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# Importance of Waste Food Products and Its Antimicrobial Activity against Food Spoilage.

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**ABSTRACT**

The food borne illnesses or food spoilage caused by various food pathogenic microorganisms are a major concern for consumers, food industry and food safety. So the use of natural antimicrobial compounds in food has gained much attention. Antimicrobial compounds can be derived from waste food product such as fruits and vegetable peels can be utilized as a natural source of antimicrobials agents. These waste products of various fruits and vegetables have the potential to be used for food system to enhance the food safety and food control due to their antimicrobial properties against food spoilage.

**Keywords**: Waste By- products, Antimicrobial action, Food safety.

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## INTRODUCTION

Food processing wastes are those end products which have not been recycled or used for other purposes. During food processing, these wastes pose increasing disposal which causes severe pollution problems to environment and represent a loss of valuable biomass and nutrients. So they need to be managed or they can be utilized for many purposes [1]. Food processing wastes have a potential for conversion into useful products of higher values as by-product. The utilization of food wastes reprocessing promotes marketability which includes profitable operating and employing reprocessing technology [2, 3, 4]. It should also be noted that the investigation of possible antibacterial activity of by-products is very limited in the literature. These by-products can be used as a source of antimicrobial agents or compounds [5, 6]. Numerous studies are conducted to find natural antimicrobials that can inhibit bacterial and fungal growth in foods, in order to improve the quality and shelf-life. Similarly, consumers have become concerned about the safety of synthetic preservatives used in food [7]. Many various kind of food products contain nutrients and healthier for humans which require protection from food spoilage during their preparation, storage and distribution to give them desired shelf-life, food safety and quality. Food spoilage due to contamination of microorganisms can cause many undesirable reactions that deteriorate flavor, odor, color, sensory and textural properties of foods [8]. The resistant food borne pathogenic bacterial strains are *Bacillus cereus, Campylobacter jejuni, Clostridium perfringens, Escherichia coli, Listeria monocytogenes, Salmonella enteric and Staphylococcus aureus* and pathogenic strain of fungi are *Aspergillus niger, A.flavus, Penicillum spp, Fusarium species* are linked to food borne illnesses [9, 10, and 11]. As a result, there is a increasing demand for natural products that can serve as alternatives for food preservatives which can protect the food from contamination [7] and thus could be a potential source of low-cost natural antimicrobials. There are many unexplored sources of such potential compounds that could be used as natural preservatives in food applications. In this review the importance of waste food product and its uses in food system as antimicrobial agents were discussed.

### Food spoilage:

Many pathogenic microorganisms have been found on intermediate moisture foods which include bacteria such as *E. coli, S. aureus, Salmonella, Pseudomonas, Bacillus cereus, Listeria monocytogenes, Campylobacter jejuni, Clostridium perfringens* and fungi such as *Aspergillus flavus, Penicillium roqueforti, Candida albicans, Mucor sp, Penicillium sp*. These microorganisms may produce toxins and can be hazardous to humans [12]. Each and every food product harbors its own specific and characteristic micro flora at any time during production and storage. In recent years food safety concerns have been focused on pathogens, such as *Salmonella* which is recognized as one of the leading causes of food borne bacterial diseases. The growing concern about safety of foods has recently led to the development of natural antimicrobials to control food borne pathogens and cause diseases to humans. *S. typhi* cause typhoid fever, *S. paratyphi* cause enteric fever and food poisoning in humans [13]. *Bacillus cereus* is one of the major food borne pathogen that causes vomiting and diarrhea in mammals including humans. *Campylobacter jejuni* is also a food borne pathogen that causes gastroenteritis and diarrhea in humans. The toxin producing, spore-forming food borne pathogen *Clostridium perfringens* causes gastroenteritis in humans following ingestion of contaminated meat. *E. coli* is a toxin-producing entero pathogen responsible for a hemorrhagic form of colitis, bloody diarrhea and hemolytic uremic syndrome. *S. aureus* is a highly pathogenic, toxin-producing, food borne organisms that can contaminate food and infect the skin, lung, heart and other organs [14]. The spoilage potential of a microorganism is the ability to produce the metabolites that are associated with the spoilage of a particular product. In general, several of the organisms isolated from a food product will be able to produce spoilage metabolites when allowed to unlimited growth. Almost all groups of microorganisms are initially present on a food product but it survives based on the nutrient composition, chemical and physical parameters. Food spoilage is specifically caused by organisms that capable of degrading the vegetable polymer, pectin and this spoilage characteristic of food may cause undesirable flavors and textural changes in food [15].

### By-product as a source of functional compounds:

A large amount of by-products are generated from fruits and vegetables such as pomace, seeds, peels and pulps. Some studies have shown that the by-products of fruits and vegetables are valuable and potentially good sources of minerals, organic acid, phenolic compounds and many other bioactive components that have several functionalities including antimicrobial activity [16, 17].

**Fruits and vegetables:**

According to the researchers, the utilization of apple pomace has been shown to be a good source of polyphenols which are predominantly localized in the peels and are extracted into the juice to a minor extent. Major compounds isolated and identified include catechins, hydroxycinnamates, phloretin glycosides, quercetin, glycosides, and procyanidins [18, 19, and 20]. The antibacterial activity of apple peel extracts (*Malus domestica*) was found against *S.aureus* and *P.fluorescene* [21]. Ethanolic extract of grape pomace was found to inhibit the growth of *Enterobacteriaceae, S.aureus, Salmonella*, yeasts and molds in beef patties during 48hours of storage at 40$^{o}$c [22]. The antimicrobial activity in capsicum was reported to be due to the phenolic compound and 3-hydroxycinnamic acid (coumaric acid) [23]. Flavonoids from bergamot peel, a by-product of citrus fruit processing, was found to be active against gram-negative bacteria (*Escherichia coli, Pseduomonas putida, Salmonella enteric*) [24]. The 80%methanolic extract of pomegranate peels was also reported to have antimicrobial activity against *L. monocytogenes, S.aureus, E.coli*, *Y. enterocoliticaand*, *B. cereus*, and fungi by agar-diffusion methods due to the presence of phenolics and flavonoids [25]. Similarly, tannins (gallotannins) isolated from acetone extract of mango (*Mangifera indica L*.) was found to have antibacterial activity against food spoilage organisms *B. subtilis, S. aureus* and *E. coli*. The presence of polyphenol compounds in mango kernel extracts is attributable to this antimicrobial action [26]. Banana (*Musa paradisiacal*) peel is rich in dietary fiber, proteins, essential amino acids, polyunsaturated fatty acids and potassium [27]. The fresh green and yellow banana peel fruits were treated with 70% acetone, which was then partitioned with chloroform and ethyl acetate. These extracts were found to have antimicrobial activity against food pathogens [28]. Lemon (*Citrus lemon*), the citrus peel oils showed strong antimicrobial activity. The compounds like tetrazene and coumarin were identified from the lemon peel extract [29]. Orange (*Citrus sinensis*), the peel of this fruit are a good source of vitamin c and flavonoids. The extracts of orange peel were investigated and results showed that the ethanol extract of peel had high quantity of phenols and flavonoids which inhibit the food pathogenic organisms [30]. Other fruits such as jackfruit, papaya, plum, guava and tamarind seed extracts have shown antimicrobial activity against both Gram-positive (*S. aureus, B. subtilis*) and Gram-negative bacterial strains (*E.coli, P. aeruginosa*) [31]. Garlic (*Allium sativum*) extract showed a wide range of antimicrobial activity due to presence of Allicin, an organosulfur compound that found to have higher antimicrobial activity and acts as a growth inhibitor for Gram-positive and Gram-negative bacteria including *E. coli, Salmonella, Streptococcus, Staphylococcus, Proteus, and Klebsiella* [32]. Tomato seeds, a major by-product of the tomato processing industry, contain organic acids and phenolic compounds. The extract of tomato seed was reported to have antimicrobial activity against Gram-positive bacteria (*S.aureus, Staphylococcus epidermidis*) and fungi [33]. The antimicrobial property of almond skin extract was reported to have antimicrobial activity against *L. monocytogenes* and *S. aureus* due to the presence of flavonoid compounds [34]. The aqueous extract of Potato (*Solanum tuberosum*) peel powder showed strong antibacterial activity against *E. coli* and *S.typhimurium* due to the presence of major components ( chlorogenic, caffeic, Gallic, and protocatechuic acids) [35]. The olive pomace and olive juice powder was found to have inhibition activity against food borne pathogens *E. coli, L. monocytogenes, S. enterica* and *S. aureus* [36]. These studies have provided useful information on the utilization of by-products (peels, seeds, pulps, and husks)of different fruits and vegetables as natural antimicrobial in foods. These by-products could be of great benefit from economic and environmental perspectives as a source of low cost natural antimicrobials. In addition, the waste produced by the processing industry could be incorporated into antimicrobial packaging. These are novel, natural, eco-friendly and economic sources of antimicrobics, which can be used in the prevention of diseases, caused by pathogenic microbes and also to reduce pollution [37].

**Antimicrobial action:**

The mechanism of antimicrobial action is important since it shows how the compounds act as natural preservatives in food. The phenolic compounds attack the organism's cell wall and cell membranes which results in the release of intracellular constituents. The effect of phenolic compounds can be concentration dependent. The phenolic compounds at low concentration will affect the enzyme activity, while at high concentrations, they cause protein denaturation. It was reported that while interference with the membrane function such as disruption of the electron transport, nutrient uptake, protein synthesis, nucleic acid synthesis, enzyme activity and interaction with membrane proteins causes deformation in structure and functionality. Thus, active phenolic compounds might have several invasive targets which could lead to the inhibition of bacteria [38]. The presence of –OH group in the phenolic compounds plays an important role in the antimicrobial activity of carvacrol and thymol which promotes the delocalization of electrons which then act as

proton exchangers and reduce the gradient across the cytoplasm membrane of bacterial cells. This will cause the collapse of the proton motive force and depletion of the ATP and causes cell death. It was reported that the antimicrobial activity of isothiocynates derived from onion and garlic inactivates extracellular enzymes through oxidative cleavage of disulfide bonds and that the formation of the reactive thiocyanate radical mediates the antimicrobial effect. It also proposed that the carvacrol, carvone, thymol and trans-cinnamaldehyde are reported to decrease the intracellular ATP (adenosine triphosphate) content of *E.coli* cells while simultaneously increasing extracellular ATP, which disrupts the plasma membrane [39]. Inactivation of yeasts can be due to disturbance of several enzymatic systems, such as energy production and structural component synthesis [40]. In recent studies, it was reported that the mechanisms of action of antimicrobial peptides can assume amphipathic structures which will disrupt the plasma membrane in several locations and result in the percolating out of vital cell components[41] [42].

**Application of natural antimicrobials agents or compounds in food:**

Though there is vast potential for natural antimicrobial agents in food preservation, the level of natural preservatives is required for sufficient efficacy in food products. The success of plant derived antimicrobials such as fruit and vegetable waste products is well documented in the literature [43]. Natural compounds are gaining a great interest from research and industries, due to the potential to provide quality and safety benefits, with a reduced impact on human health. In addition, utilization of natural bioactive compounds promotes the accepted criteria of food sustainability. They are well suited to be utilized as preservatives in foods and could be often used as a alternatives to synthetic food additives. Natural products have been the most successful source of drugs ever. These strategies have produced many valuable drugs and are likely to continue to produce lead compounds [44, 45]. These antimicrobial compounds have been directly applied in food systems either in the form of a powder or a liquid. However, only a few natural antimicrobials have found practical application in the food industry and their use in foods as preservatives is often limited due to the strong smell and taste they impart to these foods. It is very useful application to control measures on spoilage and pathogen microorganisms.

## CONCLUSION

In recent years most of the natural antimicrobials has expanded in response to consumer demand for controlling the food borne pathogens and food safety. There are many natural products currently being used for the food preservation and extension of shelf life of foods. These technologies provide safety benefits and enhance the food quality without causing any loss of nutritional quality. The applications of natural antimicrobial agents are likely to grow steadily in the future because of greater consumer demands for minimally processed foods and those containing naturally derived preservation ingredients. In order to further promote the application of natural active compounds at industrial level, it is necessary to have a good understanding of the mechanism by which antibacterial agents operate. For many natural compounds these information are still lacking. Better understanding of the modes by which antimicrobials can control microorganisms will provide new and upgraded natural derivatives with optimized potency and stability [43, 44].

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