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**Research Article**

# POTENTIAL EFFECT OF AGRICULTURAL WASTE ON DIFFERENT PATHOGENIC MICROBIAL STRAINS

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**A B S T R A C T**

The rise of chronic health issues world-wide and the increase in health care costs has drawn the interest of researchers for alternatives like agricultural waste which can be utilized for multiple health benefits. Agricultural waste is one of the major sources of pollution if not utilized or discarded properly. These wastes have increased with the growth of food processing industries. Wide variety of fruit and vegetable wastes are disposed-off routinely which if utilized properly may prove to be a boon to human society because of their antimicrobial potential. They can prove to be eco-friendly antimicrobial agents for therapeutic purpose, which may be used for the control of even those microorganisms which have become multidrug resistant on one hand and simultaneous effective disposal of agricultural waste.



## INTRODUCTION

In the last few decades there has been an increased social and environmental pressure for the efficient disposal and or reutilization of agricultural industry residue (Pfaltzgraff *et al*., 2013; Santana *et al*., 2012) due to the global intensification of food production, leading to the creation of large quantities of food co-products and wastes (Waldron, 2007). The therapeutic potential of plant products can be traced back to over five thousand years ago as there is evidence of its use in the treatment of diseases and for revitalizing body systems in Indian, Egyptian, Chinese, Greek and Roman civilizations (Mahesh and Satish, 2008). India has a vast and varied agricultural heritage, and herbal medications are used since ancient times. The waste obtained from food processing industry is extremely diverse due to the use of wide variety of fruits and vegetables, the broad range of processes and the multiplicity of the product (William, 2005). Vegetables and some fruits yield around 30% of non-edible products (Ajila *et al*., 2010)**.** Sometimes plant parts such as bark, stalks, leaves, fruits, roots, flowers, pods, seeds, stems, latex, hull and fruit rind which are considered as wastes contain important phytochemicals with antimicrobial properties (Kaneria *et al*., 2009; Aref *et al*., 2010). Table 1 shows the percentage of waste generated during food processing. The agriculture wastes are rich in different vitamins, phenolic compounds and carotenoids depending upon the plant species.

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The by-products of plants represent an important source of phytochemicals, which possess properties like antitumor, antiviral, antibacterial, cardio protective and anti-mutagenic activities (Jasna *et al*., 2009).

**Table 1** Percentage of wastes and by-products in food production process. (Gupta and Joshi, 2000)

| Fruit and vegetables | Nature of waste | Approx. waste in % |
|---|---|---|
| Mango | Peel | 45 |
| Banana | Peel | 35 |
| Citrus | Peel, rag and seed | 50 |
| Pineapple | Skin and core | 33 |
| Grapes | Stem, skin and seeds | 20 |
| Guavas | Peel, core and seeds | 10 |
| Peas | Shell | 40 |
| Tomato | Skin, core and seeds | 20 |
| Potato | Peel | 15 |

### *Phytochemicals*

Phytochemicals are the bioactive compounds present in plants. Phytochemicals are of different types like polyphenols, flavonoids, isoflavonoids, anthocyanidins, phytoestrogens, terpenoids, carotenoids, limonoids, phytosterols, glucosinolates and fibers. Amongst them, phenolics are a large diversified group of secondary metabolites, which includes simple phenols, phenolic acids like derivatives of benzoic and cinnamic acids, lignans, lignins, coumarins, flavonoids, stilbenes, flavonolignans and tannins (Dewick, 2002). Antimicrobial activities of a variety of naturally occurring phenolic compounds from different plant sources have been studied in detail (Burt, 2004). Many of these phenolic compounds have shown strong antioxidant properties, thus proving to be good free radical scavengers, peroxide

decomposers, metal and chelating agents (Van Acker *et al*., 1998; Van Hoorn *et al*., 2002). Phytochemicals helps to reduce the risk for a variety of chronic and inflammatory disorders. These include atherosclerosis and stroke, myocardial infarction, certain types of cancers, diabetes mellitus, allergy, asthma, arthritis, Crohn's disease, multiple sclerosis, Alzheimer's disease, osteoporosis, psoriasis, septic shock, AIDS, menopausal symptoms, and neurodegeneration (Cseke *et al*., 2006). Fruits and vegetables are sources of phytochemicals (Sharma *et al*., 2011). Peels from apples, peaches, pears as well as yellow and white flesh nectarines have been found to contain twice the amount of total phenolic compounds as that contained in fruit pulp (Gorinstein *et al*., 2001). List of various phytochemicals commonly found in plant waste is shown in Table 2.

**Table 2** Phytochemicals obtained from plant waste. (Oreopoulou and Tzia, 2007; C. Galanakis, 2012; Wolfe and Liu, 2003; Shrikhande, 2000; George *et al*., 2004)

| Plant material | Phytochemical present |
|---|---|
| Pomegranate peel | Phenolic compound |
| Apple peel | Phenolic compound |
| Grape skin and seed | Proanthocyanidins |
| Tomato seed and peel | Phenolic compound |
| Orange Peel | Hesperidin |
| Potato peel | Polyphenol |

***Antimicrobial activity***

- Antimicrobial activity of agricultural waste is due to its phytochemical composition.
- Research has revealed that fruit peels and seeds, such as grape seeds and peels, pomegranate peel and mango seed kernel may potentially possess antimicrobial property (Kabuki *et al*., 2007). Grape seed extract inhibits common clinical isolates namely methicillin resistant *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* species and *Pseudomonas aeruginosa* (Mohanakrishnan *et al*., 2016). Grape wastes obtained during the processing of wine have also been reported to exhibit a broad spectrum of antibacterial activity (Vasan, 2009). Antimicrobial activity of an ethanolic extract from mango seed kernels against food-borne pathogenic bacteria has also been reported. Mango extract has been found to be more effective against Gram-positive than Gram-negative bacteria, with a few exceptions (Kabuki *et al*., 2007).
- Antimicrobial activity of different extracts of pomegranate fruit peels were evaluated against some food-borne pathogens. It was found that methanolic extract of peels inhibited *Yersinia enterocolitica*, *Listeria monocytogenes*, *Staphylococcus aureus* and *Escherichia coli*. The presence of phenolics and flavonoids were revealed by phytochemical analysis as potent compounds (Al-Zoreky N.S., 2009).
- Papaya peel exhibits antimicrobial activity on *Corynebacterium diphtheria* and *Streptococcus pneumonia* (Muhamad *et al*., 2017).
- Peels of citrus fruits are a rich source of flavones and many polymethoxylated flavones have exhibited potential antimicrobial activity (Ahmad *et al*., 2006). Researchers from different countries showed that different types of citrus peel exhibited broad spectrum antimicrobial activity with MIC ranging between 130µg/ml-50 mg/ml (Javed *et al*., 2011; Jwany *et al*., 2012).
- Potato peel, a vegetable waste was found to be fungicidal and bacteriostatic against Gram negative bacteria at higher concentrations (Deviprasad and Pushpa 2007; Rodrigues de Sotillo *et al*., 2007).
- Turmeric oil, a byproduct from curcumin manufacture contains α ar-turmerone, β- trans-farnesene, turmer one, and curlone, as the main components. It is found to be active against several Gram-positive and Gram-negative bacteria (Negi *et al*., 1999). This oil act like other phenolics that is disturbing the cytoplasmic membrane, disrupting the proton motive force, electron flow, active transport, and coagulation of cell contents (Burt *et al*., 2004).
- Ethanolic extracts of garlic and ginger inhibits *Escherichia coli* and *Salmonella typhi*. (U. N. Ekwenye and N. N. Elegalam, 2005).
- Antimicrobial effect of onion peel against *Bacillus cereus, Staphylococcus aureus, Microcroccus luteus*, and *Listeria monocytogenes* has also been reported. (Kim *et al.,* 2011; Lee *et al.,* 2011; Santas *et al.,* 2010).
- Leaves of Piper betel (Paan) have been used as medicine for its antioxidant and antimicrobial properties. Betel leaf extract possess bioactive components like carbohydrates, proteins, phenolic components, flavanoids and antioxidants. *Proteus vulgaris*, *Klebsiella*, *Pseudomonas* and *Staphylococcus aureus* were inhibited by the betel leaf extract (Arani *et al*., 2011).
- Other agricultural wastes such as corn hull and chestnut hull contains tannins which were found to inhibit pathogenic bacteria - *Listeria monocytogenes*, *Bacillus coagulans*, *Shigella flexneri*, Methicillin-Resistant *Staphylococcus aureus* (Sung *et al*., 2012).
- Agricultural wastes like rice straw, cotton waste, maize waste has an inhibitory effect against fungi *Rhizoctonia solani* causing root rot (Osman *et al*., 2011).
- Chanda S. (2010) evaluated antimicrobial activity of peels of Bottle gourd, Potato, Pineapple, Ridge gourd, Bitter gourd and Drumstick against pathogenic microorganisms like Gram positive - *Staphylococcus aureus*, *Staphylococcus subflava*, *Corynebacterium rubrum*; Gram negative - *Salmonella typhimurium*, *Enterobacter aerogenes*, *Klebsiella pneumonia*, *Proteus mirabilis* and fungi - *Cryptococcus luteolus*, *Candida albicans*, *Candida tropicalis*, *Candida glabrata.* In this study, polar solvents like acetone and methanol were more effective as antimicrobial agents than non-polar solvents like hexane and chloroform. Maximum zone of inhibition was shown by acetone extracts followed by methanol extracts of all the 7 peels. Fruit and vegetable peel extracts showed better antifungal activity than antibacterial activity whereas for bacteria, Gram-positive bacteria were less susceptible than Gram-negative bacteria. This difference may be due structural differences in cell wall of these bacteria. Gram-negative cell wall has an outer phospholipid membrane, which makes the cell wall more complex and acts a permeability barrier. The Gram-positive bacteria contain a single outer peptidoglycan layer, which is not an effective permeability barrier (Costa *et al*., 2008).

The most susceptible organism was fungi *Candida glabrata* and Gram-negative *Klebsiella pneumonia.*

Table 3 shows antimicrobial activity of some vegetable peels against water borne pathogens.

**Table 3** Antimicrobial activity of some vegetable peels against water borne pathogens. (Geetha *et al*., 2014)

| Test organisms | Bottle gourd | Ridge gourd | Drum stick | Pumpkin | Bitter gourd | Control |
|---|---|---|---|---|---|---|
| *E. coli* | 7 | 0 | 6 | 12 | 4 | 18 |
| *S. aureus* | 18 | 20 | 0 | 0 | 12 | 12 |
| *Pseudomonas* | 7 | 0 | 12 | 20 | 0 | 13 |
| *Vibrio cholera* | 18 | 12 | 0 | 15 | 0 | 20 |
| *Salmonella* | 0 | 15 | 21 | 0 | 15 | 12 |

Note : activity in terms of diameter of zone of inhibition in mm.

## CONCLUSION

From different studies conducted on agricultural wastes, it has been found that these wastes hold a tremendous potential to serve as a source of novel, effective, cheaper, safer and better antimicrobial agents to combat the pathogenic strains of microorganisms. The investigations have opened up for the possibility of the use of the agricultural waste in the drug development for the treatment of various microbial diseases. Therefore, the study of agricultural waste in terms of its antimicrobial properties gives a scope for future utilization of the agricultural waste for therapeutic purpose.

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