Egyptian Journal of Food Science
http://ejfs.journals.ekb.eg/

Prolong Shelf Life of Kareish Cheese: A review

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KAREISH is one of the earliest varieties of cheese found in Egypt. Egyptian consumers appreciate this type of cheese due to its high protein content, low fat and salt content, appropriate price, and health benefits. Kareish cheese has a limited shelf life due to its high moisture content, low salt content, and exposure to numerous contamination issues, including spoiling and pathogenic bacteria, molds and yeast. Preservatives can protect food products from pathogenic bacteria, spoilage microorganisms, and other undesirable chemical changes, thus improving product quality and extending shelf life. The quality and processes used to extend Kareish cheese's shelf life at refrigerator temperature were discussed. These processes include the application of chemical preservatives, bio-preservatives, biofilms, and gamma radiation. This review aimed to shed light on the procedures used to extend the shelf life of Kareish cheese and focus on the most recent research published in the area of preserving Kareish cheese.

Keywords: Kareish cheese, Chemical preservatives, Bio-preservatives, Biofilms, Radiation

Introduction

Cheese is an important food in the human diet; all over the world, we can find at least one or more types of cheese on the breakfast table. Kareish cheese is among the most widely consumed varieties of fresh soft cheese in Egyptian cities and Arabian countries. It is an acid-coagulated fresh cheese produced from the coagulation of skimmed buffalo or cow milk or their mixture. *Str. thermophilus* and *Lb. bulgaricus* are essential starter microorganisms required for the production of fermented dairy products such as yoghurt and Kareish cheese (Ibrahim et al., 2020). Laban Rayeb, Laban Khad or Laban Zeeris also used in the production of Kareish cheese (Abou-Donia et al., 1984). As mentioned by Todaro et al. (2013), Kareish cheese has its origins in the era of the Pharaohs, according to what was found in the Pyramids when they were first opened.This type of cheese is also widely manufactured in the Egyptian countryside, and it was then propagated to other Arab countries.

Kareish cheese is one of the cheese typesthat have a healthy value for humans. Where cheese is considered low in fat as well as salt and cost, it can also be made without salting. So, it is suitable for the elderly who suffer from problems with fat and salt intake, such as obesity-related illnesses or high blood pressure diseases (Todaro et al., 2013; Darwish, 2022). Kareish cheese contains highprotein and moisture content, a small amount of sugar, soluble vitamins, calcium, and phosphorus. Therefore, many Egyptian farmers used Kareish cheese in their diet for its nutritional value and low price (Allam et al., 2017a; Topcu et al., 2020). However, Kareish cheese has a limited shelf life due to its high moisture content (~75%) and relatively high pH (~5). It can only be kept at 4 °C for two weeks or less before undesirable microbiological development appears on the surface (Assaf & El Khatib, 2021). Yeasts and molds can greatly contribute to the deterioration of kareish due to the presence of mycotoxins, which can cause health problems that are cancer-causing. Therefore, the aim of this work was to

*Corresponding author: mabdelaziz69@yahoo.com
Received: 21/5/2023; Accepted: 3/6/2023
DOI : 10.21608/EJFS.2023.212526.1165

focus on the quality and composition of Kareish cheese and the attempts made to extend its shelf life at refrigerator temperature.

Manufacture and quality of Kareish cheese

The traditional method of making Kareish cheese is done most of the time using unheated milk, which is placed in a clay pot known as Matrad or Shalia (Fig. 1).Then it is left in a warm place until complete fermentation results in the formation of curd and the separation of the fat on the curd top. When the fat is separated, the formed curd is placed in the mat for draining the whey from the curd and forming the well-known shape of Kareish cheese after hanging the mat for a period of time (usually 2–3 days) (Fig. 2). During the traditional manufacturing process, cheese is exposed to many contamination problems, including spoilage and pathogenic bacteria, molds and yeasts (Hamam et al., 2020). Kareish cheese is being produced in big factories. For whey drainage, cheese cloth was used rather than a mat, and pasteurised skim milk was utilised rather than unheated milk. Also starters of *lactococci*, such as *L.lactis* sub sp *lactis* and *L.lactis* sub sp *cremoris,* or yoghurt starters that contained *Lb. delbrueckii* sub sp *bulgaricus* and *Str. salivarius* sub sp *thermophiles* have been used instead of fermentation by natural microflora. However, the best flavor of Kareish cheese was obtained from fermentation by natural microflora (Hammam et al., 2020).

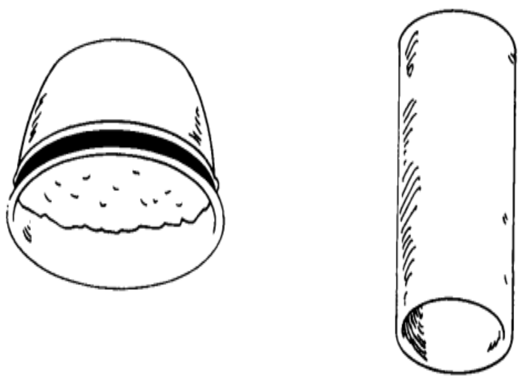

Fig. 1. Muradd or Shalia used for fermenting raw milk in the Kareish cheese production.

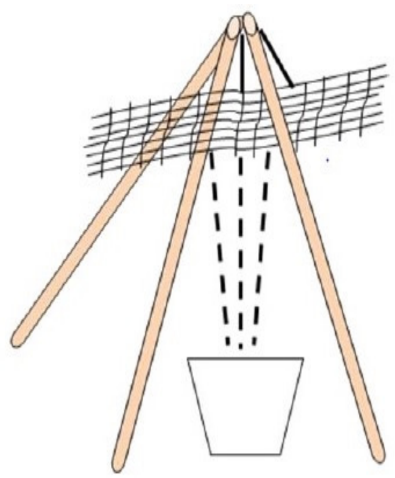

Fig. 2. The mat used to drain the whey from the curd of Kareish cheese.

Kareish cheese's composition and quality may vary considerably depending on a number of factors, including the clotted skim milk's composition and quality, the manufacturing process, the period of time required to complete the whey drain, the salt quality used, and how the finished cheese is handled (Todaro et al., 2013). Mostly, this product is sold uncovered and without a container, where the risk of contamination is high. Kareish cheese production also affords many opportunities for microbial contamination (Aly et al., 2012). Kareish cheese is an example of an acid-coagulated fresh-type cheese that has a low pH (< 5) and high water activity (a_w = 0.95-0.97), both of which are conducive to the growth of bacteria that can survive in such an environment. Fresh cheese often contains lactic acid, peptides, and amino acids in its surface moisture which encourage the quick growth of yeasts, changing the pH and promoting the growth of spoilage and pathogenic bacteria (Barukčić et al., 2020; Moubasher et al., 2018). Cheese may harbor many spoilage yeasts and molds as well as pathogenic microbes such as *Candida*, *Debaryomyces*, *Galactomyces*, *Fellomyces*, *Mycoderma*, *Pichia*, *Saccharomyces*, *Rhodotorula*, *Aspergillus*, *Cladosporium*, *Mucor, Penicillium*, *S. aureus*, *L. monocytogenes*, *Salmonella* spp., and Shiga toxin-producing *E. coli*.This depends upon the raw milk used as well as the hygienic manufacturing, handling, andcheese storage (Possas et al.(2021); Ibrahim et al., 2020). Moubasher et al. (2018) identified and evaluated the range of yeasts and filamentous fungi that infect several dairy products sold in the marketplaces in Assiut, Egypt. They found that Kareish cheese had the highest content of microbes, which may lead to an increase in medical problems associated with the presence of fungi or their metabolites. The percentage of microbial flora content in Egyptian Kareish cheese is illustrated in Fig. 3 (Elbassiony et al., 2021). The acceptable level of total bacterial count is not taken into account by the Egyptian standards for Kareish cheese No. 1008/2000, but they do require pasteurization or any other heat treatment of the cheese milk with the addition of a powerful starter culture.The total amount of coliforms should be less than10cfu/g; *E. coli, S. aureus* (coagulate-positive), and *L. monocytogenes* should not be present in 1 g of cheese; *Salmonella* and other pathogens should not be present in 25 g of cheese; besides, yeasts and moulds should be less than 10 cfu/g (Todaro et al., 2013).

Antagonistic mode toprolong shelf life and preserve the Kareish cheese

Kareish cheese is becoming more and more popular due to its tasty organoleptic characteristics and beneficial health attributes. The microbiological quality and safety of Kareish cheese are important considerations for both producers and consumers. Therefore, increasing the shelf life of Kareish cheese is a necessary demand, along with enhancing its quality. Preservatives are substances or chemicals that are added to products like food, beverages, and many other products to prevent decomposition by bacteria or undesired chemical changes. These preservatives used in food can be classified into three categories: natural preservatives (salt, essential oils, herbs, or their extracts); bio-preservatives (lactic acid bacteria, bacteriocin, lysozyme, nisin); and chemical preservatives (benzoic acid, sodium benzoate, sorbic acid, calcium sorbate, propionic acid, natamycin, boric acid, formaldehyde, etc.) (Davidson & Taylor, 2014; Shaker et al., 2022). There are many attempts to extend the shelf life of Kareish cheese, which can be presented as follow:

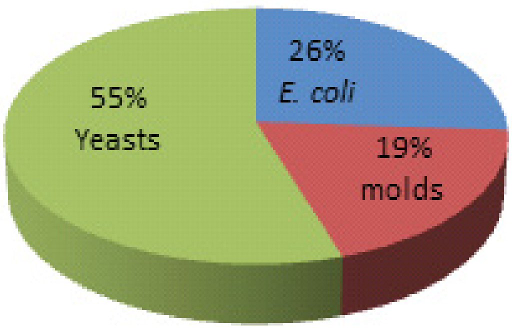

Fig. 3.The microbial flora percentage content (%) in Egyptian Kareish cheese.

Chemical preservatives

Although the usage of natural alternatives is growing, acidulants, organic acids, and parabens are still commonly used antimicrobials. Chemical preservatives are additives that are intentionally added to food in order to prevent or delay food spoiling caused by microbial, enzymatic, or chemical reactions. Organic acids, including sorbic acid, lactic acid, propionic acid, benzoic acid, etc., work well as preservatives for foods with a pH below 5. When the pH is acidic, protonated or uncharged organic acid passes through the cell membrane and into the cytoplasm. Organic acids dissociate and release the proton that acidifies the cytoplasm at a pH level that is neutral in the cytoplasm. This cell uses ATP to pump protons out of the cell to de-acidify the cytoplasm, which makes energy unavailable for their growth (Brul & Coote, 1999; Dhakal, 2022).

The effectiveness of chemical treatments such as sodium metabisulfite, sodium benzoate, and propionic acid as preservatives for soft cheese was investigated by Joseph & Akinyosoye (1997). The shelf life of West African soft cheese was extended by 0.8% sodium benzoate, propionic acid, or sodium benzoate for a total of 8 days and 0.8% sodium metabisulfite for a total of 6 days. Sorbic acid and potassium sorbate efficiently prevented *P. fluorescens, B. cereus, S. aureus, Y. enterocolitica*, and *S. typhimurium* from growing in cottage cheese. These microorganisms are related to the formation of a slimy surface film (Sims et al. 1989). Ho et al. (2016) found that adding 0.05–0.07% of either sorbic acid or potassium sorbate to the cream dressing can extend the shelf life of cottage cheese by 50–75%. However, a bad taste resulted when using potassium sorbate or sorbic acid at a higher concentration (0.075–0.10%).

Bio-preservatives

The growing consumer awareness of the importance of consuming food free of chemicals and replacing them with natural products has led researchers and food manufacturers to search for new and alternative strategies for bio-preserving food. There is a lot of research that has shown the effectiveness of many of these natural alternatives that have been used recently to prolong the shelf life and preserve Kareish cheese. On the other hand, it should be noted that the process of preserving cheese not only reduces the loss of cheese as a result of spoilage by microorganisms but also reduces the physicochemical and sensory changes of this cheese until the date of its consumption (Ho et al., 2016).

Use of lactic acid bacteria

The main commercially accessible microorganisms are lactic acid bacteria (LAB), which include *Lactobacilli, Streptococci, Lactococci,* and *Bifidobacteria* (Ranadheera et al., 2010). They produce a wide variety of metabolites, such as organic acids, hydrogen peroxide, diacetyl, antifungal chemicals, and bacteriocins, which protect the products against microorganisms that cause spoiling (Ogueke et al., 2014; Anjum et al., 2014). Among them are *Str. thermophilus* and *Lb. bulgaricus*, which are bacteriocin-producing cultures that are substantialstarter microorganisms required for the manufacture of Kareish cheese. Ibrahim et al. (2018) studied the effect of using *Str. thermophilus* and *Lb. bulgaricus* as starter cultures for the reduction of Shiga toxin-producing *E. coli* in Kareish cheese during storage time. The starter culture in kareish cheese significantly enhanced the decrease of pathogenic bacteria. The use of both *Lb. casei* and *Lb. plantarum* in a ratio of 2% in the manufacture of Kareish cheese, which was contaminated with both *S. aureus* and *Y. enterocolitica*, had a positive effect on reducing the number of these pathogenic bacteria. The study recommended the possibility of developing the use of probiotic bacteria as a natural preservative to maintain Kareish cheese (Awad et al., 2014). Allam et al. (2017b) found that the use of two isolated strains of LAB, *Lb. plantarum* and *Lb. delbrueckii subsp. lactis*, as a method of bio-preservation led to an increase in the quality of the cheese and a reduction in diseases that could be transmitted through cheese. The addition of *Lb. plantarum* and inulin to Kareish cheese led to improved hygienic quality and cheese shelf life (Hegab et al., 2021). The different antibacterial properties of *Lb. plantarum* against a wide range of Gram-positive and Gram-negative bacteria have been described by several researchers. It has the ability to produce organic acids, hydrogen peroxide, and bacteriocins (Dinev et al., 2018). One of the most beneficial and health-promoting lactic acid bacteria is *Lb. plantarum.* It is well-known for producing plantaricin, which prevents the growth of a variety of pathogenic and spoilage bacteria, including *Proteus vulgaris, E. coli, S. typhimurium, S. aureus, E. aerogenes,* and *P. aeruginos* (Dinev et al., 2017). After one week of cold storage (2–6 °C), *Lb. helveticus* CNRZ 32 inoculation in Kareish cheese showed no pathogenic or spoiler growth. If used properly, LAB, particularly *Lb. helveticus* CNRZ 32, can efficiently ensure the safety and quality of cheese

(El-Sayad et al., 2021). According to Ferreira & Lund (1996), adding nisin, a distinctive bacteriocin produced by the fermentation of a specific strain of LAB, to cottage cheese accelerated the rate of reduction in the number of *L. monocytogenes* injected into the product by 1000 times after 3-days period of storage at 20 °C,. Similarly, it was found that nisin, when used at a concentration of 2.55 mg/g, inhibited the growth of nine strains of *Listeria* spp., particularly *L. monocytogenes*, even after the cottage cheese had only been kept at 4 and 37 °C for one day Benkerroum & Sandine (1988). Natamycin, a natural antifungal compound produced by *Str. natalensis*, is another substance used to preserve cottage cheese. According to Stark & Tan (2003), natamycin mostly prevents the growth of mold and has no impact on microorganisms that cause spoilage. When natamycin or mycostatin were added to the cream dressing at doses of 1, 2, or 5 g/mL, the shelf-life of cottage cheese at 4.4 °C was increased by 2.3, 18.6, and 26.7 days, respectively. At higher storage temperatures (10-15.6 °C), these antifungals also increased the shelf life of cottage cheese, but the effect was not as strong as it was at 4.4 °C (Nilson et al. 1975). Kareish cheese produced with mutant strains of *Lb. bulgaricus* and *Str. thermophillus* had a lower viability, mold, and yeast counts than the control. After 21 days of storage, very low levels of mold and yeast were found in the mutant-produced Kareish cheese, whereas they first appeared in the control after 14 days (Abd El-Aty et al., 2016).

Use of lactoferrin

Lactoferrin plays an important role in a wide range of physiological activities, including antiviral, antibacterial, and anticancer properties (Farid et al., 2019). Lactoferrin is an iron-binding glycoprotein and a member of the transferrin family that plays a number of critical protective roles in the mammalian body. As a natural antibacterial for bio-preservation, it extends the shelf life of dairy products, maintains product safety, and improves health by protecting against diseases that can be harmful to babies. Additionally, it helps in the treatment of foodborne illnesses, respiratory infections, and hepatitis (Diarra et al., 2002). Lactoferrin's bactericidal activity in Gram-negative bacteria can be explained based on the fact that some Gram-negative bacteria have receptors for the N-terminal region of lactoferrin on their surface, which allows lactoferrin to bind to these receptors, leading to disruption in the cell wall. These results in impaired permeability and a higher sensitivity to lysozyme and other antimicrobial agents (Sherman et al., 2004). While the contact between positively charged regions and anionic molecules found on the surface of some Gram-positive bacteria results in an increase in membrane permeability, causing bacterial damage, bactericidal activity on Gram-positive bacteria is produced by the contrary (Haversen et al., 2010; Hassan et al., 2022). The bacteriostatic effect of lactoferrin is due to its ability to bind free iron, which is one of the elements essential for the growth of bacteria. Otherwise, lactoferrin can act as an iron donor and enhance the growth of *L actobacillus* sp. or *Bifidobacterium* sp. (Sherman et al., 2004).

Many studies have shown the importance of using lactoferrin as an antioxidant, antiviral, antibacterial agent, especially against pathogens that may be found in cheese (Fig 4), especially Kareish cheese. Lactoferrin had a significant effect on the *E. coli* count in Kareish and Domiati cheese, and the high concentration of 20 mg/mL of lactoferrin also showed an inhibition of *S. aureus* in Kareish.The count decreased from 3.9×10^4 at zero time to 2.6×10^2 after 10 days (Hassan et al., 2022). Also, 4% concentrations of bovine lactoferrin affected the growth of *E. coli* O157:H7, *S. aureus, L. monocytogenes*, and *B. cereus* in vitro use the agar well diffusion test. This concentration was applied to Kareish cheese kept in the refrigerator, and the results suggested that it prevent bacteria from growing there and increase the cheese's shelf life while it was kept cold (Ombarak et al., 2019; Perraudin & De Valck, 2020). Bobreneva & Rokhlova (2021) reported thatyoghurt, cheese, and kefir are just a few examples of fermented foods that are made with bovine lactoferrin. Whey protein lactoferrin, which shows antibacterial and bifidogenic qualities, was used to extend product shelf life.In addition, the fermented milk treated lactoferrinhad significantly lower *C. albicans* counts in comparison to the control groups. Yoghurt samples treated with lactoferrin 1.5% had the highest reduction percentage of *C. albicans* counts, followed by lactoferrin 0.5% (Fetouh et al., 2023). According to Samaranada et al. (2001), *C. albicans* isolates rapidly lose viability at lactoferrin concentrations of 20 g/mL.

Use of plant extracts and essential oils

Since ancient times, cheese has frequently been made using herbs, spices, or their oils to enhance the taste and flavor of the final product (Vazquez et al., 2001). The use of herbs and spices may often lead to the transfer of the microbial load from them to the cheese, which causes cheese contamination with both spoilage and microbe-related diseases (Baydar et al., 2004). Therefore, the use of plant extracts or their essential oils (EOs) is the best solution to avoid this contamination and acts as natural preservatives (Ritota & Manzi, 2020). In the dairy sector, many scientific works have reviewed the use and effects of herbal extracts (Abd El-Aziz et al., 2023). Many countries add aromatic herbs to their native cheese types, particularly in Italy (Casoperuto, Marzolino, Romano pepato, PiacentinuEnnese, etc.), as well as numerous other European nations, including Switzerland, France, the Netherlands, and many other countries around the world, including Egypt (Kariesh), Syria (Shankalish), Morocco (Jben, and Raib), and Turkey (Otlu, Surk, and Carra) (Ritota & Manzi, 2020).

The natural compounds that have antimicrobial activity are present in higher concentrations in plants, including phenolic compounds, terpenoids, sesquiterpenes, and possibly diterpenes of various groups (Tajkarimi et al., 2010). Bukvicki et al. (2018) mention that the antimicrobial activity of *Thymus algeriensis* EOs refers to its major monoterpenoid phenol compound, carvacrol, while in the EOs of various species of *Pimpinellaanisum* L. plant, benzene derivatives play a major role in antimicrobial activity (Ehsani et al., 2012). In addition, the antimicrobial activities of *Allium* species refer to the major sulphur-containing compounds (Al-Snafi, 2015). The antibacterial and antifungal properties of clove and thyme oils are mostly attributed to eugenol and thymol, whereas carvone and limonene, two of spearmint's principal terpene components, are responsible for the antimicrobial activity of spearmint essential oil (Vazquez et al., 2002; Foda et al., 2009). Gingerol, gingerdiol, and shogaol are the antimicrobial active compounds available in ginger (Abd El-Aziz et al., 2012). Plant extracts and their EOs appear to affect bacteria by rupturing the cytoplasmic membrane, which subsequently allows the passage or release of associated compounds (Gouvea et al., 2017). Such as an increase in the permeability of the cell membrane that causes the release of intracellular substances, including potassium, calcium, and sodium ions. Cells suffered irreversible damage as a result of the release of cytoplasmic substances, including the leakage of potassium ions necessary for charge balance into the membrane (Zhang et al., 2016; Gouvea et al., 2017). Moreover, the cell energy production enzyme (ATPase) may be inhibited by plant extracts and their essential oils, which leads to cell death (Gouvea et al., 2017).

Many extracts or EOs, from aromatic herbs have been used in the production of cheese to take advantage of their antibacterial properties that prevent illnesses and spoilage. Such plants are fennel, oregano, rosemary, dill, cumin, pepper, sage, thyme, ginger, and parsley. The antibacterial effectiveness of aromatic herbs and their EOs added to cheeses against pathogenic and spoilage microorganisms are shown in Table 1. EOs contain 10 to 100 various substances, with 2-3 main bioactive components present in high concentrations (20–70%). These bioactive substances include phenylpropanoids (phenols, aldehydes, and alcohols), terpene compounds (limonene, pcymene, and terpenes)and terpenoids (phenols, ethers, ketones, aldehydes, alcohols, and esters). According to Ibrahim et al. (2020), terpenes and terpenoids have been shown to be effective agents against bacteria, fungus, viruses, and protozoa. It is important to note that their composition can vary due to intrinsic factors based on the plant parts used (roots, stems, leaves, seeds, and others) and extrinsic factors based on the extraction method (water or steam distillation, solvent extraction, expression under pressure, microwave-assisted extraction, ultrasonic-assisted extraction, supercritical fluid extraction, and subcritical water extraction).

In Kareish cheese, *S. aureus* concentrations dropped when green pepper or cayenne was added, and they disappeared after two days of storage at 4±2 °C. In the same study, the use of dill and parsley extracts resulted in significant antibacterial activity, as well as for the coliforms, and showed a strong antifungal effect (Wahba et al. (2010). Black cumin, cumin, and cloves were used in varying amounts (0.50, 0.75, and 1.0%, respectively) to produce high-quality Kareish cheese (Saleh, 2018). The average count of yeast and mold in fresh cottage cheese ranged from 0 to 0.3103 log cfu/g, but after being treated with 30, 40, and 50 ppm of a 30% thymol solution in butter oil for up to 12 days, there was no sign of yeast or mould in the treated samples. These microbes somewhat increased in the treated samples from days 12 to 16. Thus, thymol has antifungal activity as a result. Yeast growth slows down when thymol levels increase (Makhal et al., 2014). The *S. aureus* counts in Egyptian Kareish cheese were also lowered by cayenne and green pepper extracts (Wahba et al., 2010). The addition of 15% Aloe vera gel to kareish cheese was found to be the best ratio for extending the storage period of the final product due to its antioxidant and antimicrobial properties, according to Ebeid et al. (2017). Sajadi (2015) studied the inhibitory effect of Aloe vera gel at concentrations of 0.5, 1, 2, 5, 10, and 15% on *P. citrinum* growth in UF cheese. The results of the research proved that the maximum percentage of *P. citrinum* growth inhibition on UF cheese at 15% concentration was 37.3%.

The *S. aureus* population decreased in one cycle of cottage cheese using thyme EO at a concentration of 2.5 L/mL (Carvalho et al., 2015). Kareish cheese's shelf life was extended to 30 days at 42 °C by adding 5 or 10% propolis and 0.5% each of garlic and ginger EOs as natural preservatives (Metwalli, 2011). Refaey et al. (2019) found that Kareish cheese made with *Menthaspicata* extract (alcohol or water) at 0.1% had the lowest number of microbiological properties, and its extended shelf life reached 30 days as compared with control cheeses.

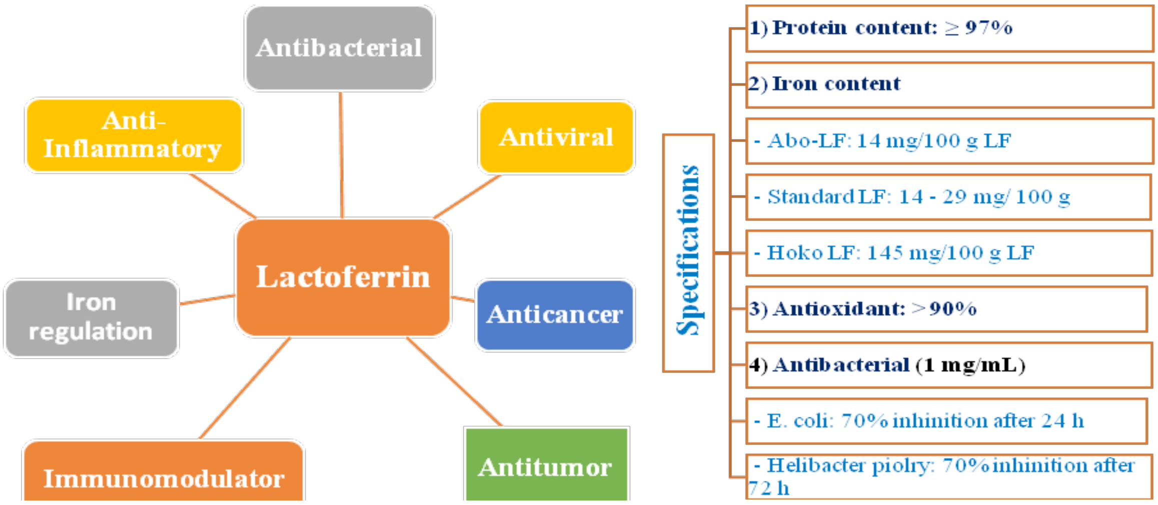

Fig. 4. Relation between the biological activities of lactoferrin and its specifications (Perraudin & De Valck, 2020).

TABLE 1. Antimicrobial effect of aromatic plants and their essential oils added to kareish cheese.

Aromatic Plants	Concentration	Bioactive com.pounds	Antimicrobial effect	Reference
Cayenne	3%	Phenylpropanoid compounds, capsaicin, and dihydrocapsaicin	Inhibition of *S. aureus* to undetectablelevels after 2 days at 4 ± 2°C.	Wahba et al. (2010)
Green Pepper	9%	3,4-dihydroxyphenyl ethanol glucoside, 3,4-dihydroxy-6-(N-ethylamino) benzamide	Inhibition of coliform, total counts, mold and yeasts	Wahba et al. (2010)
Nigella, Black cumin	0.5 – 1.0%	Thymoquinone, Eugenol, Nigellone, Carminative	Reduced coliform, total counts, mold and yeasts	Saleh (2018)
Cumin	0.5–1.0%	P-cymene, Cuminal, Pinene, α-Terpinol	Reduced coliform, total counts, mold and yeasts	Saleh (2018)
Clove	0.5–1.0%	Eugenol, Acetyl eugenol, vanillin	reduced coliform, total counts, mold and yeasts	Saleh (2018)
Propolis	5–10%	flavonoids and phenolicacids	Has antibacterial, antifungal and antiviral activities	Metwalli (2011)
Ginger	0.5%	Camphene,phellandrene, zingiberene, and zingerone	Killing *Salmonella* and inhibits aflatoxin producing fungi.	Metwalli (2011)
Aloe vera gel	30%	coumaricacid, pyrocatechol, cinnamic acid	Inhibits of *P. citrinum.*	Sajadi (2015)

Coating and biofilms

Similar to other water-oil emulsions, dairy products are susceptible to hydrolytic and oxidative rancidity, which is what gives them their unpleasant flavor and smell. In order to extend the shelf life of cheese, various methods have been used, including the addition of preservatives to modified atmosphere packaging, active coatings with antimicrobial agents, and edible packaging based on proteins, polysaccharides, and lipids with various functional additives (Ritota & Manzi, 2020). The biofilms, composed of natural materials, that are coated on the food's surface as a thin coating of material with a particular composition help regulate the rate at which the product's molecular components are transported from the inside of the packaging to the outside.The biofilms also prevent food goods from changing unfavorably and act as a barrier against moisture absorption during storage. In contrast to a coating, which is applied to and forms immediately on the food surface, biofilm is a stand-alone wrapping material. Many investigations have looked at the possibility of using antimicrobial substances like nisin, natamycin, essential oils, or probiotic bacteria in coatings or biofilms to inhibit the growth of microorganisms on the surface of cheese (Guldas et al., 2015).

The addition of EOs like rosemary oil has a significant effect on the quality of cheese. Cheese's shelf life is extended by rosemary oil, which is considered as edible coating oil with antifungal properties (El-Sayed et al., 2020). *E. coli* O157:H7, *L. monocytogenes*, and *S. aureus* counts all increased over the 60-day storage period in uncoated control samples, whereas they decreased in samples coated with thyme-fortified film and clove-fortified film (Kavas et al., 2015). Antibacterial activity and the coating of cheese samples with EO-containing films were shown to be significantly correlated. El-Diasty et al. (2012) stated that chitosan has three types of reactive functional groups: an amino group as well as both primary and secondary hydroxyl groups at the C-2, C-3, and C-6 positions, respectively. One of the most acceptable mechanisms for microbial inhibition by chitosan is the interaction of the positively charged chitosan amino group with the negatively charged microbial surface cell membrane, causing tears in the cell membrane and changing cell permeability (El-Dahma et al., 2017; Reshad et al., 2021). Chitosan can enter the cell nucleus and interfere with messenger RNA and protein synthesis, which allows it to attach to microbial DNA and prevent the synthesis of messenger RNA. It can also create a polymer membrane on the cell's surface that serves as an oxygen barrier and a barrier to nutrients, inhibiting the growth of aerobic bacteria (El-Aidie, 2018). Aloe Vera gels are used as edible coatings in much food preservation, especially fresh products, and delay the postharvest deterioration of food (Ebeid et al., 2017). Sayed-Elahl et al. (2019) found that because nano-chitosan has antibacterial properties against various bacteria and fungi, adding 0.25 or 0.5% to the ingredients of kareish cheese before manufacture or coating it with 0.25 or 0.5% after manufacture could lead to their prolonged safe preservation.

Whey proteins, a by-product of cheese production, are used in an edible whey protein-based film with rosemary EO to extend the shelf life of Kareish cheese (El-Sayed et al., 2020). Cheese's quality is noticeably improved when a film consisting of edible whey protein and rosemary is applied to it. The antimicrobial activity of whey proteins can be explained by the iron-binding properties of β-lactoglobulin, α-lactalbumin, lactoferrin, lactoperoxidase, serum albumin, and lysozyme. However, its effects are not limited to iron-needing bacteria. Lactoferrin can damage the outer membranes of Gram-negative bacteria by binding to lipopolysaccharides and enhancing the effect of hydrophobic antimicrobials such as lysozyme (Jiménez et al., 2012). Giannakas et al. (2022) use edible films based on new hybrid nanostructures to extend the shelf life of soft cheese.They produced a unique TO@NZ hybrid nanostructure by modifying the natural zeolite (NZ) by incorporating thyme essential oil (TO). The sodium-alginate/glycerol (ALG/G) polymer matrix was perfectly combined with TO@NZ nanostructures to produce a very promising active film that served as an antimicrobial, antibacterial, and antioxidant for the extended shelf life of soft cheese.

Gamma irradiation

In order to produce high-quality and safe food, cold pasteurisation (food irradiation as gamma irradiation) has been identified by other researchers as one of the most important peaceful applications of nuclear energy (FDA, 1997; WHO, 2005). Irradiation reduced the total colony and coliform count, as well as the total yeast and mold, *Enterobacteriacae*, and *Staphylococcus* counts. The greatest dose (5 KGy) had a more significant effect. Aly et al. (2012) concluded that high percentages of bacterial populations were reduced when the radiation dose was increased up to 5 KGy, but neither the chemical nor sensory properties were affected. Odueke et al. (2018) investigated the impact of gamma irradiation on the shelf-life of pseudo-dairy food products made up of various concentrations of the macronutrients that serve as the food's structural and calorie-giving components. After 100 days of analysis, the total viable count for samples treated with 10 kGy was below log 3.94 cfu/g at the end of the shelf-life trial. These findings showed that the product could be safely stored in a refrigerator for between 14 and 28 days for non-irradiated samples, 56 days at 3 kGy, 42 days at 1 kGy, and >100 days at 10 and 5 kGy for irradiated samples, and without much alteration to its physicochemical and microbiological properties.

Conclusion

One of the challenges that Kareish cheese manufacturers face is its limited shelf life. The use of natural bioactive compounds like plant extracts and lactoferrin as antimicrobials to extend the shelf life of Kareish cheese and its nutritional and sensory qualities has recently attracted a lot of interest due to the risks associated with chemical preservatives.The use of bioactive components in biological membranes developed using nanotechnology has extended the shelf life of cheese.The use of gamma radiation to increase the shelf life of cheese has become accepted in recent years, but more research is needed to determine safe doses and to understand the impacts on cheese quality

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