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Article Review

Antimicrobial compounds and antioxidants as preservatives to enhance food safety and quality

Mohamed H. Gaffer [*], Rania I. Ismail [**] and Shaimaa M. Nada[*]

[*] Food Control Department, Animal Health Research Institute, Shebin El koom Branch, Agriculture Research Center (ARC). Egypt
[**]Brucellosis Research Department, Animal Health Research Institute (AHRI), Dokki Agriculture Research Center (ARC), Egypt.

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ABSTRACT

Numerous pathogenic and spoilage microorganisms can contaminate food products; the first type can result in foodborne illnesses, while the second can have a significant negative financial impact on the food supply chain by affecting the quality of the food. Microbial food deterioration is another major source of worry for the food sector. According to estimates, as much as 25% of the food produced is wasted after it is produced due to microbial growth. The rapid growth of spoilage bacteria in food may cause no harm to human health, but it has an adverse affect on durability, texture and overall quality. The value of the final product influences consumer choice, lead to serious economic losses. So, preventing or inhibiting microbial development in foods is critical for today's globalized food supply.

Chemical preservatives have been widely utilized to suppress growth and multiplication of microbes, but their safety and influence on human health are being questioned. Naturally derived preservatives serve as vital for boosting the shelf life and food safety. In recent years, there has been a lot of interest in antimicrobial compounds obtained from natural sources that inhibit the growth of bacteria and fungi in order to improve food quality and prolong its duration of storage. Plants, animals, and bacteria are the primary sources of natural antimicrobials. Plants, particularly herbs and spices, are becoming popular as natural antibacterial sources.

Therefore, this study's objective was to review the previously released research on naturally derived preservatives and their capacity to improve food safety and increase food product shelf life.

INTRODUCTION

Food safety means, food is prepared, processed, and preserved in a way that reduces the risk of humans developing foodborne diseases (**Australian Institute of Food Safety, 2019**). In sustainable development, which aims to protect the environment, animals, and human health, food safety is of the highest priority.

Corresponding author: Mohamed H. Gaffer , Food Control Department, Animal Health Research Institute, Shebin El koom Branch, Agriculture Research Center (ARC), Egypt.
Email address:
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(FAO, 2022).

Preservatives are food additives that are essential for extending the shelf life or improving the flavor of food. They specifically aid in regulating and preventing food degradation, offering defense against spoiling microorganisms especially those causing food poisoning, the production of healthy food products without synthetic preservatives is one of the biggest challenges facing the food production industries because chemical additives and artificial antibacterial agents may have an adverse effect on people's quality of life **(Fadhil, Y. 2023).**

Chemical treatments, for example, are used in food preservation to preserve food from dangerous germs and lengthen shelf life. Chemical preservatives could be bad for people's health. For instance, nitrosamines, which are carcinogenic, can be created when amines and ammonium compounds react with nitrite, a curing agent used to prevent Clostridium development in meat products **(Ferysiuk et al. 2020)**

Fresh food consumption has grown as a result of customers' need for easy, ready-to-eat, or ready-to-cook foods, as well as their desire to live a healthy lifestyle. Because fruits, vegetables, fish and meat frequently have a limited shelf life, using appropriate methods of preservation is crucial to boost their shelf lives (**Mart´ınez et al. 2015).**

This study summarises current information on the use of natural preservatives in food production process to protect against food-borne diseases and spoilage microorganisms. Natural preservatives usually come from plants, animals, fungi, and algae García and Searle (2016), they can be classified into antimicrobials and antioxidants **(Gokoglu 2019).**

Antimicrobials:

Antimicrobial compounds can be added to or naturally exist in foods to ensure food safety and quality by retarding and/or inhibiting the growth of harmful microorganisms (bacteria, yeasts, and molds) that cause food spoilage **(Quinto et al. 2019).**

Because synthetic preservatives have the potential to result in health issues, consumers and businessmen are attempting to utilize natural preservatives derived from animals, plants, algae, bacteria and fungi which are deemed safer for both individuals and environment instead of synthetic types **(Gokoglu 2019)** natural antimicrobial substances have several sources can be summerized in the following figure1.

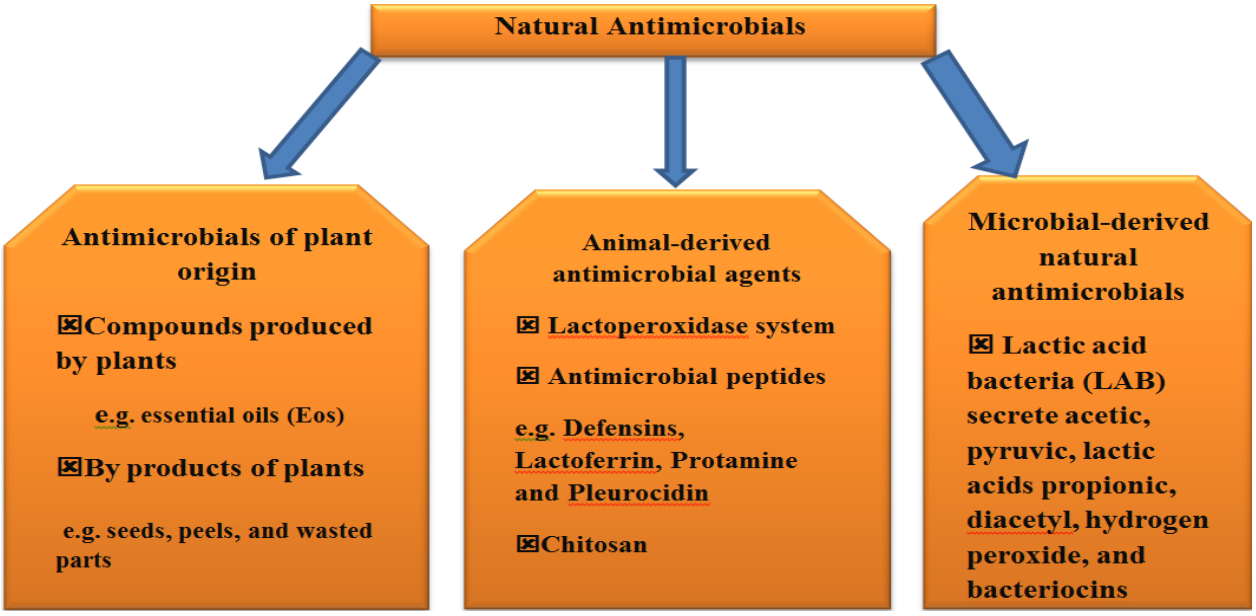


Figure 1. some naural antimicrobial substances uesd as natural prerservatives

1.1.Antimicrobials of plant origin.

They can be devided into compounds produced by plants and byproducts of plants **(Gyawali and Ibrahim (2014).**

1.1.1. Compounds produced by plants,

Grape seeds, fennel, nutmeg, parsley, caraway, and olive leaves are examples of leaves and seeds that contain natural antimicrobials. Spices and herbs include oregano, basil, thyme, marjoram, sage, cardamom, rosemary and clove considered strong antimicrobials **(Tajkarimi et al. 2010).** For many years, essential oils (Eos) and herbal extracts have been utilized as food additives to enhance flavor, create distinctive flavours, and lengthen shelf life of food by reducing microbial contamination and rancidity. Indeed, owing to the high concentration of secondary metabolites present in these herbs (primarily phenolic compounds, iso-flavonoids, terpenes, ketones, aliphatic alcohols, acids, and aldehydes) that have the cabability to restrict or delay the growth of hazardous microbes **(Singh 2018).**

Essential oils derived from spices are widely utilized in food flavouring and are thought to be a good food preservative. It offers a wide range of applications and great growth potential. It has antibacterial properties as a natural food addition, it demonstrated substantial antibacterial activity against pathogens that cause food poisoning and food deterioration **(Yong-Xin et al. 2022).**

1.1.2.By products of plants.

Fruit and vegetable processing yields a variety of by-products, including wasted parts, peels and seeds exhibit biomedical features including antioxidant and antibacterial activities, for this reason it can be employed as naturally derived antimicrobial compounds **(Ayala et al. 2010).**

In the food manufacturing sector, reusing pomegranate unused items (peels and seeds) could be an effective means to reduce disposal expenses, environmental impact and food preservation owing to its antimicrobial action **(Ul Ain et al. 2023).**

Citrus peel as a byproduct has been found to be a rich source of essential oils, phenols, and dietary fibre, as well as an efficient, economical, and environmentally friendly source of food preservation against food spoilage bacteria and fungi (**Charu 2022).**

1.2. Animal-derived antimicrobial agents.

Most animal species naturally produce antimicrobial agents as their defensive strategy against numerous pathogens or germs. **(Hoskin et al. 2008).** Certain examples of these antimicrobial agents include proteins or enzymes, like lactoperoxidase system (LPS), that found obviously in saliva and milk **(Fan et al. 2018).** Antimicrobial peptides (AMPs) of animal origin, like Defensins, Lactoferrin, Protamine, and Pleurocidin, among others, might be applied as biological food preservatives **(Pisoschi et al. 2018).** Another type of animal derived antimicrobial agents is Chitosan which is a biopolymer derived from arthropods and crustaceans exoskeletons that has antimicrobial effects against most bacterial species and fungus. It also has low toxicity level so it is used in edible caotings **(Tiwari et al. 2009).**

1.3. Microbial-derived natural antimicrobials.

In addition to producing a variety of molecules necessary for development, survival, and spread, microbes also use these substances to fight off competitor organisms and other environmental bacteria. Lactic acid bacteria (LAB) provide a a preservation impact on foods, because of its ability to produce a wide variety of antimicrobial secondary metabolites, like organic acids (e.g. acetic, propionic, pyruvic, lactic acids) that may be adequate to kill many pathogens, owing to pH decline **(Holzapfel et al. 1995).** Diacetyl, H_2O_2, and bacteriocins are released by lactic acid bacteria (LAB) as a defense process to combat a hostile microorganisms which competes for binding sites, nutrients and oxygen **(Chen and Hoover, 2003).** Bacteriocins generated by LAB have bacericidal actions against urinary tract and gastrointestinal pathogens; thus they have the potential to replace chemicals and antibiotics in

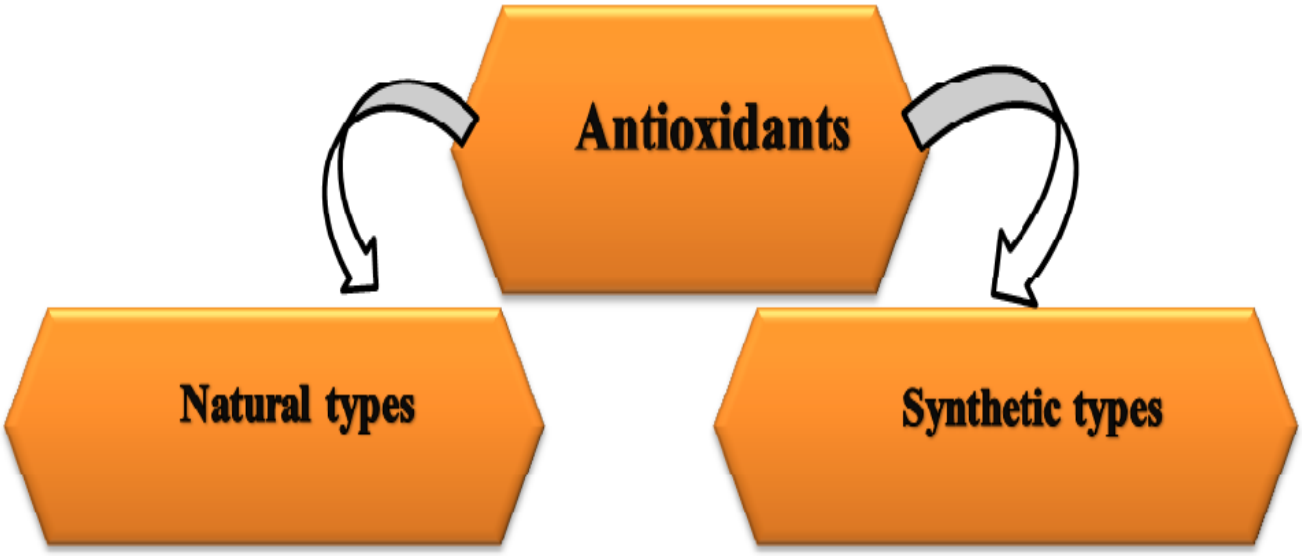
a variety of domains **(Mokoena 2017).**

Mushrooms are soft fungus that grow quickly and have a wide range of antibacterial activity against a variety of foodborne microorganisms for example, *Klebsiella pneumoniae*, *E.coli* 0157:H7, *Pseudomonas aeruginosa*, *Listeria monocytogenes*, *Salmonella enteritidis*). It has antifungal action against filamentous fungi that are found in food (e.g. *Cladosporium herbarum*, *Aspergillus species* and *Fusarium species*) and yeasts (e.g. *Saccharomyces cerevisiae* and *Candida albicans*) **(Shen et al. 2017).**

Antioxidants

Foods rich in oils and fat, whether from natural sources or industrially produced, can undergo oxidative reactions, resulting in disagreeable flavour and odour, as well as a loss in nutritional value, among other effects **(Martins et al. 2019).** Preservatives and antioxidants are similar in that both contribute to food preservation. Antioxidants prevent or reduce food degradation by preventing or reducing oxidation (**Lorenzo et al. 2018).**

In food processing, antioxidants postpone or stop oxidation or neutralise free radicals to enhance aroma, flavour, and colour **(Uzombah 2022).** Antioxidants can be classified into synthetic and natural types as in figure 2.



Plant phenols
Vitamin C
Vitamin E
Spices and herbs
Oregano , rosemary, sage, thyme , clove, basil, nutmeg, cinnamon and pepper.
plant extracts
grape seed and tea

2 and 3-tert-butyl-4-hydroxyanisole (BHA)
Butylated hydroxytoluene (BHT)
Tert-butyl hydroquinone (TBHQ)
Gallate antioxidant
Propyl gallate (PG)
Octyl gallate (OG)

Figure 2. Classification of antioxidants.

Synthetic antioxdants characterized by cheapness, have a better level of purity, and have more homogeneous antioxidant qualities (**Ousji and Sleno 2020).** The use of artificial phenolic antioxidants in food manufacturing has expanded year after year owing to their great constancy and negligible influence on food colour and flavour, the main artificial phenolic antioxidants are 2 and 3-tert-butyl-4-hydroxyanisole (BHA), 2,6-di-tert-butyl-4-methylphenol or butylated hydroxytoluene (BHT), tert-butyl hydroquinone (TBHQ), gallate antioxidant, propyl gallate (PG), and octyl gallate (OG) **(Xu et al. 2021).**

Many in vitro and in vivo research have been conducted in recent years to study toxicity resulted from antioxidants and the association among the intake of foods high in artificial antioxidants and certain types of tumors and other disorders **(Wang et al. 2021)**

Many spices, herbs (oregano, rosemary, sage, thyme, clove, basil, nutmeg, cinnamon and pepper) and plant extracts (grape seed and tea) contain plant phenols that considered natural antioxidants **(Arshiya 2013)**

Main polyphenols (flavonoids, phenolic acids, anthocyanins, lignans, and stilbenes), carotenoids (xanthophylls and carotenes), and vitamins E and C derived from plant materials are examples of natural antioxidants **(Li et al. 2016).**

CONCLUSION

The need for food peservation methods increased in recent years due to increased food poisining outbreaks caused by different food posisoning microorganisms. These methods used for food preservation must be effective for total elimination of causative agents. There are several food preservatives discussed in this article focusing on natural types to fullfill the requirements of food safety to guarantee both food presevation as well as safety to the consumer. There are two types of preservatives, antimicrobial compounds and antioxidants. Natural types of both usually less effective than chemical types although more safe to consumers. On the contrast chemical antimicrobials and synthetic antioxidants have much harmfull side effects to consumers although they are more effctive. This problem must be overcomed by development of recent techniques that guarantee effectiveness as well as safety to consumers.

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