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Conventional Medicinal Plants as Natural Food Preservative for Food Preservation in Food Industry

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Abstract

The application of naturally derived anti microbial compounds obtained from plants, animals and microorganisms to save meals spoilage microorganisms, proliferation and formation of food borne bacteria in food and fresh produce is referred to as a natural meal preservation process. Many researchers are becomingly increasingly interested in the use of these natural antibacterial agents as a safe replacement for chemical and physical meal preservatives, which have various side effects and pose health risks to customers. Plant-derived antimicrobial compounds are thought to be an eco - friendly approach food preservatives. Antimicrobial agents like bacteria, enzymes or protein secretions and plant bioactive compounds have also been used to preserve food in various ways. Anti bacterial and anti parasitic properties have been discovered in herbs and spices. Vital oils have been used by local population for centuries for preservation food. They are fragrant oily substance acquired from parts of a plant like flowers, seeds, wood. Health beneficial compounds may be used alone or with new strategies to help substitute conventional methods and reduce the stiffness associated with chemical and physical nutritional additives. The effect of production process intrinsic product parameters, and external space specifications on the design of effective food preservation systems are also discussed. As a result, the primary goal of this review paper is to address the industrial use of conventional medicinal herbs as organic meal preservatives in order to extend the shelf life of the food.

Natural antimicrobial compounds are increasingly used in food and biomedical applications, thanks to current technological developments that place a premium on natural products. Since the most prevalent type of bio-preservatives is the direct application of natural compounds obtained from food, despite various attempts to find alternate solutions to avoid undesirable inactivation. To meet consumer demand for nutritional and sensory aspects of foods, a range of non-traditional preservation techniques have been created. In order to kill vegetative microorganisms, foods are usually thermally treated by exposing them to

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temperatures ranging between 60 to 100°C for a few seconds to a minute. However, this energy can cause unfavourable reactions, such as organoleptic and nutritional impact, which can have a negative impact on consumers' health[8].

As a result, there has been a steady increase in the quest for alternative and successful food preservation compounds that can partially or fully substitute chemical antimicrobial additives. This led to the introduction of the principle of bio-preservation, which seeks to reduce the use of chemical preservatives in order to prolong the shelf life of foods. Bio-preservatives are a diverse group of natural products derived from plants, animals, and microbes that can be used to prolong the shelf life of foods. The use of bio-preservatives reduces or avoids the survival of pathogens while also improving overall food quality. Many natural biological substances have antimicrobial properties, acting as antioxidants, deconstructing into cellular membranes, and disturbing the biosynthetic pathways of microbes[13,55].

Since many food items are perishable and quickly spoil, they must be secured from spoilage during harvest, preparation, storage, and delivery in order to preserve the required shelf life. Food safety and quality are particularly challenged by minimally processed foods, quickly prepared and ready-to-eat fresh items, globalisation of food trade, and delivery from centralised manufacturing. Bacteria and fungi can contaminate food products, causing them to lose their taste, odour, colour, sensory, and textural properties. In packaged foods, a number of intrinsic factors, such as pH and oxygen availability, as well as extrinsic factors associated with storage conditions, such as temperature, time, and relative humidity, influence the growth and survival of common spoilage and pathogenic microorganisms.[44,58,61]. As these authors (Davidson and Taylor[19] and Farkas[26]) noted, many chemical preservation strategies have been used in the food industry to prevent the growth of spoilage and pathogenic microorganisms in foods, as well as alternative methods such as a blend of biological and chemical additives. Foods treated with natural additives are becoming extremely healthy as a result of increased consumer awareness and concern about synthetic artificial chemicals. It is possible to incorporate antimicrobials into product formulations, coat them on the surface of foods, or incorporate them into packaging materials to stop the development of undesirable microorganisms in the food sector, but their mechanisms of action are also different[6,34].

Essential oils derived from plants, enzymes obtained from animals, bacteriocins extracted from bacteria, organic acids, and naturally produced polymers (chitosan) have all been used in the food industry. Plant essential oils, which are Generally Recognized as Safe (GRAS) are gaining a lot of attention in the food industry because of their ability as decontaminating agents. The active ingredients are typically found in essential oil fragments, and it is well known that most of these have antibacterial effects against food-borne pathogens and microbes[30,31]. The existence of hydrophilic functional groups, such as hydroxyl groups of phenolic components and/or lipophilicity of certain essential oil components, contributes to the antibacterial activities of plant essential oils[23,47,48,62].

Essential oils, which are secondary metabolites formed by plants, have the potential to inhibit the growth of a broad range of food contamination and food-borne microorganisms such as bacteria, yeasts, and moulds. They are made up of aromatic and volatile compounds that play a key role in plant protection and have antimicrobial properties, according to chemistry[38]. Flowers, roots, seeds and the whole plant can all be used to extract these compounds[33,59]. Essential oils are being used for decades in the fragrance and cosmetic industries, as well as in the food industry as flavouring agents and preservatives, in addition to their medicinal applications. Several researchers attempted to use essential oils as a possible bio-preservative to prolong the shelf life of dairy products and increase their microbiological consistency[2,4,24,25,37]. This study concentrates on the use of natural products derived from plants to regulate the microbial and physicochemical life span of major food groups, such as meat, fish, dairy products, minimally processed fruits and vegetables, and cereal-based foods, as well as their industrial use as microbial food preservatives.

Application of plant antimicrobials in shelf-life extension of food :

Antimicrobials obtained from plants are phytochemicals that are essential for the plant's proper functioning. These antimicrobial agents assist the pants in their protection against plant pathogens and other pests. It also promotes soil fertility by controlling growth, pollination, and implantation[17]. Phenolic compounds, terpenoids and oils, alkaloids, lectins, and polypeptides are all forms of phytochemicals found in plants. When applied to food, they contribute to the sensory attributes and have antibacterial and antifungal properties[7], which are useful in increasing the shelf life of food. The antioxidant as well as other biological properties of phenolic compounds have been related to health benefits when polyphenol-rich foods are eaten[46]. In a nutshell, antimicrobials are chemical compounds or compounds that, when introduced into a food matrix, can inhibit bacterial activity or cause microbial death. Traditional pathogens and novel antimicrobials known as "naturals" are two types of antimicrobials. Natural antimicrobials are extracted from plant, fruit, herb/spices, or bacterial raw materials. Plant extracts, for example, may include antioxidants, shelf-life enhancement (natural antimicrobials), and innovative new flavours, among other benefits.

Vegetables :

To preserve food and extend its shelf life, various preservative technologies were employed. The various methods of applying active substances to fresh produce are dipping, impregnation, coating, and spraying, but perhaps the most recent findings on the application of active ingredients to prepared fruit and vegetables cope with coating systems. Traditional antimicrobials in food preservatives are proposed as a good alternative in reports by Raybaudi-Massilia *et al.*[56] To reduce the effect of these compounds on sensory attributes, most of the time its implementation necessitates integrating the use of antimicrobials and food preservation methodologies[56]. Essential oils and its active compounds have been shown in various studies to regulate or prevent the production of pathogens in both fresh produce and fruit juices. Raybaudi-Massilia *et al.*,[56] used this concept to integrate active compounds from spices and herbs into an alginate-based edible film that they introduced to fresh-cut apples and proved to be extremely successful in reducing populations of immunised *E. coli* O157:H7 during storage period.

Raybaudi-Massilia *et al.*,[56] used malic acid in conjunction with different stabilising compounds for fresh-cut apples. The cumulative effect of chemical or edible covering, regulated atmosphere (CA), and fresh-cut banana condition was examined by Bico *et al*.[9]. Raybaudi-Massilia *et al*.,[56] examined the cumulative influence of malic acid, cinnamon, palmarosa, and lemongrass oils (0.3 and 0.7 percent) and their major active substances on the bacterial and physicochemical shelf-life of fresh-cut melon. The active ingredients were mixed into an edible coating made of alginate. Before spreading the coating, the melon pieces were immunised with a *S. enteritidis* (108 CFU/ml) culture. Essential oils or related active compounds added to the edible coating increased the microbiological life span by more than 21 days. Citral (25–125 ppm) and citron essential oil(300,600, 900 ppm) all extended microbial life span. One of the main drawbacks when introducing biologically active coatings containing essential oils on fruits and vegetables is their effect on the sensory attributes of the coated products, owing to the large amount of volatile compounds that mask the natural flavour of the fruits and vegetables. One solution to the issue described above could be the use of a blend of multiple food preservation systems, which would offer the advantages of both while also cutting the level of antimicrobial needed. As a consequence, the use of moderate thermal treatmentand/or the preservation of foodstuffs in cold, refrigerated conditions may be necessary. This method allows for the production of a nutritious and microbiologically safe food without sacrificing sensory quality.

Dairy products :

New milk products are ready-to-eat products that are prone to microorganism contamination. Others are spoilage microorganisms that create an unpleasant external appearance and reduce the market value of cheese, whereas others are pathogens that threaten product protection. Some studies have recently documented the effectiveness of natural products when applied directly to milk[14] or cheese by applying, immersing, or dusting the items, either alone or in conjunction with other preservation methods. Antimicrobials can also be applied to packaging products that come into contact with cheese, or they can be integrated into plastics used for packaging. We'll talk about some research that was done on the use of plant extracts to protect dairy products in this subtopic. According to Abdalla *et al*.[1], a mango seed kernel concentrate may reduce total microbial counts, inhibit coliform development, exert extraordinary antimicrobial activity against an Escherichia coli strain, and increase the shelf life of pasteurised cow milk. High wateractivity has a positive effect on antimicrobial substance application in milk since it speeds up the transfer and transmission of antimicrobial compounds to the intended microorganisms[14]. Saturejacilicica essential oil is a natural antioxidant and fragrance agent that could be used in butter.[53] Cinnamon, cardamom, and clove oils also inhibit the growth of yoghurt functional ingredients more than mint oil; however, mint oil was proven to be effective against *Salmonella enteritidis* in low-fat yoghurt and cucumber salads in another study.[13] Again, propolis extracts showed antibacterial and antifungal activity towards pathogenic microorganisms, particularly at low concentrations, to protect starter culture varieties in fermented products.

A microbial sachet containing allylisothiocyanate was developed by Pires *et al*.[54]. Its effectiveness was tested in sliced mozzarella cheese stored at 12°C 2°C against yeasts, moulds, *Staphylococcus* sp., and psychrotrophic bacteria. Over the course of 15 days, counts of yeasts and moulds in mozzarella packed with the antimicrobial sachet decreased by 3.6 log cycles. The sachet was also antibacterial against *Staphylococcus* sp., but psychrotrophic bacteria were highly resistant. In a study conducted by Hosny *et al.*,[36] a new milk product called "Karishcum" was developed by adding *Curcuma longa* to classic Karish cheese at a value of 0.3 percent (w/v) (2011). A primary experiment was carried out to determine the appropriate percentage of Curcumin to introduce to cheese milk in order to achieve a good taste and long life cycle. The activity of pathogenic bacteria in the artificially infected item during 14 days of cold storage showed that adding the extract (0.3 percent) reduced bacterial counts by about 1 log of *Salnonella typhimurium*, two log of *P. aeruginosa*, and two log of *E. coli* 0157:H7.

Meat and poultry products :

Plant extracts have been shown to be effective in reducing pathogens present in meat products. In broth culture, a blend of 1% cloves and oregano had an inhibition against *Listeria monocytogenes*, but the same dosage was ineffective in meat slurry.[43] The addition of roselle effectively prevented the survival and development of both prone and antibiotic-resistant *Campylobacter* varieties on agar plates and in infected ground beef.[65,66].

Chitosan (0.5 percent and 1 percent) was tested as an ingredient, either alone or in combination with nitrites (150 ppm) to protect fresh pork sausages from spoilage microorganisms. It was demonstrated that it can be used as an active coating[10]. Chitosan is active against total viable amount, lactic acid bacteria, *Pseudomonas* spp., *Brochothrix thermosphacta,* Enterobacteriaceae, yeasts, and moulds, according to Soultos *et al*.[63]. Krisch *et al*.[40] examined the antimicrobial activity of commercial herbs, spices, and oils (fresh and dried garlic, onion, thyme, marjoram, and oregano) in pork mince in a comparative review. Though fresh spices had little to no impact on viable cells of pork mince, essential oils had some effects. Pork meat marinated in garlic and marjoram oil had the longest shelf life. By dipping fresh chicken breast meat in oregano oil before packaging under MAP, a significant preservation result was achieved for fresh chicken breast meat stored at 4°C. Fratianni *et al*.[27] also suggested using essential oils of thyme and balm to reduce the natural microflora of chicken breast meat. Balm essential oil, in specific, strongly inhibited *Salmonella* sp. growth, while thyme essential oil successfully inhibited *Escherichia coli* growth. Clove oil mixed with lactic acid had synergistic antioxidant and antibacterial benefits, and vitamin C added to the mix preserved the product's colour. Naveena *et al*.,[49] Ntzimani *et al*.[51] found that using EDTA, lysozyme, rosemary, and oregano oil in combination increased the life span of semi-cooked covered chicken fillets preserved under vacuum packaging at 4°C to over 2 weeks.

Fresh fish and fish products :

Because of its biological makeup, fresh fish is a perishable commodity. The activity of spoilage marine microorganisms is the primary cause of degradation, which results in the loss of essential fatty acids, fat-soluble vitamins, and protein functionality, as well as the development of biogenic amines and the formation of off-odors[28]. *Salmonella enteritidis*, *Listeria monocytogenes*, and organic spoilage flora were prevented by using essential oils on the top of whole fish or as a covering for shrimp[13,35]. When compared to a sterile 0.2 percent agar solution as a guide, the life span of carp fillets was increased fourfold by using a combination of carvacrol + thymol with other additions[45]. Antimicrobial properties of Garlic oil had the best antimicrobial activities against isolated bacteria from carp, followed by iso-eugenol, eugenol, garlic oil, and citral for growing the life span of carp fillets, respectively[45]. Essential oils of Aloysiasellowii, on the other hand, were successfully tested in brine shrimp against a number of Gram-positive and -negative microorganisms, as well as two yeasts[60]. Basil, clove, garlic, horseradish, marjoram, oregano, rosemary, and thyme have all been effectively used to apply hurdle technology for preventing *Vibrio parahaemolyticus* infection of seafood[65]. Treatment using anodicelectrolyzed NaCl solution, along with eugenol and linalool, was found to have a synergistic effect in increasing the life span of coated semi-fried tuna[3]. According to Ojagh *et al*.[52], coating trout fillets in chitosan and cinnamon essential oil increased life span (16 days vs. 10 days for the control) and improved texture, odour, and colour. New trout fillets coated in gelatin enriched with cinnamon oil yielded similar results (1 % , 1.5 % , and 2 %). Experiments showed that the active covering can be used to protect fillets and hold them in good condition.to an appropriate standard of quality[5].

Cereal-based products :

Some results have been documented using various natural compounds as part of initiatives to enhance bread quality. Chitosan covering, in particular, was found to improve bread quality by preventing microbial growth and delaying oxidation and staling. When bread was coated in chitosan and stored at room temperature, microbial proliferation was reduced[50]. Citrus peel oils have a variety of uses in bread, according to Rehman *et al*.[57] The oils affected sensory characteristics and slowed microbial development, according to the findings. Spraying peel essential oil had the greatest inhibition activity against bacteria and fungi. For artificially inoculated wheat and rye bread, a mixture of MAP and mustard oil was suggested[64]. The various combinations of the three natural additives extended the life span of the bread. For bread containing lecithin and ascorbic acid, lower cell loads of yeasts and moulds is observed[42]. The life span of gluten-free sliced bread was extended using active packaging containing cinnamon essential oil and MAP. The active packaging outperformed

MAP in terms of increasing lifespan because it prevented microbial growth while preserving the gluten-free bread's sensory attributes[32]. Del Nobile *et al*.,[20] suggested using thymol, lemon extract, chitosan, and grapefruit seed juice at different doses (2000 mg/kg and 4000 mg/kg) to increase the bacterial stability of refrigerated amaranth-based fresh pasta. The results showed that chitosan was by far the most efficient at delaying spoilage among the studied compounds, while lemon extract was the least effective. The antibacterial activities of chitosan in combination with different MAP was evaluated in a subsequent analysis. The blend of 30:70 N_2:CO_2 was found to increase the shelf life over two months among the studied MAP conditions[21]. Costa *et al*.[16] also found that chitosan has antibacterial activities against the key microorganisms found in fresh pasta. The life span of pasta with chitosan packed under MAP circumstances in a low barrier layer made of polypropylene and a multilayer high barrier film made of polyethylene terephthalate, ethylene-vinyl alcohol, and polyethylene was found to vary statistically significantly.

Combined technologies for food preservation:

The goal of food preservation is to be able to produce a healthy food product with a long shelf life that is acceptable to the customer when adhering to the applicable food standard guidelines. This is accomplished by customising processing steps for various items. The aim is to combine a variety of processes, such as mild heat stress and low preservative concentrations, to produce a healthy and high-quality food product. The use of minimal/non-thermal production technology such as High Pressure Processing (HHP) and Pulsed Electric Field (PEF), as well as active and adjusted atmosphere packaging, is gaining popularity[18,22,29].

Challenges of using plant extracts in food systems:

According to the literature, a variety of plant oils are needed to prevent the natural microbiota contained in various types of food. This is in contrast to conventional preservatives, which use the same additives in various food systems, such as meta bisulphites, sodium benzoates, and sorbates. The challenges of using plant antimicrobialsare:

- Few plant extracts have flavours that can be troublesome, so it's essential to fit the food to the flavour of the plant extract or consider the synergies before deciding on the concentration.
- Understanding the antibacterial effect of plant extracts depends on the form of microorganisms present in the foods that cause bacterial growth and disease, since not all microbes have the same antibacterial activity.
- Because of variations in microbial ecology, the inclusion of plant antibiotics in food can promote the growth and infectivity of certain pathogens. The impact of plant extracts on the behaviour of these microbial populations in complex food processes is crucial.
- The rates of antimicrobial compounds in supply plants are influenced by their growing climate. Furthermore, the harvest time, storage, and extraction processes used will affect the levels of active ingredients

responsible for antimicrobial activity, making it difficult to use as a functional ingredient.

Concluding and future perspectives :

Most food products, especially in the food industry, require protection from microbial spoilage while storage, and buyers demand healthy natural products. As a result, food officials and researchers must seek out mild preservation strategies that increase microbial quality and protection while minimising nutritional and organoleptic losses, allowing consumers to be more satisfied. As a result, science and industry are very interested in using natural compounds from conventional medicinal herbs as biological food preservatives, because they have the ability to offer quality and safety benefits while having a low effect on human health. Food technologists are becoming more interested in natural antibiotics as alternatives to physical and chemical-based antibacterial drugs. However, there are a number of drawbacks to using natural antimicrobials in foods, necessitating additional research into their antimicrobial effectiveness, consumer acceptability, and value. Development of resistant bacteria to natural antimicrobials, uniformly mixing of certain antimicrobial compounds in food products, large-scale production of these substances from natural sources without destroying their functional efficacy, and regulatory approval of their use are some of the main research issues which need to be addressed. If the antimicrobials used are not used at their effective doses for target microbial environment, antimicrobial resistance can grow. Resistance adaptation mechanisms may help injured or damaged cells regenerate in the presence of suboptimal antibacterial doses. Consumer acceptance of different natural antimicrobials, like herbs and essential oils, continues to be a key challenge. These antimicrobials may have an adverse effect on the organoleptic properties of the food when used at the concentrations required to achieve the desired degree of antimicrobial potency. Many natural antimicrobials are GRAS for particular food purposes, but they need approvals for use in other industrial applications. Natural antimicrobials have the potential to revolutionise the field of food preservation and protection, but further research is required to fully realise their potential. More research is required into the interactions and various varieties of antimicrobial substances, plant extracts, and other ingredients, with the objective of determining the form of interaction in terms of synergistic, antagonistic, or additive impact. In order to reduce undesirable variations or low effectiveness of these substances in the products, it is also important to improve awareness of the impact of plant, post-harvest, and agro-industrial administration on the structure and final content of chemical compounds. Finally, in order to fully understand the potential impacts on customer acceptance, tactile studies related to the use of individual and integrated antimicrobial compounds and plant products in various types of food industries must be expanded and deepened.

Abbreviations :

HHP High Pressure Processing
PEF Pulsed Electric Field
GRAS Generally recognized as safe

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