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Foods Bio-preservation : A Review

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ABSTRACT

In developed countries, the danger of food-borne illness and product deterioration has been reduced thanks to advances in food processing technology and microbiological food safety standards. However, this risk has not been eradicated entirely. Biopreservation is a method of preserving food that makes advantage of the antibacterial capabilities of naturally occurring organisms and the metabolites produced by them. This method is also known as "living preservation." The efficiency of biological antimicrobial systems such as lactic acid bacteria (LAB) and/or their bacteriocins, in addition to other metabolites, is essential to the biopreservation of a wide variety of foods. This biopreservation technique is also known as cold storage. As a result of the growing desire for natural foods among consumers, it is of the utmost significance to conduct research on and develop natural and efficient food preservation components as a replacement for artificial preservatives. This review was conducted with the intention of shedding light on natural food preservatives such as LAB bacteriocins, organic acids, plant essential oils, salts, and sugars.

Keywords- Foods Bio preservation, LAB bacteriocins, organic acids, plant essential oils, salts, sugars.

I. INTRODUCTION

The presence of several types of microbes is the primary cause of food rotting (bacteria, yeasts and moulds). This issue has a financial impact on producers, distributors, and consumers. Microorganisms are thought to contaminate more than 20% of all food produced on the planet. (1). Food spoiling is the degradation of a food's natural nutritional content, texture, and flavor to the point that it becomes dangerous to people and unfit to eat. In developed countries, the risk of food-borne illness as well as the risk of product deterioration has decreased as a direct result of technological advancements in food processing as well as advancements in microbiological criteria for food safety. However, this risk has not been eradicated entirely. Foodborne disease outbreaks are being caused by an increase in the use of precooked foods, particularly seafood, which is susceptible to temperature abuse, as well as the import of raw seafood from underdeveloped nations. Salmonella, Campylobacter jejuni, Escherichia coli 0157:H7, Listeria monocytogenes, Staphylococcus aureus, and Clostridium botulinum are only few of the bacterial pathogens that have been related to outbreaks. Others include Staphylococcus aureus and Clostridium botulinum (2).

People are now avoiding meals that contain chemical preservatives in favor of items that are widely regarded as safe (GRAS). Biopreservation is extensively employed in food items to meet the rising demand of customers as food and technology develop. Biopreservation is the process of employing microorganisms or products of their metabolism that are pathogenic in order to reduce or eliminate the presence of bacteria that are undesirable in foods in order to increase food safety and shelf life. Beyond the usual methods of curing, chilling, freezing, boiling, heating, sugaring, canning, pickling, fermentation, and others, the food business is looking at new ways to preserve food goods. Natural food preservatives work by reducing the pH of the food, changing the water activity (aW), and adding antioxidants (3) . The practice of using natural preservatives, microbiota that have been subject to regulation, and/or antibacterial compounds that are generated from microbes in order to lengthen the shelf life of food products is referred to as bio-preservation. This process often involves selecting fermentation products as well as beneficial microorganisms. The goals of these two goals are to reduce the risk of spoiling and render infections inactive. The organism of significant interest or major organism utilized for this purpose is lactic acid bacteria (LAB), as well as their metabolites. They can inhibit the growth of bacteria and contribute an interesting flavor and texture to foods, in addition to having antibacterial properties. The production of bacteriocin, organic acids, and hydrogen peroxide are among the most significant and useful compounds that LAB is capable of. Because it has been given the go-ahead by the Food and Drug Administration (FDA), nisin is the LAB bactriocin that is used the most frequently (FDA). Nisin and other bacteriocins are beneficial to a wide variety of foods, including crops, dairy products, and meat. Bacteriocins are proteins or peptides synthesized in ribosomes that have the ability to inhibit pathogen proliferation in goods during storage and distribution. The fundamental information of these natural antimicrobials along the food chain will be summarized in this review.

II. BACTERIOCINS

Bacteriocins are complex proteins or peptides that are biologically active and kill bacteria that are

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related to each other. Bacteriostatic proteins are often called bacteriocins, which is just another name for this type of protein. Even though they are made by bacteria, they are not usually called antibiotics. This is done to make people less confused and worried about therapeutic antibiotics, which can make some people have allergic reactions and other health problems [4]. In contrast to other therapeutic antibiotics, bacteriocins are proteinaceous agents that are rapidly broken down by proteases in the human digestive tract. Since bacteriocins are created by the ribosome, there is a possibility that their characteristics, specifically their intensity and spectrum of activity, can be improved [5,6]. Initially, bacteriocins were mostly defined in terms of colicins, which are relatively big proteins with a molecular weight of up to 80 kDa that were derived predominantly from E. coli. When they bound to the inner membrane or other cytosolic targets, they were able to kill bacteria that were extremely closely related (7)García-Bayona et al., 2017). Bacteriocins, on the other hand, are tiny, heat-stable cationic peptides produced by Gram positive bacteria, notably LAB, and have a broader spectrum of inhibition (8) (Mokoena, 2017). Bacteriocins derived from LAB are frequently utilized in the process of biopreserving food since it is conventionally believed that LAB is safe for use in food. Bacteriocins are thermostable cationic chemicals that are produced by LAB. These molecules have anywhere from 40 to 60 amino acid residues, in addition to hydrophobic areas. When electrostatic interactions with negatively charged phosphate groups on target cell membranes result in binding at the beginning, hole generation, and cell death, autolysin is activated. However, these bacteriocins are rendered ineffective by proteases that are naturally present in the digestive tract. LAB bacteriocins are considered suitable biopreservative agents since they are considered to be non-toxic, non-immunogenic, resistant to high temperatures, and have a broad bactericidal effect. Bacteriocins are mainly effective against Gram-positive bacteria and certain pathogenic Gram-negative bacteria. Bacteriocins are also effective against some Gram-negative bacteria. The mode of action of LAB bacteriocins has been the subject of a significant amount of research, despite the fact that the majority of the pioneering work was done with nisin, the first Gram-positive bacteriocin. Because of their cationic and hydrophobic properties, the vast majority of these peptides are able to function as membrane permeabilizers. The formation of pores leads to the total or partial loss of the proton motive force, which ultimately results in the death of the cell. It seems that a target is what mediates the development of the bacteriocin pore.

Some bacteriocin-producing strains are suitable for use as protective cultures in a wide variety of food products. LAB bacteriocins have a number of desirable features that make them attractive candidates for use as food preservatives. These properties include the following:

Non-toxic to laboratory animals that were tested and typically non-immunogenic due to the protein nature and inactivation by proteolytic enzymes of the gastrointestinal system Eukaryotic cells are not impacted in any way by this substance.

In general, tolerant of high temperatures (can maintain antimicrobial activity after pasteurization and sterilization)

Bactericidal action that affects the majority of Gram+ve bacteria as well as those Gram-ve bacteria that have been injured, including pathogens such as Salmonella, Listeria monocytogenes, and Staphylococcus aureus.

When selecting bacteriocin-producing strains for use in food applications, the following qualities must to be taken into consideration:

It is preferable for the producing strain to have GRAS certification (generally recognized as safe).

The bacteriocin should have a broad spectrum of inhibition, including pathogens, or high specific activity, depending on the application. Additionally, it should have thermostability, improved safety and favorable affects, and there should be no negative impact on the quality or flavour

III. ORGANIC ACIDS

Lactic acid, acetic acid, propionic acids, azelaic acid, hydrocinnamic acid, DL-phenyllactic acid, DLhydroxyphenyllactic acid, p-coumaric acid, polyporic acid, 2-hydroxybenzoic acid, 4-hydroxybenzoic acid, vanillic acid, caffeic acid, succinic acid, The principal fermentation end products of carbohydrate metabolism in LAB are succinic acid, 2-pyrrolidone-5-carboxylic acid, and 2-pyrrolidone-5-carboxylic acid. All three of these acids are considered to be weak organic acids (9) (Leyva Salas et al., 2017Among the organic acids that are produced by LAB, lactic acid and acetic acid are the most potent metabolites and have been the subject of the most research. Both of these organic acids are bioactive in their protonated state when the pH is low (10)(Arena et al., 2016) Organic acids, for instance, are a metabolic byproduct of LAB that have the ability to kill bacteria in addition to providing food with a unique flavor and texture. LAB can be found in almost all types of foods [11]. Fermentation carried out by LAB has a number of benefits over conventional methods for the preservation of food One of these benefits is a greater availability of nutrients, and another is the ease with which one can carry out actions that require very little or no energy at all. Organic acid production is assumed to characterize a LAB strain's mycotoxigenic fungal inhibitory features; the kind of acids generated and the quantity of acids produced might vary from strain to strain [12]. The majority of these acids are produced by LAB as a byproduct of the acidification process rather than as an active synthesis of metabolic compounds geared towards

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the restriction of fungal growth [13] Lactic acid, also known as 2-hydroxypropionic acid, is an organic acid that can be found in nature in both its L and D forms. It is the major acid that is produced by LAB. L-lactic acid has been given the go-ahead by the FDA as a safe preservative [14]. Lactic acid, oleic acid, linoleic acid, palmitic acid, 3-pyrrolidine-carboxylic acid, stearic acid, pyroglutamic acid, and 5-oxo-2-pyrrolidine-carboxylic acid were identified as antifungal chemicals in L. plantarum K35. These chemicals inhibited the development and synthesis of aflatoxin by A. flavus and A. parasiticus [15]. By creating an acidic environment and reducing the pH below the metabolic inhibition and growth range, it is believed that organic acids can impede the development and activity of many types of pathogenic and putrefactive bacteria and fungi [16]. Organic acids alter the permeability and electrical characteristics of the plasma membrane, which ultimately results in the death of the bacterium [17]. In other words, organic acids are able to penetrate the membrane of the fungus and cause cell death, which results in the release of hydrogen ions and a decrease in pH [18].

IV. ESSENTIAL OILS

Synthetic preservatives have been employed in the food business for many years, with antimicrobial preservatives being the most common, but studies now show that chemical additions can cause allergies, intoxications, cancer, and other degenerative disorders (19). Volatile odoriferous oils, often known as aromatic liquids, are derived from a variety of plant materials such as roots, barks, flowers, and fruits [20] The method of steam distillation is widely employed in the commercial manufacturing of essential oils. They are organic molecules with a low molecular weight that have a lot of antimicrobial action. Terpene hydrocarbons and oxygenated compounds containing major active components such as terpenes, terpenoids, and phenylpropenes have been comprehensively categorized. Essential oils (EOs) are volatile compounds that are derived from various parts of medicinal and aromatic plants (flowers, buds, seeds, leaves, twigs, bark, herbs, wood, fruits, and roots), and they are provided as a natural liquid. Essential oils can be used for a variety of purposes, including aromatherapy, medicinal applications, and culinary uses. In addition to their usage in aromatherapy and cosmetics, essential oils also have a place in the culinary and culinary preparation industries (21). Essential oils provide important protective properties for plants, including antimicrobial activity, antiparasitic activity, insecticidal activity, antiviral activity, antifungal activity, and antioxidant activity (22). The use of essential oils as natural bio preservatives was developed with the goal of reducing fat rancidity and maybe preventing chronic degenerative illness. They are commonly and effectively employed in food items because to their antibacterial and antioxidant properties. Carvacrol, eugenol, and thymol are among the phenolic chemicals found in the EOs that have the greatest antibacterial effects against foodborne pathogens. The hydroxyl (-OH) groups of phenolic compounds are hypothesized to have an inhibitory effect because they can interact with bacteria's cell membrane, disrupting membrane structures and causing cellular component leakage (23).

V. MECHANISM OF ANTIMICROBIAL ACTION OF EOS

By disrupting the cellular structure, causing damage to the integrity of the membrane, increasing the permeability of the membrane, and suppressing cellular activities, EOs are able to impede bacterial activity such as the creation of energy and the transit of membranes. (24). The disruption of the cell membrane has an effect on a wide range of critically important processes, including as the digestion of nutrients, the creation of structural macromolecules, and the regulation of growth (24). Through a process known as permeabilization, EOs are able to penetrate fungal cells, where they alter both the cell wall and the cytoplasmic membranes. This, in turn, leads the mitochondrial membranes to disintigrate (24). It's possible that nutrient-dense matrices, like meat and meat products, can improve bacterial repair and turnover of cellular components, which in turn can improve bacterial populations' tolerance to a range of stresses (25). On the other hand, there is a wide variety of other stuff that might influence the antibacterial action of EOs in meals (26). Traditional meat products have a high fat content, and EOs are lipid-soluble; this, combined with the typical low pH, which increases EO solubility, and the typical low aW, which reduces the aqueous phase of food products, increasing contact between EOs and spoilage or foodborne microbiota, enhances the antimicrobial effect of EOs. Traditional meat products have a low aW, which reduces the aqueous phase of food products. EOs have the ability to extend the shelf life of dairy products not only by preventing the growth of unwanted bacteria but also by lowering the rate at which chemicals degrade during storage and distribution.

The amount of mesophilic bacteria in cream cheese has been influenced by the addition of oregano and rosemary essential oils. As a result of this happening, the pH dropped less and the acidity was reduced less. Furthermore, because the oxidative and fermentative processes were suppressed, the rancid and fermented flavors that indicated a lower shelf-life of the product were less evident in goods with additional oregano and rosemary EOs (27, 28). Fruits and vegetables are perishable items with a short shelf life caused by weight loss and degradation, the latter of which is mostly caused by fungal activity. For producers, stakeholders, and consumers, this is a major issue. Because of their antibacterial capabilities, EOs from diverse plant species have been researched for their effectiveness in controlling fungus in vitro and later in vivo in vegetables and fruits.

VI. SALTS AND SUGARS

Sodium chloride (salt or table salt) has played a significant part in human communities throughout history. Salt was utilized as a form of payment and to preserve commodities like meat and fish in ancient times. Salt has also taken on a significant role as a flavor enhancer in cuisine. In both commercial and domestic cookery, salt is well-known for its use as a flavoring ingredient and a food preservative. Salt works as a preservative by limiting the amount of water accessible in foods, preventing germs from utilising it as a nutrition [29, 30] and reducing enzymatic activity [30]. Pathogens and bacteria that cause spoiling are prevented from developing or growing more slowly when salt is present [30]. Salt exerts a significant inhibitory effect on the growth of Clostridium perfringens and Clostridium botulinum, although Staphylococcus aureus and Listeria monocytogenes are moderately halotolerant [31].

The main mechanisms by which salt inhibits microorganisms are cellular plasmolysis, impeded respiration, o-nitrophenyl—galactoside hydrolysis, glucose utilization, suppression of substrate transfer across cell membranes, restriction of oxygen solubility, and interference with enzymes [31]. The addition of salt can help improve the shelf life of cured beef products and canned fish, such as sardines, tuna, mackerel, or anchovies, This can be beneficial for items like anchovies, tuna, mackerel, and sardines [32].

Curing foods using preservation chemicals such as sugar has two primary objectives: first, to stop perishable commodities from going bad, and second, to stop the growth of dangerous food-borne pathogens such as Salmonella and Clostridium botulinum. When added to fresh foods like fruits and vegetables, sugar causes an osmotic reaction that draws water into the food. Consuming sugar causes a decrease in water activity because it draws water from the body's system (aW). Because bacteria can only survive and reproduce in the presence of water, decreasing the water activity in a food product means that the bacteria there are exposed to fewer free water molecules It produces an environment in which microbial survival and development are restricted (33) (Goldfein and Salvin,2015). In certain foods, sugar plays an important role in the production of natural preservatives such alcohol and acids. Fermentative yeasts in wine, beer, and other fermented beverages convert sugar to ethanol. Fermentative yeasts in fermented foods convert sugar to organic acids like lactic acid. Fermented foods include sauerkraut, kimchi, pickles, sourdough bread, yogurts, miso, and tempeh. In these conditions, the alcohol or acid that is produced acts as a preservative all on its own. When present in sufficient amounts, sugar's osmotic effect makes it an effective preservative. Sugar has the ability to absorb all of the water in its surrounding environment, which is subsequently passed from the bacteria to the concentrated sugar syrup. The microflora has lost their ability to proliferate as a result of their dehydration.

Sugar preserved items must have a sugar content of at least 68 percent, which prevents bacteria from growing. Unless the items include acid or are refrigerated, lower amounts may be effective for a short time. The crucial sugar concentration necessary to suppress microbial development varies depending on the kind of bacteria and other dietary ingredients present. Jelly, jam, and marmalade are some of the most popular sugar preserves. These are the gels that are stable. Pectin is a naturally occurring component of fruits, and the formation of a gel is dependent on both the presence of sugar and acid. Even after the jars have been opened, jams, jellies, and preserves that contain sugar will not go bad. Sugar can't bring the water activity down lower than 0.845% no matter how much is added to the solution. Although this level of water activity is sufficient to prevent the growth of mesophilic bacteria and yeast, it does not prevent the growth of mold. As a consequence of this, several processes, such as pasteurization of the finished product (jams, jellies, and the like), as well as the employment of chemical preservatives to accomplish antiseptization of the product surface, are utilized in order to prevent the growth of mold in sugar-preserved goods. The vast majority of these products originate from fruits that are high in acidity. When low-acid foods are consumed, it is common practice to follow up with an acidic fruit after the meal. The acid not only lends the product a flavor, but it also contributes to the product's ability to be preserved. There is a large degree of variation in the quantity of sugar that is used in the manufacture of these things. After being opened, sugar prevents jams, jellies, and preserves from going bad and turning rancid. Because of its ability to suck water, microorganisms, such as yeast and bacteria, get dehydrated, which stops them from growing and causing the food to become spoiled (34)Varzakas and others 2012. In baked goods, sugar also performs the function of a humectantin, preventing the food from drying out and going stale, which results in an increase in the shelf life of the product (35). (Spillane 2006).

VII. CONCLUSION

There is a possibility that bacteriocins, LAB organic acids, plant essential oils, salts, and sugars all play a part in the processing, preservation, and safety of food. Utilizing natural microflora and/or their antimicrobial chemicals, bio-preservation has the potential to lengthen the amount of time that food can be stored while also improving food safety. It is possible to successfully inhibit the development of microbiological growth and guarantee the safety of food by combining

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bio-preservation with other types of preserving materials, also known as Hurdles.

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