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Research

A Review of Natural Protective Agents

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Abstract

Natural protective agents sourced from diverse biological origins offer promising solutions for protection against environmental toxins. This review explores various natural protective agents such as antimicrobial agents, hepatoprotective agents and antioxidants. Plants, animals and microbial antimicrobial agents such as essential oils, lysozyme, glucose oxidase and bacteriocins; antioxidants like herb extracts and dairy products and hepatoprotective agents like *Foeniculum vulgare, Solanum nigrum* and *Azadirachta indica* are also discussed.

Keywords: Natural protective agents, bacteriocins, natural antioxidants, Hepato protective agents.

1. INTRODUCTION

The human skin has a major impact on the body's defense system, thermoregulation, sensation, protection and metabolic processes that support homeostasis. The main environmental factors it is exposed to are diseases, hazardous chemicals and radiation. Many types of skin problems are caused by the ultraviolet (UV) component of sunlight. Long-term exposure to UVB causes a number of negative skin consequences. The demand for herbal skincare products skyrocketed as people became more aware of the photo aging and cancer-causing effects of UV radiation (UVR) [1]. Natural substances are mainly utilized to absorb UV radiation and are frequently used to reduce the need for chemical filters found in skin care cosmetics. Antioxidant, anti-inflammatory, immunostimulating and protective are just a few of the many uses for natural substances.

However, compared to other filters, such as chemical ones, natural compounds and plant extracts have a low sun protection factor (SPF), allowing them to be utilized alone in tanning cosmetics. Nonetheless, because of their many advantageous qualities, they can provide useful ingredients for the creation of low-SPF creams that are suitable for everyday skin care [2]. Industrial processes ultimately aim to build a more sustainable society where the goods we consume on a daily basis are safe for both the environment and humans. By substituting natural substances for harmful ones, we may lower the risk of illness considerably, protect biodiversity and guarantee everyone's health in the future [3]

2. ANTIMICROBIAL AGENTS:

2.1 Plant based on antimicrobial agents

2.1.1 Essential oil

Essential oils (EOs) are volatile, natural substances that are identified by their taste and odor. Alcohols, acids, esters, epoxides, aldehydes, ketones, amines, sulfides, terpenes and alcohols are examples of essential oils. They are produced in plant cells' cytoplasm and plastids via the methyl-D-erythritol4-phosphate pathway, malonic acid and mevalonic acid. Essential oils of clove, garlic, coriander, parsley, lemongrass, rosemary, sage, oregano and cinnamon all work well. EOs with high concentrations of citral (litsea cubeb a, lemon myrtle and lime), trans-cinnamaldehyde (cinnamon) and eugenol (allspice, clove and cinnamon) have potent effect [4].

Table 1: Classification of Essential Oil Activities

S.no.	Essential Oil	Activites	Mechanism Of Action	Uses
1	Cinamon	Exhibits antibacterial against foodborne pathogens, disrupts cell membrane integrity.	Interferes with cellular process, causing leakage of cellular contents.	Useful in food preservation, antimicrobial therapy and anti-oxidant activity, aromatherapy, Topical application.[5]
2.	Clove	Shows strong antimicrobial activity against bacteria , fungi and virus	Disrupts cell membrane , intering with cellular processes	Effective in treating toothaches[8],promating oral health[9]
3.	Lemon grass oil	Exhibits antimicrobial, anti inflammatory	Disrupts cell membrane interfering with cellular processes	May help with skin issues , pain relief and stress reduction, Pain relief [6]
4.	Garlic	Exhibits antimicrobial, antioxidant activity.	Disrupts cell membrane ,interfering with cellular processes	May help with cardiovascular health, immune system support.[7]
5.	Sage	Exhibits antimicrobial activity	Disrupts cell membrane ,interfering with cellular processes	May help with cognitive function, digestive issues.[5]

2.1.2. Enzyme (lysozyme)

It is a natural antibacterial agent and enzyme that hydrolyzes the beta 1, 4 glyosidic linkages that are present in peptidoglycan between N-acetyl glucosamine and N-acetylmuramic acid. Since peptidoglycans make about 90% of the cell wall of G+ bacteria, these bacteria are susceptible to lysozyme. It is a natural antibacterial agent as a result. However, in the presence of membrane-destabilizing substances like detergents and chelating agents, this enzyme can also impact G-bacteria. Because of its great tolerance to a broad range of pH and temperature, lysozyme can be used in edible active films. Along with other antimicrobial substances, lysozyme has also been tested in eggs, milk, beef and a component of edible films and coating[4].

2.3. Microbial agent

2.3.1. Glucose oxidase

The bacteria A. Niger and Penicillium species produce glucose oxidase. An oxidoreductase called glucose oxidase catalyzes the conversion of D-glucose to H_2O_2 and D-glucono-δ-lactone. When D-glucono-δ-lactone and water combine, D-gluconic acid is produced. Due to the cytotoxicity of H_2O_2 and the production of D-gluconic acid, which lowers pH, glucose oxidase has an antibacterial function. Hydrogen peroxide concentrations can potentially be higher than what the FDA considers safe and lead to harmful issues. Laxity and increased lipid oxidation can result from storing food in H_2O_2 for an extended period of time. By converting H_2O_2 to oxygen and water, catalase can be used to eliminate it from meals. Baking items, flour, yolks and white eggs all contain microbial glucose oxidase, which is used to extract oxygen and maintain flavor and aroma in bottled beverages. Since D-gluconic acid is a safe by product of glucose oxidase, it is not regulated by the WHO [4] .

2.3.2. Bacteriocins

Antimicrobial action against similar genetic strains is typically exhibited by ribosomal antimicrobial proteins, or BACs. Stability at high temperatures, low pH and sensitivity to proteolytic enzymes are among BACs' advantageous characteristics. [4]

Table 2: Classification of Bacteriocines[10]

Class 1	**type A type B**	**L antibiotics**
Class 2	type A type B type C	Peptides without modified amino acids
Class 3		Batteriolysins
Class 4		Glycoproteins and Lipoprotein
Class 5		Cyclic bacteriocins

2.3.3 Mechanism of action (Bacteriocins)

Although BACs have an impact on transcription, translation, replication and cell wall biosynthesis, they typically destroy the potential energy of sensitive cells by causing membrane channels or pores. BACs work against bacteria (both kinds) by interfering with cell division and blocking the synthesis of proteins or nucleic acids through a variety of methods. BACs can bind to components of cell walls through specific or nonspecific receptors, such as the molecular surface or the lipid-binding site. This can result in the creation of pores or direct cell lysis, which eventually kills the bacteria by destroying its proton motor system. Because EDTA chelates cell wall components, nisin is a more effective combination with EDTA at targeting the cytoplasmic membrane of G-bacteria. Through cell wall inhibition, mercasidine kills G+ bacteria. G-bacteria's membrane pore-forming mechanism is eliminated by colicin .[4]

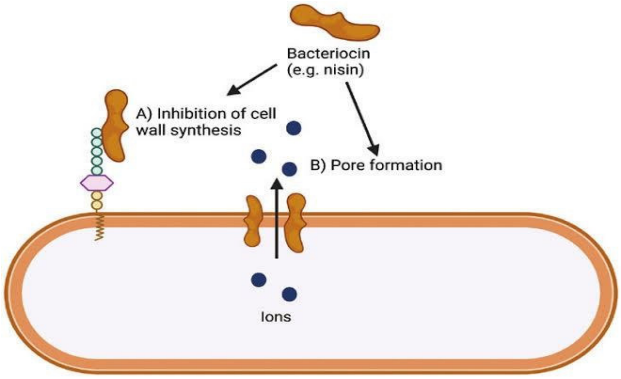


Fig 1: Mechanism of Bacteriocins[11]

Table 3: Classification of Antimicrobial agents[12]

Class	Composition	Targeted micro organisms
Bacteriocins (especially Nisin)	Peptidic antimicrobial compounds synthesized by different bacteria	Listeria innocua Listeria monocytogenes
Enzymes (Lysozyme)	Naturally occurring enzyme produced by humans and many animals.	Alicyclobacillus Acidoterrestris
Phytochemicals (essential oil and plant extract)	Basil essential oil Grape fruit seed extract	E.coli, Salmonella enteric and monocytogenes E.coli

3. NATURAL ANTIOXIDANTS

The most crucial chemicals for halting the oxidation process are antioxidants. Partially described as a chemical reaction that can generate free radicals, oxidation can lead to chain reactions that can seriously harm an organism's cells. Compounds called antioxidants scavenge free radicals in the human body. Free radicals are restrained by the body's built-in antioxidant defense mechanism. In instance, fruits, vegetables and other plant-based diets include natural antioxidants that are beneficial for preventing disease [13].

3.1 Herb extracts

3.1.1Tea and fruit extracts

With 94% flavonoid content, green tea extract has the highest overall phenolic content. Oolong tea contains 4.4% flavonoids and around 18% total phenols. The main components of black tea are thearubigins and teaflavins. Tea's flavonoids, tannins, and vitamins contribute to its high antioxidant content. Grape seed extract contains catechin and epicatechin. The total phenolic amounts depend on the grape varieties, climatic conditions, degree of maturity, extraction and solvents.[14].

3.1.2 Rosemary

Source: Rosemary
Scientific Name: *rosmarinus officinalis*
parts used : Leaf and secondary branches of leaf
Extraction solvent: Dimethyl sulfoxide, deionized water[15].

Applications of natural antioxidants include the use of rosemary extracts for food preservation either by themselves or in combination with additional antioxidants including nisin, polyphenols, BHA and BHT.[4]

Fig 2: Rosemary [16]

3.2. Vegetable and fruits

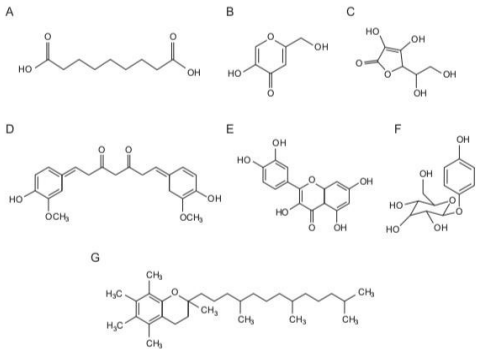
Spraying, coating, and immersion are a few techniques used to preserve the freshness of fruits and vegetables. Fuji apple slices with an alginate coating containing EOs (lemongrass, cinnamon EOs, citral and cinnamon aldehyde) had lower E. coli O_{157}:H_7 levels and longer shelf lives. Propionic, maleic, acetic, lactic and citric acids were also shown to have antimicrobial activity against S. typhimurium, L. monocytogenes.[4] .

3.3. Dairy products

Dairy products are contaminated by microorganisms, particularly fungus. Natural substances have been shown to have an impact on milk or cheese directly or in packaging materials, either by themselves or in combination with other techniques like spraying, immersing, or dusting. Mango seed extract has been shown to have a strong antibacterial impact on E. coli, lower the number of bacteria and stop the growth of coliforms, and prolong the shelf life of pasteurized milk[4]

3.4. Meal products

Meat products' antioxidants are one type of addition that could be swapped out for natural extracts. Because these substances prevent lipids, proteins and pigments from oxidizing, they extend the shelf life of foods to which they are added while maintaining the product's color, texture, flavor, aroma and general quality.[4] The meat industry has been changing globally due to a variety of causes, including financial, economic, political, cultural and religious ones, as well as customer tastes, concerns, and lifestyles. Since extended meat preservation has historically been the cornerstone of the global meat trade and is closely related to meat safety and quality assurance, its evolution [17] .



(A)Azalaic acid, (B)Kojic acid, (C)ascorbic acid, (D) Curcumin,(E) Quercetin
(F) Arbutin, (G) alpha- tocopherol.

Fig 3: Chemical structure of pure natural antioxidants [18].

4.HEPATOPROTECTIVE AGENTS

One of the most important organs, the liver serves as a hub for the metabolism of nutrients like proteins, lipids and carbohydrates as well as the excretion of waste metabolites. It also manages the body's metabolism and excretion and getting rid of them to protect the body from foreign chemicals. Among other things, the bile that the liver secretes is crucial for digestion[19]. The liver is an essential organ that is involved in the body's metabolism and removal of xenobiotics. Damage to the liver caused by a variety of harmful substances (certain antibiotics, chemotherapeutic drugs, carbon tetrachloride (CCl_4), thioacetamide (TAA), and microorganisms has been thoroughly researched. Keeping the liver healthy is crucial for a person's general health since herbal remedies have long been utilized to treat liver problems. Toxic liver damage is more prevalent these days. In the pharmaceutical business, herbal treatments are being used to provide a safe treatment for liver problems.[19]

Table 3: A brief description of Hepatoprotective agents

S.No	Botanical Name	Comman English Name	Parts used	Chemical consistutients	Uses
1.	*Foeniculum vulgarae* (Apiceae)[20]	Saunf oil	Fruit	Volatile oil, Fenchone, an ethole Limonene, anisa lydeEstragole	Antioxidant, chemo preventive, hepato Protective and hypoglycemic activities[24].
2.	*Curcuma longa* (Zingiberaceae) [21]	Turmeric	Leaf	Curcumin,beta sitosterol, eugen ol	Anti inflammatory, anti cancer, antidiabetic, antiviral.anti microbial and carminative effects[25].
3.	*Phyllanthus emblica* (Phyllanthaceae) [22]	Amla/ emblica	Fruit	Vitamin c (ascorpic acid)	Treatment of jaundice, diabeties, inflammation and ulcer[26].
4.	*Azadirachta indica* (meliaceae)[23]	Neem	Leaf	Nimbin, nimbolinin Nimbidin, nimbidol	Used in treatment of cancer, hypertension, heart diseases & diabetes[27].

4.1. *Foeniculum vulgarae*

Depending on the variety, fennel (*Foeniculum vulgare Mill.*, family Umbelliferae) can be an aromatic herb that grows annually, biennially, or perennially. The plant's leaves, stalks and seeds (fruits) can all be eaten. The fragrant herb *Foeniculum vulgare* produces oblong, ellipsoid, or cylindrical fruits that are either straight or slightly curved and have a greenish or yellowish brown [19] .

Fig 4: *Foeniculum vulgarae*[28]

4.2 *Solanum nigrum*

The impact of *Solanum nigrum* extract (SNE) on mice's liver fibrosis caused by thioacetamide (TAA) was assessed. During the course of the trial, mice in the three TAA groups received daily gastro gavage treatments of distilled water and SNE (0.2 or 1.0 g/kg). In mice treated with TAA, SNE decreased the levels of α smooth muscle acting protein and ic hydroxy proline. SNE suppressed transforming growth factor-β1 (TGF-β1), mRNA levels and TAAinduced (α1)[19]

Fig 5: *Solanum nigrum*[29]]

4.3. ***Phyllanthus emblica***

Phyllanthus amarus ethanolic extract (Euphorbiaceous), the amount of thiobarbituric acid reactive substances (TBARS), increased the reduced glutathione level and improved the activity of antioxidant enzymes such as glutathione peroxidase (GPx), glutathione-S transferase (GST), superoxide dismutase (SOD) and catalase (CAT). These findings demonstrated a hepatoprotective effect.[19]

Fig 6: *Phyllanthus emblica*[30]

4.4 *Azarectica Indica* (NEEM)

In order to determine whether Azadirachta indica (neem) has any potential hepatoprotective effects, the effect of A. indica leaf (Meliaceae) extract on serum enzyme levels (glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, acid phosphatase and alkaline phosphatase) raised by paracetamol in rats was investigated. It is stated that the group treated with the extract was shielded from the harm that paracetamol induction produced to the liver cells. The results were further supported by a liver histological analysis. Picroliv's antihepatotoxic effect appears to be caused by a change in the toxic chemicals' biotransformation, which reduces

the production of reactive metabolites. The hepatoprotective effects of Azadirachta indica may be attributed to its anti-inflammatory qualities. Research has shown that mice given extracts from had improved liver histology and notable decreases in liver biomarker enzymes (AST, ALT, ALP,and GGT).[19]

Fig 7: *Azarectica indica*[31]

4.5. *Curcuma longa* (TURMERIC)

Turmeric, or *Curcuma longa*, is a perennial herb with short, thick rhizomes that belongs to the Zingiberaceae family. Both the Ayurvedic and traditional Chinese medicinal systems make substantial use of turmeric. About 2% of Curcuma longa's volatile oil is made up of monoterpenes, primarily, a and b turmerone,5% curcuminoids, primarily curcumin, minerals, carotene and vitamin C_{11} Curcumin, the yellow pigment found in turmeric, is the active ingredient in *Curcuma longa*.[19]

Fig 8: *Curcuma longa*[32]

CONCLUSION

Natural protective agents play a crucial role in safeguarding health and enhancing well-being, highlighting the importance of integrating these substances into our daily lives for optimal protection against various threats. Emphasizing their benefits can lead to more informed choices and a healthier lifestyle and sustainable future.

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