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Phytochemicals as Alternative Treatments for Salmonella: Efficiency and Mechanism

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ABSTRACT

The emergence of multidrug resistant (MDR) microorganisms has made treating many infectious diseases effectively challenging and poses a major global risk. In worldwide Salmonella is most frequent causes of foodborne diseases. It has recently become evident that the effective control of this and other pathogenic bacteria depends on their resistance to antibiotics. The production of natural goods derived from plants is becoming more and more popular as a means of treating and preventing harmful diseases. Phytochemicals and herbal remedies have been utilized for their strong antibacterial properties since the beginning of time. Medicinal herbs that possess antibacterial properties and combine phytochemicals and antibiotics have demonstrated synergistic effect against Salmonella enterica serovar *Typhimurium*. This article focuses on the how Salmonella developed resistance to antibiotics, mechanism and use of plant derived medicines against Salmonella. There is also discussion of the developments and possible future uses of phytochemicals in the fight against resistance.

Keywords: Salmonella *Typhimurium*, Salmonellosis, Multi drug resistance, Phytochemicals

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Introduction

Salmonella is the primary causes of foodborne illnesses that cause infection called salmonellosis. It has long been known that salmonella is a significant zoonotic infection that affects both humans and animals economically [1]. Numerous animal species, including pigs, horses, sheep, and goats, cattle, and sheep can contract *Salmonella* Typhimurium infections by consuming contaminated food, herbs, and drinks, together with dangerous substances including, mycotoxins, bacterial toxins, and heavy metals as well as fermentation byproducts like ethyl carbamate and biogenic amines, can result in foodborne illnesses. Although there are many species of salmonella in the wild, their main origins are polluted environments from human or animal waste and the gastrointestinal tracts of, reptiles, insects, birds and mammals [2]. Although clinical sign of salmonellosis in animals is gastrointestinal disease, a variety of other illnesses such as respiratory disorders, abortion, acute septicaemia, and arthritis can also be seen. Various antimicrobial preservatives are typically used into food to prevent infections caused by Salmonella sp. Regrettably, data indicates that these synthetic, preserved meals are carcinogenic and poisonous. High concentration antibiotic preservative must be added to meat products to achieve the optimal biological activity due to the rising occurrence of antimicrobial resistance in Salmonella [3]. Plants create bioactive molecules known as phytochemicals to defend themselves. There are many different sources of phytochemicals, including whole grains, fruits, vegetables, nuts, and herbs. To date, over a thousand phytochemicals have been identified. Phytochemicals are added to livestock feed to increase productivity are often referred to as Phyto-biotics or phytogenics. Additionally, to shield animals from free radical-induced oxidative damage, it is recommended to use phytochemicals as antioxidants in animal feed. Phytochemicals work through several different mechanisms, such as the target alteration, drug degradation enzymes and inhibition of efflux pumps [4]. when used either alone or in conjunction with other antibiotic compounds, phytochemicals have been demonstrated to exhibit antimicrobial efficacy against relevant infections, such as Salmonella species. This article focuses on the antibiotic resistance development, mechanism of action and use of phytochemicals and future prospectives.

Symptoms and treatment of Salmonella

This focuses on salmonellosis, an illness caused by most kinds of Salmonella. Typhoid and paratyphoid fever are caused by some additional strains of Salmonella. Salmonella infection symptoms include stomach cramp, fever and diarrhea. Symptoms usually develop six hours to six days after infection. Infections in the joints, bones, blood, urine, or neurological system (brain and spinal fluid) caused by certain strains of Salmonella can occasionally result in significant illness. A laboratory test for Salmonella infections finds the bacteria in a patient's stool, bodily to it [5].

Patients should drink additional fluids for the duration that their diarrhea persists. The patient may occasionally have to be admitted to the hospital due to the severity of their sickness. In rare cases, an infection from the intestines may spread to other parts of the body or the bloodstream. These individuals should receive antibiotics immediately. Drugs Apart from suggesting that you stay hydrated, a medical professional might also suggest: preventive of diarrhea. Loperamide, also known as Imodium A-D, is one drug that relieves diarrheal cramps. Your doctor might recommend antibiotics to get rid of the infection. Usually, your doctor will prescribe them if they suspect that you have a serious infection, bloodstream infection or weakened immune system with salmonella [6].

Antibacterial resistance in Salmonella

Multidrug-resistant Salmonella has become a serious foodborne disease that poses a concern to public health worldwide. Antibiotics are administered to feed at subtherapeutic dosages to promote growth, reduce diseases, enhance feed conversion efficiency, and raise the financial effectiveness of animal production. However, as animal husbandry intensifies, the use of in feed antibiotics (IFAs) may lead to the development of antibiotic resistance, potentially endangering human health [7]. Numerous antibiotics, such as, cefotaxime, tetracycline, trimethoprim, chloramphenicol, ampicillin, sulfamethoxazole, cephalosporins, and nalidixic acid have been linked to reports of salmonella resistance. It is commonly recognized that when bacteria grow, they become highly resistant, and that resistance is transferred horizontally between bacterial cells via conjugation and transformation. Planktonic cells exhibit antimicrobial resistance mechanisms through the activity of target adaptability, efflux pumps, enzyme expression, and mutation [8].

Mechanism of phytochemicals

Phytochemicals are employed for animal nutrition and health enhancement; they may have biological effects such as antibacterial, antioxidant, antiviral, and anti-inflammatory properties. By a number of methods, phytochemicals prevent S. *Typhimurium* from growing. These may involve inhibiting the bacterial capacity to connect to host cells, decreasing the bacterial production of proteins, cell walls, and nucleic acids, and losing them lethal effect of transmembrane electrochemical gradient, decreased bacterial osmoregulation, and increased nitric oxide (NO) production [9]. Furthermore, Phytochemicals have immunomodulatory effects on the

immune system, resulting in increased cytokine modification, higher antibody titers, and increased proliferation of immune cells.

Cell wall Inhibition

Peptidoglycan is made up of repeating units which are linked by small amino acid (AA) chains called N-acetylglucosamine and N-acetylmuramic acid. The precise configuration of AA molecules is necessary for microorganisms to be robust and as a result, protected [10]. Phytochemicals have been discovered to be useful in therapeutic techniques to more effectively regulate the bacterial cell wall's synthesis. Because of its effect on the cell wall of bacteria, flavonoids exhibit potent antimicrobial activity in contrast to a diversity of bacterial and viral illnesses. More lipophilic flavonoids have the potential to damage bacterial membranes. It has been observed that bacteria were contact with phenolic combinations lyse their cell walls. One way to combat S. *Typhimurium* with tannins is Tannic and gallic acid; flavanol gallates from Acacia nilotica and Tea; and condensed tannins from Quebaracho and Calliandra calothyrsus. All of the tannins prevented S. *Typhimurium* from growing [11].

Inhibition of biofilm

Preventing biofilms, A biofilm is a group of surface-integrated microbial colonies that are surrounded by a matrix of exopolysaccharide. Plant based chemicals are utilized to both stop and impede the establishment of biofilms and combat the emergence of antibacterial resistance by interfering with some crucial aspects of the creation of biofilms, including intercellular accumulation, attachment, movement, and contact [12]. Thymol and carvacrol, the primary constituents of oregano and thyme oil, exhibit antibacterial activity against S. *Typhimurium* and S. Enteritidis on polypropylene. Salmonella growth and biofilm formation are inhibited by terpenoids, alkaloids, lectins, polypeptides, phenolics and polyacetylenes found in essential oils (Eos).

Plant-derived phytochemicals against Salmonella

Phytochemicals obtained from plants that combat Salmonella. There are several ways to avoid, lessen, and even reverse antibacterial resistance. one of the most effective strategies has been shown to be the use of medicinal plant extracts with inherent antibacterial properties. When related to artificial chemicals, phytochemicals are naturally occurring, they have been shown to be among the safest and most useful substances. In traditional treatment systems for many years to treat infections that cause bye bacteria, medicinal plants have been used. Phytochemicals have demonstrated potential as antibacterial or bactericidal substances that can augment the actions of currently marketed antibiotics [13]. Phytochemicals have shown to be able to inhibit important resistance-development pathways, such as cell. Salmonella species are classified as environmental persisters primarily due to their strong ability to create biofilms. This leads to the usual long-term and chronic colonization of people, animals, and plants. The rapid development of antibiotic substitutes is imperative in light of the escalating worries regarding the emergence of superbugs and the glacial pace of developing novel drugs for human and livestock use. Approximately 80% of impoverished countries rely on traditional medicine derived from phytochemicals as their main source of HealthCare. When it comes to side effects, medicinal plants are usually less expensive than their synthetic counterparts [14].

Conclusion

Concluding remarks and potential paths Salmonella species are categorized as environmental persisters primarily because of their strong ability to produce biofilm. This leads to the usual long-term and chronic colonization of people, animals, and plants. The rapid development of antibiotic substitutes is imperative in light of the escalating worries regarding the emergence of superbugs and the glacial pace of developing novel drugs for human and livestock use. It has been discovered, that a variety of herbal extracts and the phytochemicals extracted from them exhibit strong antimicrobial activity against microbes that cause foodborne illness. These plants derive chemicals have proven to be able to inhibit important resistance building pathways, such as cell permeability, replication machine. While the creation of novel phytochemicals compounds through combined chemistry and computational modelling remains an exciting challenge, there is a chance that plant derived compounds and existing or recently developed antibacterial agents could work synergistically.

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