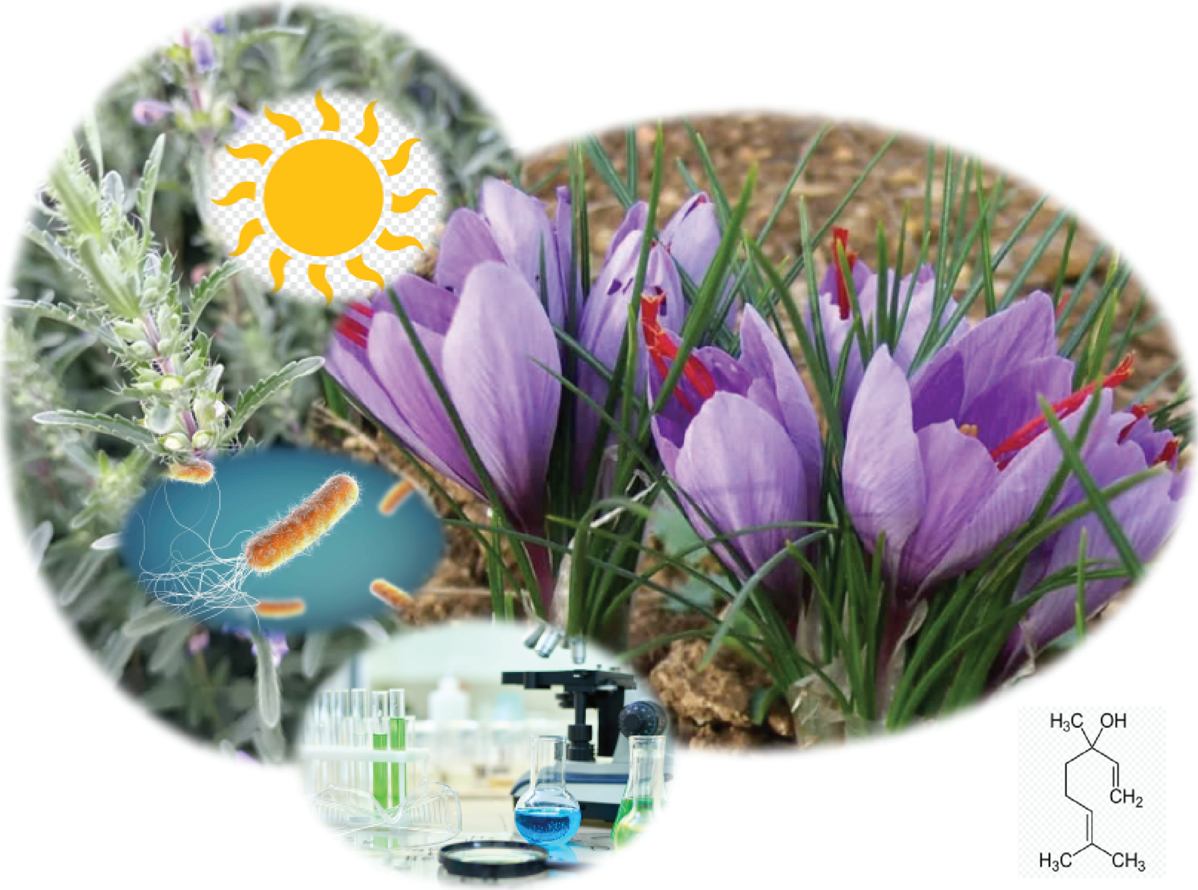

MEDICINAL PLANTS:
SECONDARY METABOLITIES, UTILIZATION, HUMAN HEALTH-I

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CONTENTS

CHAPTER 2

USE OF MEDICINAL AND AROMATIC PLANTS IN EDIBLE FILMS AND COATINGS

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INTRODUCTION

Packaging, the final stage of the food production process, plays a critical role in ensuring the quality and safety of the finished product (Kapetanakou, et al., 2014). Foods deteriorate due to various factors during production, storage, and transportation. (Topuz and Boran, 2018). Packaging has versatile functions such as delaying deterioration by protecting the product from external factors, extending shelf life, and maintaining quality and reliability in packaged foods. (Ahmad et al., 2012 Kumar et al., 2022). Various types of packaging are used for purposes such as preventing quality losses, ensuring food integrity, and informing the consumer (Topuz and Boran, 2018). Plastic, paper, glass, metal and composites are traditional food packaging (Kumar et al., 2022). Plastic packaging, constituting approximately 70% of the total packaging materials, is widely used in the packaging of foods (Hammam, 2019). The impact of packaging on the environment as well as the product is important (Emaeilpour and Rajabi, 2016). Plastics such as polyethylene, polypropylene and polyethylene terephthalate, which are food-grade plastics obtained during the processing of oil and called petroleum-based products, are not environmentally friendly (Sundqvist-Andberg and Akerman, 2021). Today, pollution caused by plastic packaging has reached alarming proportions (Gheorghita Puscaselu et al., 2021). Furthermore, studies conducted in recent years have proven that plastic packaging adversely affects human health due to the interaction between foods and packaging (Hammam, 2019). Developments in food packaging have brought about the use of new packaging techniques instead of synthetic packaging (Pal et al., 2019; Díaz-Montes and Castro-Muñoz, R. 2021). Edible films and coatings are one of these significant developments. Edible films are environmentally friendly materials as they are produced from agricultural-origin, natural, and biologically recyclable substances, contributing to environmental preservation by not polluting the environment (Debeaufort et al., 1998; Díaz-Montes and Castro-Muñoz, R. 2021).

1. EDIBLE FILM AND COATING

Food packaging materials derived from natural sources, as opposed to synthetic ones, are known as edible films and coatings. These materials can be put to the outside or inside of food products to safeguard them and prolong their shelf life (Krochta and Mulder-Johnston 1997; Miller ve Krochta 1997). In recent years, interest in edible films and coatings has increased due to their environmental friendliness, easy accessibility and cost advantages (Bourtoom, 2008; Sharma et al., 2016). Edible films and coatings attract a lot of attention today because they provide a barrier against moisture, oxygen, carbon dioxide and lipids between food and the surrounding atmosphere (Bourtoom, 2008; Kapetanakou, et al., 2014). Edible films and coatings reduce undesirable color formation, lipid oxidation, and loss of taste and aroma compounds in foods (Tural et al., 2017; Hammam, 2019). They also improve the quality and shelf life of the food by ensuring that components such as antioxidants, antimicrobial substances, pigments, ions that stop browning reactions and vitamins are kept in the packaging. (Kaya and

Kaya 2000; Guillard et al., 2003; Silva-Weiss et al., 2013; Tural et al., 2017).

Edible film is defined as applying pre-prepared thin edible material on food components or food itself. Edible coating is often characterized as a thin layer of edible material created on a food (Kester and Fennema 1986). The main difference between edible films and coatings is that edible coatings are generally applied to food by dipping method or spraying, while edible films are prepared as a solid layer and then the food is wrapped with this film (Tural et al., 2017). Edible films and coatings materials are extracted from plant and animal sources in the form of polysaccharides, proteins and lipids. These materials are used either individually or in varying combinations (Caner and Küçük, 2004; Shiekh et al., 2013; Chhikara and Kumar, 2022). However, their use in edible coatings is limited due to the impermeable natural waxy structure of animal-derived materials, the allergic conditions they cause or the religious beliefs of consumers (Shiekh et al., 2013). For this reason, coatings using components obtained from plant sources are more widely used (Hashemi et al., 2017; Nawab et al., 2017).

2. USE OF MEDICINAL AND AROMATIC PLANTS IN EDIBLE FILMS AND COATINGS

Interest in natural additives has increased in the food industry due to the understanding of the negative effects of synthetic additives on health. Plant materials are a good source of obtaining natural additives (Silva-Weiss et al., 2013). Plants that are used as medicine to treat illnesses, preserve health, or prevent sickness are known as medicinal and aromatic plants. A pleasant scent and taste are provided by aromatic plants, whilst medical plants are utilized in sectors like nutrition, cosmetics, body care, incense, or religious activities (Faydaoğlu and Sürücüoğlu, 2011). Medicinal and aromatic plants can produce a broad range of chemical substances that serve crucial biological roles (Laranjo et al., 2022). Medicinal and aromatic plants are good sources of natural antioxidants and contain various polar and non-polar phenolic compounds (Miguel, 2010; Charles, 2012). In recent years, because of their antibacterial and antioxidant properties, medicinal and aromatic herbs are increasingly used in edible coatings and films (Cerqueira, 2019). Their antioxidant activities are due to compounds such as vitamin C, phenolic compounds, carotenoids and vitamin E (Calucci et al., 2003; Shahidi and Naczk, 2004; Turhan and Üstün, 2006). In addition, many non-volatile compounds they contain, such as carnosol, quercetin, caffeic acid and rosmarinic acid, are known to be good free radical scavengers (Zheng and Wang, 2001; Calucci et al., 2003). Consumer interest in essential oils derived from aromatic and medicinal plants is growing as one of the natural antimicrobial agents utilized in food packaging (Haworth, 2003; Skerget et al., 2005, Seydim and Sarikus 2006; Mohammed et al., 2020). Below are some examples related to the use of medicinal and aromatic plants in edible films and coatings.

Maurya et al., (2013) reported in their study that the essential oil obtained from turmeric has antimicrobial effects against *Bacillus* *subtilis, Staphyloccoccus aureus* and *Corynebacterium diphtheriae* bacteria, while the essential oil obtained from clove, cinnamon and thyme has antimicrobial effects against *Listeria monocytogenes* and *Salmonella enteritidis* bacteria. In a study investigating the inhibitory effects of rosemary extract on bacterial growth, it was found that after 24 hours at 30°C, rosemary extract had no antimicrobial effect on gram-negative bacteria such as *Escherichia coli, Salmonella enteritidis*, and *Erwinia carotovora*. However, it completely inhibited *Listeria monocytogenes, Bacillus cereus, Leuconostoc mesenteroides*, and *Streptococcus mutans* (Del Campo et al., 2000). In studies examining the shelf life of shrimp (Cadun et al., 2008) and turkey meatballs (Karpińska-Tymoszczyk, 2008) marinated with rosemary extract, it was found that the shelf life of the trial groups with rosemary extract increased compared to the control group. In studies examining the effects of *Urtica diocia* and thyme, which contain natural antioxidants, on the shelf life of *Oncorhynchus mykiss* fillets, it was found that the shelf life of the fillets was extended compared to the control groups (Hisar et al., 2008; Mexis et., 2009).

Smith et al., (1998) determined that thyme, clove, cinnamon and bay essential oils have bacteriostatic effects against foodborne pathogens (*E. coli, S. aureus, Salmonella enteridis, L. monocytoges, Campylobacter jejuni*). Rojas-Grau et al., (2007) found in their study that films prepared from alginate and apple puree containing thyme, cinnamon, lemon verbena (*Lippia citriodora* L.) essential oils and the main components of these essential oils, carvacrol, cinnamaldehyde and citral, showed significant antibacterial effects against *E. coli* O157:H7. Ayana and Turhan (2009) applied methylcellulose-based films containing olive leaf extract to sliced kashar cheese to prevent the growth of *S. aureus*. As a result of the study, it was determined that the number of *S. aureus* decreased by 24.5% in kashar cheese slices coated with methylcellulose-based film containing 1.5% olive leaf extract. In their study, Torlak and Nizamlıoğlu (2011) investigated the antibacterial activities of edible films containing thyme and clove essential oils and chitosan against S. aureus and *E. coli* O157:H7 and found that the antibacterial effects of all film types were significant.

Kavas et al., (2015) used a film containing whey isolate containing 1.5% thyme and clove essential oils and 1.5% sorbitol in the coating of traditional semi-hard cheddar cheese. In the study, it was stated that the film containing thyme and clove essential oil had positive effects on the physical and chemical properties of kashar cheese. It was also observed that films containing essential oil reduced the levels of *E. coli* O157: H7, L. monocytogenes and S. aureus during daily storage. In the study conducted by Gómez-Estaca et al., (2009), the antioxidant capacities of films to which thyme and rosemary essential oils were added were investigated and it was determined that thyme showed more antioxidant activity than films to which rosemary oil was added. In a study examining the effects of chitosan coatings containing rosemary and thyme oils on the ripening index, water loss, sensory, and microbiological properties of cheeses, it was determined that, according to sensory evaluation results, the best application in terms of taste and aroma was in double-coated cheeses containing chitosan-thyme oil (Embuena et al., 2016). Jouki et al., (2014) prepared edible films from quince seed mucilage by adding thyme essential oil at different concentrations (0%, 1%, 1.5%, 2% v/v). Antibacterial activity, physical and mechanical barrier properties and antioxidant properties of the prepared films were evaluated. While researchers detected an increase in both antioxidant activity values and phenol content due to increasing concentrations of thyme oil, they reported that films containing 1% thyme oil showed effective inhibitory properties against all test microorganisms.

Naga Mallika et al., (2020), nanoemulsions prepared from ginger and cardamom essential oils were added in 10, 20 and 50 μl amounts to the film formulation solution prepared by adding sodium alginate (2%) and glycerol (4%). The addition of ginger oil and cardamom essential oil to the films significantly increased antioxidant activity in relation to rising concentrations compared to control films. Raybaudi-Massilia et al., (2008) inoculated melon slices with Salmonella enteritidis (108 cfu/ml) and then coated the natural antimicrobial substances, cinnamon, palmorasa and lemon verbena (*Lippia citriodora* L.) essential oils and malic acid by combining them with an alginate-based edible film. Then, they examined its effects on shelf life during storage. At the end of the research, they observed significant decreases in the population of *S. enteritidis* inoculated into melon samples to which edible film was applied. Benitez et al., (2013) coated kiwis with aloe vera-based edible film and found that textural properties were better preserved compared to the control sample, and respiratory rate and microbial load decreased. In a study where a thymol-containing soy protein-based coating was applied to strawberries, it was observed that compared to the control samples, coated samples exhibited a prolonged inhibition of total colony, mold, and yeast development. Additionally, the content of ascorbic acid and chroma value were found to be preserved for an extended period. (Amal et al., 2010).

3. CONCLUSION

The use of medicinal and aromatic plants in edible films and coatings has yielded successful results by offering various advantages. By incorporating these plants into the compositions of edible films and coatings, they contribute to both the health and flavor enhancement of food products. Particularly, the antioxidant and antimicrobial properties of medicinal plants carry the potential to extend the shelf life of foods and reduce the risk of microbial contamination. Additionally, the extracts and volatile oils from aromatic plants have the capacity to impart natural aroma and taste to foods through edible films and coatings. This represents a significant advantage in providing consumers with more appealing and healthier products. Furthermore, the use of medicinal and aromatic plants can enhance the environmental sustainability of edible films, replacing traditional packaging materials. In conclusion, the utilization of medicinal and aromatic plants in edible films and coatings presents a successful approach from both functional and environmental perspectives.

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