DERLEME MAKALESİ / REVIEW ARTICLE

USING BEESWAX COATINGS FOR PROLONGATION SHELF-LIFE OF CHEESE

Peynirin Raf Ömrünü Uzatmada Bal Mumu Kaplamaların Kullanılması

(Genişletilmiş Türkçe Özet Makalenin Sonunda Verilmiştir)

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ABSTRACT

Cheese, being a nutrient-dense dairy product, is a good source of essential components like protein, minerals in particular phosphorus and calcium of highly consumed foods. It is susceptible to physical, chemical and biochemical spoilage, hence the increased consumer demand for high quality cheese has initiated the development of several innovative methods to increase storability and shelf-life and to enhance microbial safety. Packaging has been a significant process within preservation techniques to provide the efficient (functional and mechanical) protection of the commodities. Since synthetic packaging materials has been mentioned to contribute to the environmental pollution, packages and edible coatings have been proposed to replace or complement conventional packaging in order to protect food products from deterioration and decrease the quality loss. These films should have appropriate sensory characteristics, suitable barrier properties (oil, humidity, O_2, CO_2), biochemical, physicochemical and microbial stability, aside being safe, and produced by simple technology with low cost. They also can affect as carrier for color, flavor, nutritional, antioxidant or antimicrobial additives. This review discusses mainly using biodegradable films, in particular beeswax, for extension of shelf-life of cheese.

Key words: Shelf-life, cheese, packaging, edible film and coating, beeswax

ÖZ

Peynir besin bileşeni bakımından konsantre ve tüketimi yaygın olan bir süt ürünüdür. Farklı peynir çeşitlerinin farklı tüketici gruplarının damak zevklerini karşılayabilmesi yanında protein ve madensel maddeler (özellikle kalsiyum ve fosfor) bakımından zengin içeriği tüketici talebini arttıran nedenler olarak sıralanabilir. Peynirin fiziksel, biyokimyasal ve mikrobiyolojik bozulmalara hassas bir gıda olup kolay bozulabilmesi; mikrobiyolojik açıdan güvenliği arttırmak, raf ömrü ve dayanımı uzatmak için yenilikçi muhafaza yöntemlerinin geliştirilmesine yol açmıştır. Paketleme, gıda maddelerinin farklı amaçlarla tüketime sunulmasına, farklı boyut ve şekillerde korunmasına olanak veren bir işlemdir. Bazı yapay ambalaj maddeleri tüketici sağlığına zarar verebilmekte ve doğada kolay parçalanmadığından çevre kirliliğine yolaçmaktadır. Bu nedenlerle alternatif ambalaj maddeleri arayışına gidilmiş, kalite kayıplarını azaltmak ve muhafaza amacıyla yenebilir film kaplamalar geliştirilmiştir. Yenebilir kaplama filmleri; tüketimi güvenli, ucuz ve üretim teknolojisi basit, dış etkenlere (yağ, nem, O_2 ve CO_2); biyokimyasal, fizikokimyasal ve mikrobiyolojik bozulmaları dayanıklı olmalıdır. Bunların yanında yenebilir filmlere renk, aroma, besin öğeleri, antioksidant ve antimikrobiyal maddeler de katılabilmektedir. Bu derleme makalede özellikle bal mumu başta olmak üzere; yenebilir film kaplamaların peynirin raf ömrünü arttırmada kullanılabilirliği ele alınmaya çalışılmıştır.

Anahtar sözcükler: Raf ömrü, peynir, paketleme, yenebilir film ve kaplama, balmumu

INTRODUCTION

The shelf-life of a commodity has been defined as "the period of time during which the food product will (i) remain safe (ii) be certain to retain its desired physical, chemical, microbiological, sensory and functional characteristics; (iii) where appropriate, comply with any label declaration of nutrition data, when stored under recommended conditions" (IFST 1993; Nicoli 2012). It is clear that the main aspects of an acceptable shelf-life are food safety and desired quality. In order to sustain safe, durable and high quality food products throughout shelf-life product composition, processing requirements, packaging properties and the handling, storage and distribution conditions are crucial (Kilcast and Subramaniam 2011).

Prolongation of shelf-life of food products depends on the use of preservation methods. This involves retardation of microbial, biochemical and enzymatic reactions through various approaches such as moisture control; temperature control; addition of chemicals such as carbon dioxide, sugar, salt, or natural acids; removal of oxygen; or a combination of these with effective packaging (Lee et al. 2008; Robertson 2014). There are other commercial applicatios of alternative non-thermal preservation methods, such as high-voltage pulsed electric fields (PEF), gamma irradiation, ultraviolet (UV) radiation, ultrasound, ultrahigh hydrostatic pressure (HPP), and non-conventional chemical reagents (Farkas and Hoover 2000; Bermudez-Aguirre and Barbosa-Canovas 2011; Martinez-Rodriguez et al. 2012; Ortega-Rivas and Salmerón-Ochoa 2014)

There has been a rapidly growing awareness among the consumers for high quality products with both guaranteed safety, prolonged shelf-life and preserved nutritional, functional and sensory characteristics with new processing technologies aside with the development and use of innovative packaging materials. Packaging plays an important role to protect and preserve the commodity from environmental influences like heat, light, pressure, oxygen, moisture, microorganisms, enzymes, insects, and etc. The ideal packaging material should be inert and resistant to hazards and should not allow molecular transfer from or to packaging materials (Marsh and Bugusu 2007; Brody et al. 2008; Robertson 2014). Synthetic packaging materials results in food wastes that contribute to the environmental pollution, thus, edible polymers have been offered as alternative/complement for conventional packaging materials (Akpinar and Ozcan 1999).

Edible coatings or films, consisting of natural and biodegradable agricultural products, that covers the surface of the food as a thin layer of material of certain composition, helps to control the rate of transport of the product's molecular components from the inside to the outside of the packaging. It also forms a barrier to moisture absorption during storage and retards the undesirable changes in food products (Embuscado and Huber 2009; Robertson 2014)

A film is differentiated from a coating as it is a stand-alone wrapping material, whereas a coating is applied and formed directly on food surface itself (Kokoszka and Lenart 2007; Pavlath and Orts 2009; Guldas et al. 2010; Shit and Shah 2014).

There are several reasons for investigating biodegradable and edible films/coatings, which are designed to be similar to those of conventional films, however made from naturally occurring polymers and functional ingredients. The potential benefits pertaining to their use in foods are (Embuscado and Huber 2009; Janjarasskul and Krochta 2010; Pascall and Lin 2013; Robertson 2014):

- Desirable sensory characteristics
- Sufficient barrier properties (CO_2, O_2, moisture, oil) by controling the rate of transport of the product's molecular components from the inside to the outside of the packaging and slowing down respiration which delay deterioration
- Microbial, biochemical and physicochemical durability by slowing down adverse reactions which were responsible for undesirable changes and loss of nutrients in food products
- Safety of public health
- Effective carrier for antioxidant, flavor, color, nutritional or anti-microbial additives
- Low cost
- Simple technology for production

The objective of this review is to study the progress on the development and different applications of edible films and coatings, in particular beeswax, on cheese.

EDIBLE FILMS AND COATINGS IN CHEESE

The studies on coating formulations have mainly focused on assessing and improving barrier properties. The coatings and edible films may be

classified according to the material type of which they have been derived and each class has its inherent characteristics, advantages, and limitations to be used as films. The main ingredients of coatings and edible films are divided into three groups: lipids (waxes, beeswax, candelilla, carnauba, paraffin, rice bran, fatty acids, and acetylated monoglycerides (AM)), hydrocolloids (proteins, cellulose derivatives, κ-carrageenan, alginates, pectins, starches, and other polysaccharides), and composites (contain both hydrocolloids and lipids) (Deheaufor et al. 1998; Akpinar and Ozcan 1999; Bourtoom 2008; Embuscado and Huber 2009).

Hydrocolloid-based coatings have the required mechanical and optical properties with low water vapor barrier characteristics. In addition to this, lipid–based coatings are characterised by highly satisfactory moisture barrier properties during handling and serving, but usually form relatively low elastic surfaces (Guilbert et al. 1996; Fang et al. 2002). Addition of lipids (oleic acid or beeswax) into sodium caseinate film structure resulted in opacity and loss of gloss to the film, especially as beeswax increased in the lipid mixture, due to the formation of greatest lipid aggregates in the internal and surface parts of the film (Fabra et al. 2009).

Shelf-life of dairy products is mainly determined by the activity of spoilage microorganisms, enzymatic degragation and chemical deterioation, such as fat creaming and oxidation, protein gelation, syneresis, crystallization and non-enzymatic browning (Kilcast and Subramaniam 2011).

Cheese has a complex structure and its quality attributes (i.e., texture, melt/stretch, color, and flavor) are affected by a variety of factors such as raw milk composition, manufacturing, variety, and changes during ripening (Law and Tamime 2010; Enab et al. 2012) (Table 1). Flavor and texture of cheeses are affected by the amount of milk fat, moisture content, the activation of intrinsic milk lipases, and the rate and extent of acid development (Walsh et al. 1998; Fenelon and Guinee 1999; Eren Vapur and Ozcan 2012).

Maintaining cheese quality throughout the predicted shelf-life requires protection against dehydration and inactivation of harmful pathogenic microorganisms. Protection against dehydration can be accomplished by using packaging films with low water vapor permeability such as low density polyethylene, polypropylene, orientated polypropylene and polyvinylidene chloride. The use of modified atmosphere packaging (MAP) or use of preservatives (i.e. sorbic acid, sodium benzoate) can be effective to control microbial growth, however, this might result in undesired changes in the sensory characteristics (Gonzales-Fandos et al. 2000; Azza and Ahmed 2010). Therefore, recent studies have focused on the applicability of biodegradable packaging materials composed of proteins, cellulose derivatives and lipids in order to extent the storability. The coatings and edible films, obtained from food-grade additives and edible biopolymers, might protect cheese from physical, chemical and biological deterioration as well as improve visual and tactile features. It has been observed that edible films are effective to control microbial growth on the surface, moisture migration, oxidation of nutrients and light-induced chemical changes (Ramos et al. 2012; Mastromatteo et al. 2013; Wagh et al. 2014) (Table 2).

The growth of microorganisms on the surface of cheese may be reduced by incorporating antimicrobial agents, like nisin, natamisin, essential oils, or probiotic bacteria, in the coatings/films (Delikanli and Ozcan 2014; Soukoulis et al. 2014). When cheese is subjected to temperature changes during storage, water condensation may occur inside the package and the surface moisture is increased, hence, microbial spoilage is induced. By appliying coatings/films on cheese surfaces moisture condensation/migration can be controlled. The exchange of natural vapourable flavor compounds and color compounds between the cheese and its surrounding environment can be restricted as the coating acts as gas barrier (Mei et al. 2000; Cerqueira et al. 2009; Fajardo et al. 2010; Pierro et al. 2011).

Table 1. Factors effective on major quality attributes of cheese

Quality Factor	Primary Concerns
Milk	Composition (fat, casein, protein, lactose, calcium and pH)
	Microbial activity and enzymatic activity
	Lactational variation (health, season, breed, diet, storage and transport)
	Somatic cell count
	Contaminants and chemical residues
Milk Pre-treatments	Cooling
	Thermisation
	Pateurization conditions
	Bactofugation
	Microfiltration
	Protein standardization
	Protein/fat ratio
Curd Manufacture	Gelation properties (milk temperature / pH, rennet type / level, rennet: casein, coagulant type and starter culture: casein)
	Starter culture (activity, level, type)
	Gel cutting (firmness, time, speed and revolutions of knife and vat/knife type)
	Cooking / stirring (heating intensity, scald temperature, time and speed)
	Whey drainage (pump-out time and curd pH)
Curd	Salting and pressing (salting type, salt level, pressure, pressing temperature and time)
	Bacterial flora types, residual chymosin and populations
	Composition factors (pH, fat, moisture, calcium, protein, lactose/lactate and salt)
Maturation Conditions	Temperature, humidity, time
Cheese	Lypolysis
	Proteolysis
	Glycolysis
	Secondary fermentations (lactate to propionic acid)
	Catabolism of free fatty acids/free amino acids
	Protein hydration
	Mineral migration

Table 2. Examples of edible coating applications on cheese

Cheese Type	Coating Material	Primary Functions	References
Dry-White and Semi-Hard Brined	Alginate, gellan and K-carrageenan	Improved textural and sensorial properties	Mei et al. 2000
Mozzarella	Sodium alginate	Microbial barrier, Antimicrobial carrier	Conte et al. 2007
Mozzarella	Chitosan-lysozyme	Microbial barrier	Duan et al. 2007
Cheese	Chitosan, galactomannan and agar	O_2/CO_2/microbial barrier	Cerqueira et al. 2009
Fior di latte	Chitosan, alginate, lysozyme and Na_2–EDTA	O_2/CO_2/microbial barrier	Del Nobile et al. 2009
Regional Cheese	Galactomannan and chitosan	O_2/CO_2/microbial barrier	Cerqueira et al. 2010
Saloio	Chitosan	O_2/CO_2/microbial barrier, Antimicrobial carrier	Fajardo et al. 2010
Kashar	Wheat gluten and methyl cellulose	Antimicrobial carrier, Microbial barrier	Ture et al. 2010
Ricotta	Chitosan and whey protein	O_2/CO_2/microbial barrier, Antimicrobial carrier	Pierro et al. 2011
Cheese	Glycerol, sunflower oil, guar gum, whey protein isolate (WPI) and tween 20	H_2O barrier, Antimicrobial carrier	Ramos et al. 2012
Kariesh	Chitosan	Microbial barrier	El-diasty et al. 2012
Gouda	Whey based	Antimicrobial carrier, Microbial barrier	Andriani et al. 2013
Mongolian	Starch and chitosan	H_2O barrier, Antimicrobial carrier, Microbial barrier	Mei et al. 2013
Mozzarella	Sodium alginate	Antimicrobial carrier, Microbial barrier	Mastromatteo et al. 2013
Kashar	Casein	Antimicrobial carrier, Microbial barrier	Unalan et al. 2013
Port salut	Starch	Antimicrobial carrier, Microbial barrier	Resa et al. 2014
Cheddar	Casein and whey protein concentrate	O_2/H_2O/Microbial barrier	Wagh et al. 2014
Mozzarella	Chitosan, sodium alginate, and soy protein isolate	Microbial barrier	Zhong et al. 2014
Bod ljong	Chitosan, water chestnut starch, and glycerol	H_2O barrier, Antimicrobial carrier	Mei et al. 2015 Guo et al. 2015
Kashar	Zein	Antimicrobial carrier, Microbial barrier	Yangilar and Oguzhan-Yildiz 2015
Göbek Kashar	Chitosan and whey protein concentrate	Microbial barrier	Yangilar 2015
Feta	Zein	Antimicrobial carrier, Microbial barrier	Ghasemi et al. 2015
Ras	Chitosan	Microbial barrier	El-Sisi et al. 2015
Kashar	Whey isolate	Antimicrobial carrier, Microbial barrier	Kavas et al. 2015

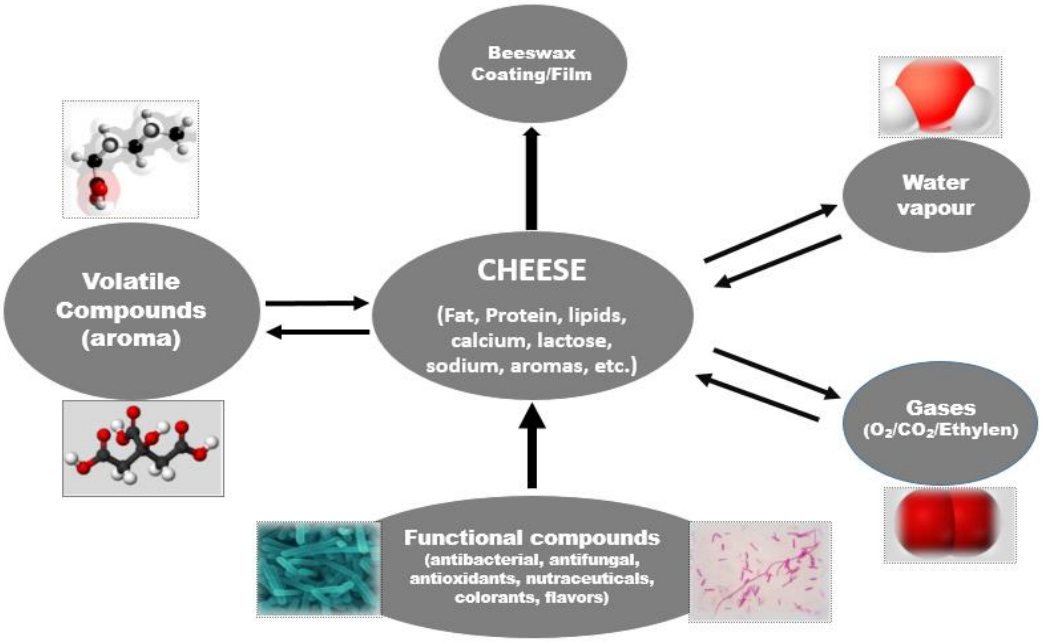
Lipid compounds exploited as edible polymers consist of acetylated monoglycerides, paraffin wax, beeswax and surfactants. Various types of wax were used as barrier films to moisture and gas (i.e. skin on fresh fruits) and to improve the external appearance of many type foods (e.g., the sheen on sweet). If applied as a thick layer, they must be removed before consumption (certain cheese); when used in thin layers, they are considered as edible. The main function of a lipid-based coating is

to block passage of moisture since they display a relative low polarity. It has been reported that water vapor permeability decreases when the concentration of hydrophobicity phase rises (Fabra et al. 2009). Lipid films, often maintained on a polymer structure matrix, form a thicker and more brittle films, and provide mechanical strength (Morillon et al. 2002).

Beeswax, a by-product of honey production, is the creamy coloured substance used by bees to build the comb that forms the structure of their nest. Its main components are palmitoleate, palmitate, and oleate esters of long-chain (30-32 carbons) aliphatic alcohols. Very pure beeswax is white, but the colouration of beeswax (shades of yellow, orange and red through to brown) is due to the presence of various components, especially pollen. It is a quite stable substance, and keeps its properties for a long time of period. It is insoluble in water and resistant to natural oxidization and hydrolysis. It is a complex material consisting of many different componets, but mainly of esters of higher fatty acids and alcohols, pigments usually from pollen and propolis, as well as the traces of bee material. It is tenacious at room temperature, brittle when the temperature drops below 18°C and soft at around 35-40°C. Purified and bleached beeswax has a multitude of uses in the cosmetic, food and pharmaceutical industries – for example, producing creams, protecting and aging cheese or coating pills (Anonim 2015).

Beeswax incorporated with antioxidant and antimicrobial agents, nutraceuticals, and flavor and color ingredients can be used to lower the surface microbial load via competitive inhibition of undesired spoilage and pathogenic bacteria, delay oxidation and discoloration, protect from physical damage caused by mechanical impact, like vibrations and pressure, and finally result in improved quality (Rooney 2005) (Figure 1).

Figure 1. Functional properties of edible coatings for cheese



Hall (2012) stated that paraffin and beeswax had been approved for coating cheese, cheese rinds and cured cheese as peelable protection removed before consumption in many countries. Yilmaz and Dagdemir (2012) evaluated the effects of the beeswax coating on the microbiological, physicochemical and sensory properties of Kashar cheese during ripening. Kashar cheeses, coated with single-layer or double-layer of beeswax, had no significant differences in terms of total aerobic mesophilic bacteria, LAB, coliform bacteria and *S.aureus* counts, however, a decrease of 2.5

logarithmic units on mould counts. It was observed that the coating formed a thick crust layer and result in low moisture loss. Cetinkaya et al. (2005) examined the organoleptic qualities of Kashar Cheese embedded in beeswax during maturation and found No significant differences were observed in mouthfeel, flavor, colour, appearance and texture.

CONCLUSION

Cheese, a dairy product derived by coagulation of the milk protein casein in a wide range of flavors, textures, is susceptible to physical and biochemical spoilage. The stability of cheese is affected by mainly growth of spoilage microorganisms, enzymatic decomposition, oxidation of lipids and weight loss. There are several methods applied to extent the shelf-life of cheese such as non-thermal processing systems, proper packaging material, or addition of preservatives. Because of diversity of cheeses, subsequent packaging systems must be specialized for each cheese variety. In recent years, current interest in more "natural" and "healthful" foods aside with their synergies in order to prolong the shelf-life of cheeses has suggested the use of active and edible coatings and combination of these described methods. Beeswax can be an alternative to synthetic packaging materials used for cheese industry. However, the reports on beeswax applications on cheese is very limited and thus, more research is required to contribute to the effort of using biodegradable packaging materials in comparison to conventional packaging.

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GENİŞLETİLMİŞ ÖZET

Giriş: İşlenmiş gıdaların tüketiciye sağlıklı olarak ulaşması ve raf ömrü boyunca gıda güvenliği kriterlerini taşıması, uygun ambalajlanmaları ve saklanmaları ile mümkündür. Bu nedenle gıda muhafazasında en başta gelen kriterler; gıda güvenliğinin sağlanması ve kalitenin korunmasıdır. Gıda endüstrisinde mikrobiyal, biyokimyasal ve enzimatik olayları önlemek veya geciktirmek ve gıdaların raf ömrünü uzatmak için, hammadde ve elde edilecek ürünün yapısına bağlı olarak bazen ısı işlemi ya da soğutma bazen de CO_2 ve organik asitler ile muhafaza gibi yöntemler kullanılmaktadır.

Tüketicinin gittikçe artan çevre koruma bilinci, plastik ve sentetik ambalaj maddeleri yerine, doğada kendiliğinden yok olan ya da biyolojik yolla parçalanabilen koruyucu özellik taşıyan ambalajlama maddelerinin kullanılmasına yol açmıştır.

Bu açıdan doğal yenebilir film kaplamalar gıdaların raf ömrünün arttırılmasında kullanılmaya başlanmıştır. Yenebilir filmler doğrudan gıdayla temas etmekte, gıdanın dış yüzeyine uygulanmakta ve gıdanın dış ortamla temas eden tüm yüzeyi boyunca ince bir tabaka (film) şeklinde bulunmaktadır.

Gıdaların yenebilir filmler ile kaplanması nem ve oksijen gibi dış etkenlere dolayısıyla mikrobiyal ve kimyasal değişmelere karşı stabilitesini arttırmaktadır. Bir dış kaplama olarak balmumu doğal olması, kolay temin edilebilmesi ve ucuz olması ile öne çıkmaktadır.

Peynirde Yenebilir Filmler ve Kaplamalar:

Bir kaplamanın koruyucu etkisi ya da verimliliği bileşimine bağlıdır. Kaplamalar elde edildiği kaynağa yada içerdiği yoğun madde oranına göre üç grupta sınıflandırılabilir. Bunlar; yağlar (mumlar, balmumu, yağ asitler vb.), hidrokolloidler (proteinler, kappa karagenan, pektinler, nişastalar, polisakkaritler vb.) ve kompozitler (hem hidrokolloid hem de yağ içeren) olarak ayrılabilir.

Hidrokolloid esaslı kaplamaların mekanik ve optik özellikleri yüksek, fakat nem engelleme özellikleri düşüktür. Yağ esaslı kaplamaların nem engelleme özellikleri yüksek olmasına karşılık elastikiyet özelliği düşüktür. Balmumu ve kazeinatın birlikte uygulandığı filmlerde ise şeffalık kaybı oluşabilmektedir.

Peynir zengin besin içeriği yanında hızla bozulabilen gıdalar grubundadır. Peynirin yağ ve nem içeriğinin yüksek olması bu gıdayı bozulmaya hassas duruma getiren temel etkenlerdir. Peynir türüne bağlı olarak karakteristik sertlik ve tekstürel özelliklere sahip olmalıdır. Bu da belirli bir nem içeriğine ile mümkündür. Peynir muhafazasında; su buharı geçirgenliği düşük filmler, MAP (Modifiye atmosferde paketleme) ya da çeşitli koruyucular kullanılır. Peynir muhafazında kullanılan filmlere antimikrobiyal maddeler (nisin, natamisin), esansiyel yağlar ya da probiyotik bakteriler katılabilmektedir. Diğer yandan peynir muhafaza edilirken sıcaklık değişimine maruz kalırsa; paket içinde su buharı yoğuşabilmekte ve hızla bozulmaya yol açmaktadır. Bu açıdan peynirde yenebilir film kaplamalarının kullanılması, paket içinde nem yoğuşmasını ya da ürüne dışarıdan nem geçişini kontrol edebilmektedir. Bu durum film kaplamanın gaz geçişini engellemesi olarak ifade edilmektedir. Peynirde kullanılan kaplama maddeleri ve peynir çeşitleri aşağıda tabloda verilmiştir:

Tablo. Peynirde yenebilir filmler ve kaplama maddelerine örnekler

Peynir çeşidi	Kaplama Maddesi	Kaynak
Yarı-sert salamura beyaz peynir	Alginat, gellan and Kappa-karragenan	Mei et al. 2000
Mozzarella	Sodyum alginat	Conte et al. 2007
Mozzarella	Kitosan-lisozim	Duan et al. 2007
Peynir	Kitosan, galactomannan ve agar	Cerqueira et al. 2009
Fior di latte	Kitosan, alginat, lisozim ve Na_2–EDTA	Del Nobile et al. 2009
Yöresel peynir	Galaktomannan and kitosan	Cerqueira et al. 2010
Saloio	Kitosan	Fajardo et al. 2010
Kaşar	Buğday gluteni and metil selüloz	Ture et al. 2010
Ricotta	Kitosan and peynir altı suyu (PAS) protein	Pierro et al. 2011
Peynir	Gliserol, ayçiçek yağı, guar gum, PAS protein izolatı (WPI) ve tween 20	Ramos et al. 2012
Kariesh	Kitosan	El-diasty et al. 2012
Gouda	PAS	Andriani et al. 2013
Moğol	Nişasta ve kitosan	Mei et al. 2013
Mozzarella	Sodyum alginate	Mastromatteo et al. 2013
Kaşar	Kazein	Unalan et al. 2013
Port salut	Nişasta	Resa et al. 2014
Çedar	Kazein ve PAS protein konsantratı	Wagh et al. 2014
Mozzarella	Kitosan, sodyum alginat, ve soya protein izolatı	Zhong et al. 2014
Bod ljong	Kitosan, su kestane nişastası, ve gliserol	Mei et al. 2015 Guo et al. 2015
Kaşar	Mısır protein (Zein)	Yangilar and Oguzhan-Yildiz 2015
Göbek Kaşar	Kitosan ve PAS protein konsantresi	Yangilar 2015
Feta	Mısır protein (Zein)	*Ghasemi et al. 2015*
Ras	Kitosan	El-Sisi et al. 2015
Kaşar	PAS izolatı	Kavas et al. 2015

Sonuç

Peynir muhafazasında yenebilir filmler ve kaplamalar düşük gaz geçirgenlikleri ve dış ortam şartlarına stabiliteleri nedeniyle başarıyla kullanılabilmektedir. Yenebilir film ve kaplamalar peynir gibi ürünleri mikrobiyolojik, kimyasal ve fizikokimysal reaksiyonlara karşı dayanıklı hale getirebilmektedir. Yenebilir film ve kaplamalara çeşitli renk maddeleri, kekik yağı gibi bitkisel yağlar, vitamin gibi besin katkıları ya da koruyucular katılabilmektedir.