subsp. casei is useful for developing the functional properties of low-fat mozzarella cheese. [22] evaluated the effects of four additional cultures with different levels of amino-peptidase activity on the taste and texture of low-fat edam cheese. Amino-peptidase activity of Lactobacillus lactis ssp. diacety lactis is higher than that of Lactobacillus helveticus (LH 212), Lactobacillus reuteri and Brevibacterium linens (BL 2), but cheese containing L. helveticus develops the highest levels of free amino acids. Beneficial texture effects were obtained using Loctobacillus helveticus (LH 212) and L. reuteri. According to [23] the taste and texture of low-fat (9%) sheep kefalo-graviera cheese have been significantly improved using a commercial additive crop which, by fermenting citrate, produces acetate, diacetyl, and acetoin. Acetate is the predominant free fatty acid in full-fat kefalo-graviera cheese and accounts for 34% of all free fatty acids in mature cheese. The selected commercial crop improves the appearance and texture and significantly improves the taste of low-fat kefalo-graviera cheese compared to the commercial regular starter crop used in the production of full-fat cheese [23] found that low-fat feta cheese has a taste like full-fat cheese, which is obtained by adding a commercially available supplement culture CR-213. However, the overall quality of this cheese is significantly lower than full fat cheese. Low calorie feta cheese contains more lactic and citric acid than low fat but less butyric acid. [24] concluded that the use of additional culture

can increase the production of organic acid in low-fat feta cheese, which ultimately has a positive effect on its sensory properties. Low-fat cheese can be produced using shock-frozen L. helveticus or L. casei. These crops do not affect the general composition of the cheese, but accelerate its maturation, especially L. helveticus.

Exopolysaccharides are used in the production of cheese to improve its structure and texture. According to [25] the texture and structure of cheese are largely determined by the nature and layout of the entire network of exopolysaccharides. Exopolysaccharides help to adhere the particles in the cheese, and by increasing their level, they improve the elasticity of the cheese. [26] in their studies included the process of ultra-filtration of milk to remove the bitter taste, all to improve the taste of low-fat cheddar cheese to which exopolysaccharides were added. During ripening, the texture, melt, and sensory characteristics of low-fat cheddar cheese made with exopolysaccharides (EPS) were monitored. The firmness, elasticity and stretch of the cheese increase significantly when the fat content decreases, while the fat reduction did not affect the cheeses that were made with the help of exopolysaccharide cultures. No differences in firmness, elasticity and extensibility were found between the young, reduced fat cheese made with Lactococcus lactis ssp. cremoris (JFR1, a crop that produces low-fat cheese) and the same whole-fat cheese. After 6 months of ripening, low-fat cheese with exopolysaccharide cultures maintained lower values of all texture parameters compared to cheese that was not made from exopolysaccharide cultures. Reducing the fat in the cheese reduces its melting point. However, no differences in melting were found between the young full-fat cheese and the low-fat cheese produced using the JFR1 culture. When heated, both types of cheese became soft and creamy without losing their shape, while low-fat cheeses that did not use EPS lost their shape, becoming liquid and splitting into fatty matter and liquid. Experts found no differences in the texture of full-fat and low-fat cheeses made with JFR1. Both types of cheese are characterized by a rubbery or firm structure, whey and crumbly texture compared to the texture of all other low-fat cheeses [27], investigated the properties of low-fat cheddar cheese obtained with the help of probiotic bacteria. The aim of their work was to investigate the viability of probiotic bacteria (Lactobacillus acidophilus LAFTI®L10 and Bifidobacterium lactis LAFTI®B94), as well as their impact on changes in composition, pH, proteolysis, and sensory properties of low-fat ultra-filtered filters. their 2-month maturation. Low-calorie ultra-filtered (UF) cheeses were produced according to the production process, which is defined as mixing UF milk protein powder, skim milk and sour cream, with or without the addition of a probiotic. Sensory evaluation showed that the overall aroma of low-fat cheese was dramatically enhanced using probiotic cultures. According to [28], probiotic bacteria are living microorganisms that in certain concentrations show numerous positive effects on the health of consumers. [29] found that the therapeutic benefits of probiotics include the treatment of conditions such as gastrointestinal disorders, hypercholesterolemia and lactose intolerance, stimulation of PR karyogenetic enzymes, and immune treatment. related to food. Ishibashi and Shimamura., (1993) recommend that probiotic-derived products contain at least 107 g / ml microorganisms to achieve a positive effect on consumer health. In the last decade, numerous research studies have been conducted on the possibility and inclusion of probiotics during the production, maturation, and storage of different types of cheese. In the production of cheese with probiotics, the type and type of probiotic bacteria and their basic characteristics should be considered, to achieve the desired viability of cells and their metabolic activity during the production and consumption of products. In addition, [30] and [28] suggested that it is very important to determine the effect of

probiotic bacteria during ripening, as well as their impact on the quality and sensory properties of cheeses. Probiotic bacteria can be added as primary starter cultures or additional associate cultures. The first method is less suitable due to the low ability of probiotics to produce enough lactic acid during fermentation. Therefore, adding probiotics in the form of an associative culture, along with other starter cultures, is a much safer and more accessible solution. However, care must be taken in combining probiotics and starter cultures and their characteristics. Ultrafiltrated cheeses are a very popular group of cheeses in the Mediterranean. They are usually produced as full-fat cheeses, but in recent years, low-fat cheeses have been produced. According to [27] low-fat cheeses belong to the group of dietary products and are a good basis for creating products that can be classified as foods with functional properties that are significantly beneficial to human health.

Fat substitutes and other additives

Fat substitutes are ingredients used to replace some or all the fat in cheese, all to reduce the calorie intake by consumers. According to [31] fat substitutes are ingredients that have a chemical structure close to fat and have similar physicochemical properties, but usually have a lower caloric value.

[32] divided the numerous fat substitutes into 3 categories:

- Carbohydrate-based fat substitutes
- Protein-based fat substitutes and
- Fat-based fat substitutes

[33] found that these fat substitutes have different functional properties that mimic some of the characteristic physicochemical properties and desirable qualities of fats in cheese such as viscosity, mouth feel and appearance. [34] states that fat substitutes can solve the problem of low-fat cheese that is too dry and has no creamy texture. Fat substitutes mainly consist of micro-particles, whey proteins or certain coal-based materials. They mimic the properties of fats by penetrating them into the water and give a feeling of lubrication and creamy texture. Fat substitutes improve the dryness and low humidity of the cheese by creating a smooth and elastic consistency that is more acceptable to consumers. Low-fat processed cheese. Grain soy lecithin gives a significantly better texture, compared to hydrogenated soy lecithin in low-fat processed cheese. with lecithin is very similar to full-fat cheese. The use of 0.05% granular soy lecithin or hydrogenated soy lecithin improves the texture of low-fat cheese without adversely affecting its acceptance by consumers. The addition of fat substitutes improves melting, reduces oil separation, and improves the firmness and microstructure of low-fat mozzarella cheese. They modify the protein matrix of the cheese and increase the openness of the cheese structure. The use of commercial β-glucan oat concentrate improves the appearance and taste of low-calorie white cheeses. Cheeses made with β-glucan concentrate increase the yield and degree of proteolysis in low-fat cheese and improve its texture. However, the color, taste and general impression of this cheese were significantly inferior to those of atypical low-fat white cheese. [35] studied the effect of exopolysaccharides (EPS), before acidification and the use of two fat substitutes, on the textural and functional characteristics of mozzarella cheese. Moisture in low-fat mozzarella cheese was increased by the use of two fat substitutes, which led to an improvement in its yield and texture characteristics. Previously acidified cheese also had increased levels of proteolysis and subsequent hydration of the protein matrix which improved its functional properties. The nature of fat substitutes, however, mostly affects the microstructure of the cheese and its functional characteristics. Cheese containing one fat substitute showed better melting, stretch and better baking characteristics compared to cheese containing two fat substitutes. By combining EPS cultures with appropriate pre-acidification fat substitutes, the yield of low-fat mozzarella cheese can

be increased and the ripening time, and thus the storage period, reduced. [36] studied the possibility of using inulin gels as a fat replacement solution in cheese. Inulin was successfully incorporated into the cheese matrix at the level of 3.44 g / 100g cheese as a gel or aqueous solution. At this level, it can directly replace 63% of the total fat in the cheese formulation without significantly affecting its melting properties. Primarily for convenience, it is recommended to add inulin as a hot aqueous solution at 80 ° C, rather than as a cold gel. The use of Arabica rubber as a fat substitute improves the texture and rheological properties of Iranian low-fat cheeses. The cheese to which 0.5 g of gum arabic was added was close to full-fat cheese. [37] state that Arabica rubber can be used as a fat substitute, but in low concentration, to reduce the energy value of the product and to improve the texture of low-fat cheese. [38] proposed gelatin as a fat substitute, due to its advantage in the production of thermo-reversible gel at 30 ◦C, to improve the organoleptic properties of low-fat cheese. Replacing butter with sucrose polyester produces cheese with smaller fat droplets and microstructure, so the cheese acquires more similar properties to fat cheese. [39] in their research found that barley β-glucan negatively affects the aroma and taste of white brine cheese. [40] investigated the effect of multi-fat substitutes, such as microcrystalline cellulose, β-glucan and whey microparticular protein on the properties of low-fat cheeses. The effect of fat reduction with fat substitutes on the chemical, physical and sensory properties of ultrafiltrated feta cheese has been studied by [41]. The aim of his research was to study the effect of whey protein concentrate - WPC80 (0-20g per 1 kg), lecithin - Lct (0-2 g per 1 kg) and a mixture of xanthine and guar gum - XG (0-1g per 1 kg) on the sensory characteristics and texture of low-fat ultrafiltrated feta cheese made from 6% fat. Different interactions between fat substitutes caused different increases in cheese firmness and elasticity. [42] showed that the interaction between sodium caseinate and xanthine gum significantly increased the hardness of the cheese. Cheese samples using WPC80 whey protein concentrate (20 g per 1 kg) showed the lowest hardness. Low fat cheeses are heavier than whole fat cheeses because of their higher casein content**.** [43] suggest that cheese fat is a lubricant that can break down the protein matrix, making the cheese softer. By combining fat substitutes, a formula that is obtained is suitable for increasing the firmness of low-fat cheeses. Cheese elasticity decreases when whey protein concentrate is added to low-fat cheese. Also, the elasticity is further reduced when 1 g of xanthine and guar gum or 2 g of lecithin are added to 1 kg of cheese. [44] reported in the same paper that the addition of Simpless-D100 (microparticle whey protein) reduced the elasticity of the cheese. From this it can be concluded that individual fat substitutes reduce the elasticity of cheese, however the interaction of some fat substitutes such as lecithin and xanthine and guar gum help to improve and increase the elasticity of low-fat cheese. The effect of xanthine guar gum and lecithin on the texture of the cheese is quite significant. In contrast, whey protein concentrate does not play a significant role in cheese texture. According to [45] low-fat cheeses are generally recognizable by their heavy and elastic texture. Fat substitutes in them continuously disrupt the protein matrix, thereby improving their texture. Different mixtures of fat substitutes contribute to improving the taste of low-fat cheese. By reducing lecithin and whey protein concentrate, the taste of cheese is significantly improved. Xanthine and guar gum do not have a significant effect on the taste of the cheese. Lecithin-containing cheese samples were characterized by an unfavorable and less milky taste, compared to those samples to which lecithin was not added as a fat substitute. [46] reported that samples of cheese to which lecithin was added were criticized by panelists, and they concluded that it adversely affects the taste of low-fat feta cheese. Based on numerous

research and methods, the formula for low-fat cheese has finally been determined with the help of fats that have been used in concentrations: 19.47g WPC80 per 1kg, 0.5g xanthine-guar gum at 1kg and 0.13g Lecithin per 1kg. The cheese produced in this way based on this optimized formula has more sensory characteristics and texture like the fat cheese.

New method of fat removal

[47] reported that the taste release in the mouth is different in low-fat compared to full-fat products, because hydrophobic flavor compounds have a higher sensory limit in oil than in water. When fat molecules are extracted from milk before production, less fat molecules remain in the cheese that bind to the sensory compounds, resulting in a lack of taste in low-fat cheese. When fat molecules are extracted from milk before production, less fat molecules remain in the cheese that bind to the sensory compounds, resulting in a lack of taste in low-fat cheese. [48] designed a method that physically removes the fat content from full-fat old cheddar cheese after it has been well processed. Full-fat cheddar cheese contains full maturity of taste and by separating the fat after its ripening, the researchers found that this fat-free cheese retains its original taste. The process is structured as follows: for the extraction method, the researchers selected three samples of delicious cheddar cheese with a high fat content. The grated cheese is weighed and placed in special bottles in combination with volatile compounds. Each bottle is mixed for 30 minutes with a rotating mixer and centrifuged after ten minutes, which allows the fat to be separated from the cheese. The cheese, after being refined, was submitted to a panel to evaluate its taste. There were only slight differences in taste between full-fat and low-fat cheese. The process allowed researchers to remove 50% of the fat from high-fat cheddar cheese. Supercritical liquid extraction technology (SFE) can be used in the dairy industry to develop low-fat cheeses with a taste that corresponds to full-fat cheeses [49]. This SFE technology allows the reduction of fat from ripe cheddar and Parmesan cheese without causing a change in their formulation. At the same time, this technology reduces fat by up to 51% in cheddar cheese and 55.56% in parmesan. This technology is used to produce low-fat cheddar cheese and parmesan with a characteristic taste that is comparable to full-fat cheese. Specifically, SFE technology allows the taste components to be partitioned between the siren matrix and the extracted lipids. Based on the above technologies it can be concluded that soon all the disadvantages of low-fat cheese will be solved. These studies will allow consumers to enjoy eating their favorite cheese without feeling guilty about high fat intake. The research will also benefit manufacturers who value high quality products. Each method is built on a new idea to create a healthy and tasty cheese. Cheese producers must take risks to create products that meet the needs of consumers. With the advancement of such research and the development of new technologies, consumers will be able to eat healthy, tasty, and harmless food for their health.

CONCLUSION

In a few, more than the last demand by consumers, the dairy industry in the countries is concentrated on the production of a wide range of cheeses with salt and fat content, and yet with approximate organoleptic characteristics of full-fat cheeses. Increasing the awareness of consumers about their proper nutrition, weight loss, as well as improving their overall health is the reason for the growing demand for this product. Fat and salt are the two most important components that give the basic qualitative, nutritional, and organoleptic properties of cheese. When producing this type of cheese, the concentration and ratio of these two components is desirable, because otherwise a product with negative and unacceptable properties will be obtained. Removing all or part of the fat from the cheese has a

negative effect on the taste, texture, and functionality. Many low-fat cheeses are characterized by greater transparency, less melting, rubbery and resinous texture, and an uncharacteristic taste. To overcome these shortcomings, a few technologies have been developed that have significantly improved the quality properties of these types of cheeses and they are well accepted by consumers. The most important technologies that improve the properties of low fat and salt cheeses are homogenization, ultrafiltration, use of additional crops, fat substitutes, and SFE technology. Among the developed techniques, the best results are achieved with the use of additional cultures and fat substitutes. The best results for improving the texture and sensory characteristics of cheeses with reduced fat and salt content are achieved with the use of whey protein concentrate, lecithin, xanthine and guar gum, gum arabica, gelatin and others.

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