International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Antimicrobial Activity of Fruits and Vegetables Peels on Human Enteric Pathogen: A Review

Denisha Kumbhani[a], Dhvani Goti[b]

[a] Student, Department of Microbiology, Bhagwan Mahavir Collage of Basic and Applied Science, Bhagwan Mahavir University, Surat, India-395007.

[b] Assistant Professor, Department of Microbiology, Bhagwan Mahavir Collage of Basic and Applied Science, Bhagwan Mahavir University, Surat, India-395007.

DOI: https://doi.org/10.55248/gengpi.2022.3.7.27

ABSTRACT

Fruits and vegetables are widely employed in food production in India. Depending on their nature and cooking procedure, these products are consumed uncooked, half-cooked, or fully cooked, with or without peels. If these peel remnants are not further handled, they become garbage. But different studies conducted on peels revealed the presence of important metabolites, using the polar and carbohydrates, carotenoids, proteins, steroids, flavonoids, alkaloids, tannins, saponins, triterpenoids, and phlobatannin, coumarin, and other nonpolar solvent systems. These extracts are also having potent antimicrobial effects on enteric human pathogens. Various phytochemical elements have antibacterial, antioxidant, antiproliferative, and anti-inflammatory properties. etc. The current study examines the medicinal potential of Indian regional fruits and vegetable peels.

Keyword: - Antimicrobial activities, Bioactive compounds, Fruit peels, Human pathogen, Therapeutic agents, Vegetable peel.

1. INTRODUCTION:

In India, diet is one of the primary causes of death and disability (Prabhakaran et al., 2018). Fruits and vegetables are an important source of critical vitamins and minerals, and their consumption is especially crucial in countries like India where micronutrient shortages are common (Meenakshi, 2016). Fruit and vegetable consumption is linked to a reduced risk of cancer, cardiovascular disease, and overall mortality (Aune, D., et. al., 2017). This is especially important in India, where Fruit and vegetable intake can help in the growing epidemic of chronic diseases associated with food (Reddy et al., 2005: Choudhury et al., 2020). Fruits and vegetables provide a nutrient-dense, flavorful, colorful, pleasant, low-calorie, and protective diet. Low fruits and vegetable intake is responsible for about 4.9% mortality ratio., as well as 1 % of stroke, 31% of ischaemic heart disease (IHD), and 19% of gastrointestinal cancers, and is still strongly linked (protective) to lung/pharyngeal/laryngeal/oral cancer, type-2 diabetes mellitus, bone health, vision/cataract. Low fruit and vegetable intake is the world's sixth most important risk factor for mortality (MCKEE et al., 2004; New et al., 2003). The importance of including citrus fruits, carotene-rich fruits and vegetables, and cruciferous vegetables in one's diet for cancer prevention was stressed. According to the national academy of sciences report on food and health published in 1989 suggested eating five or more servings of fruits and vegetables per day to lower the risk of cancer and heart disease (National Research Council, 1989).

Fruit consumption was 9.6 kilograms per person per year in rural areas, 15.6 kg in urban areas, and 11.8 kg in India, while vegetable consumption was 74.3 kg per person per year in rural areas, 79.1 kg in urban areas, and 76.1 kg in India (Mittal et al., 2007; Dwivedi et al., 2017). According to one analysis of the National Nutrition Monitoring Bureau (2011-12), average vegetable consumption among males was 143 g/person/day and 138 g/person/day for women in selected Indian states (Shankar et al., 2017). Fruits and vegetables are generally consumed because of their high nutritional value and bioactive nutritional compounds (Banerjee et al., 2005). In Indian kitchens, vegetables are cooked completely or partially as curries, and salad is served with bread or chapatis, whereas fruits are eaten raw or in a form of juices. Different components with antibacterial, antioxidant, antiproliferative, anti-inflammatory, and other actions have been extracted from various peels. Growing understanding of antioxidants and how their presence in ordinary foods benefits health, as well as the belief that many prevalent synthetic preservatives may be harmful elevated the knowledge of the common public about the use of natural vegetables and fruits products (Peschel et al., 2006; Parashar et al., 2014). Food contains not just the required bioactive elements for living, but also active chemicals that promote health and prevent many diseases. Previous epidemiologic research has repeatedly indicated that nutrition plays a critical role in chronic illness prevention (Temple et al., 2000; Willett et al., 1994). Fruit and vegetable consumption, as well as grain consumption, has been linked to lower risks of cardiovascular disease, cancer, diabetes, Alzheimer's disease, cataracts, and age-related functional decline (Willett et al., 1995).

Many fruits like mango, orange, lemon, kiwi, banana, watermelon, papaya, jack-fruit, lychee, guava, pineapple, grapes, pomegranate, beed custard apple, chikoo, nashpati, apple, and dragon fruit having peels and many of them are consumed with peels and many of this is consume without peels. Many of the vegetables like bitter gourd, cabbage, carrot, capsicum, eggplant, beetroot, white gourd, tomato, fresh ginger, and cucumber are consumed with peels and consumed without peels. Vitamin A, vitamin C, fiber, and phytonutrients are all found in peels. Vitamin A supports a healthy immune system, while Vitamin C is having wound healing activities. The peels also have an increased amount of iron and antioxidants. Fiber helps to keep bowel movements regular by mobilizing the digestive system. Phytonutrients of many fruits can have a major role in controlling cholesterol and lowering the cancer risk. When consumed with the peel, this fruit provides greater benefits. These peels can even help the lungs in detoxification. Antioxidants, histamine-blocking compounds, and flavonoids are all abundant in orange peels. Eating the fruit with the peel is a natural approach to enhancing your immune system. We can lower the risk associated with cholesterol, enhance bone health, prevent cancer, and improve our oral health by regular consumption of some of the fruit with their peel that may improve our daily fiber, vitamin C, vitamin B-6, vitamin B12, potassium, and magnesium requirements. Edible coatings are thin layers placed on the surface of the food to extend its shelf life and preserve its features, attributes, and functionality at a low cost (Zambrano-Zaragoza et al., 2018).

Furthermore, the fruits and peels are high in bioactive chemicals and have a high nutritional value (Parashar, S., et. al., 2014). Antioxidants, fiber, and oligosaccharides are all abundant beneficial components (as prebiotics) (Cerezaland Duarte, 2005; de MoraesCrizel et al., 2013; Chan et al., 2018; Coelho et al., 2019). Antioxidant phytochemicals found in vegetables and fruits are gaining popularity due to their possible role in disease prevention (Pallauf et. al., 2008). Fruits and vegetables have long been previously recognized as major sources of some critical dietary micro and macronutrients and fibers, and more recently also been recognized as major sources of a wide range of phytochemicals that may enhance health alone or in combination (Stavric 1994), (Rechkemmer et. al., 2001). As a result, some people have labeled fruits and vegetables as "functional foods." Based on the fact that many phytochemicals of fruits and vegetables act as antioxidants, one of the biologically believable reasons for this important protective connection.

Carotenoids, ascorbic acid, and phenolic compounds are examples of a few of the phytochemicals found in fruits and vegetables (Liu, 2004; Percival et. al., 2006). Chemoprevention is naturally occurring molecules such as phytochemicals that have anticarcinogenic and other beneficial characteristics. Antioxidant activity and the ability to scavenge free radicals are two of the most important mechanisms of their protective action. Some vitamins, plant polyphenols, and pigments such as alkaloids, glycosides, saponins, carotenoids, chlorophylls, flavonoids, and betalains are among the most studied chemoprevention that helps in the quick recovery of patients having bacterial infection and other diseases. The potential protective roles of certain antioxidants and other components of fruits and vegetables need to be clarified (Laura et al., 2009). The various phytochemical tests will perform to check the presence or absence of phytochemicals such as Molisch’s test for carbohydrates (Sofowora, 1993), Barfoed’s test for monosaccharides (Sofowora, 1993), Fehling’s test for free reducing sugar (Sofowora, 1993), Fehling’s test for combined reducing sugars (Sofowora, 1993), Test for tannins (Evans, 2002), Borntrager’s test (Sofowora, 1993), Liebermann-Burchard test for steroids (Sofowora, 1993), Test for terpenoids (Sofowora, 1993), Test for saponins (Sofowora, 1993), Shinoda’s test for flavonoids (Evans, 2002), Ferric chloride test for (Evans, 2002), Lead ethanoate test for flavonoids (Evans, 2002), Sodium hydroxide test for Flavonoids (Evans, 2002), Test for alkaloids (Evans, 2002), Test for soluble starch (Vishnoi, 1979).

2. ANTIMICROBIAL ACTIVITY OF FRUITS:

2.1. Orange (Citrus Sinensis):

Shehata et al., 2021 reported that the antibacterial and antifungal activity of orange peels ethanol extracts against gram-positive and gram-negative bacteria and fungi using agar they discovered that Listeria monocytogenes ATCC 19116 was extremely resistant whereas Bacillus cereus ATCC 49064 was very sensitive in the well diffusion experiment gram-positive organism. Citrus peel extracts have shown more impact on foodborne pathogens due to their contents of phenolic compounds. Several studies have found that interactions between phenolic chemicals including rutin, quercetin, and naringenin increase bacterial cell membrane permeability, decrease ATP generation, bind to metabolic enzymes, and disturb membrane integrity, all of which contribute to bacterial cell membrane death. Orange will be given the flavonoids test, alkaloids test, saponins test, and tannins test positive and glycosides test give negative result (El-Desoukey et al., 2018).

2.2. Banana (Musa Paradisiaca):

The antibacterial potency of the aqueous extract of banana peel was first assessed using a well diffusion experiment against several microbial isolates. The aqueous extract of banana peel displayed a wide range of antibacterial activity, according to the findings. These findings revealed that this extract inhibits gram-positive bacteria such as S. aureus and S. pyogenes with inhibition zones of 30 and 18 mm, respectively, with no effect on Candida albicans. Banana peel extract exhibited an inhibitory impact against gram-negative bacteria, with inhibition zones ranging from 10 to 30 mm, with M. catarrhalis being the most vulnerable, according to the findings. Followed by E. aerogenes and K. pneumoniae, with E. coli showing no susceptibility to banana peel extract (Chabuck et al., 2013).

Numerous research has found that banana peels have antibacterial properties. The antibacterial activity of banana peel extract (M. paradisiaca) against human pathogenic bacteria was investigated, and it was discovered that banana peel extract inhibited S. aureus, E. coli, and Proteus mirabilis. Two gram-positive (Streptococcus aureus and Streptococcus pyogenes) and four gram-negative (Enterobacter aerogenes, Klebsiella pneumoniae, E. coli, and Moraxella catarrhalis) and one yeast clinical isolates were tested for antimicrobial activity (Candida albicans).M. catarrhalis and S. aureus had the strongest antibacterial action, followed by S. pyogenes, E. aerogenes, and K. pneumoniae, with no effect on E. coli and Candida albicans. (Hikal and Said-Al 2021).

2.3. Papaya (Carica Papaya):

Phytochemical screening of papaya yields positive results for alkaloids, flavonoids, and glycosides but negative results for phenolics and tannins, whereas phytochemical screening with n-hexane yields positive results for alkaloids and tannins but negative results for flavonoids, phenolics, glycosides, and saponins (Alorkpa et al., 2016).

The acetone extract of Carica papaya peel had the highest polyphenol concentration (87.07 mg/meq of tannic acid), followed by the ethanol extract (41.29 mg/meq of tannic acid) and the aqueous extract (21.28 mg/meq of tannic acid). The antibacterial capabilities of Carica papaya peel have been demonstrated to be effective against both gram-positive and gram-negative bacteria. Bacillus subtilis was shown to be the gram-positive bacterium most vulnerable to Carica papaya peel, whereas Klebsiella pneumoniae was found to be the gram-negative microbe most susceptible to Carica papaya peel (Lydia et al., 2016).

2.4. Jackfruit (ArtocarpusHeterophyllus):

The researchers wanted to investigate the phytochemical composition, antioxidant activity, and antibacterial activity of extracts from three jackfruit fruit components, as well as other parameters in this study (peel, fiber, and core). The flavonoids were tested at 28.5512.42 mg/g, 35.49.53 mg/g, and 36.232.54 mg/g, while the phenolics were measured at 17.075.16 mg/g, 23.284.73 mg/g, and 15.683.74 mg/g. Following homogenization, distilled water extracts had the highest tannin concentration, with 10.822.63 mg/g, 10.394.10 mg/g, and 10.521.05 mg/g for peels, fiber, and core, respectively. With 61.5129.90% and 51.0633.39%, respectively, the core and fiber extracts showed the highest 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging activity. With a DPPH radical scavenging activity of 61.5129.90% and a reducing power assay of 7.944.56 mg/mL, methanol fiber extracts showed the best antioxidant activity. Ethyl acetate extracts demonstrated the greatest antibacterial action against Xanthomonas axonopodispv. manihotis (Xam) (Adan et al., 2020).

2.5. Mango (Mangifera Indica):

Mangoes are tropical fruit native to India, which is the world's biggest grower. Mango is a seasonal fruit that is made into many products such as puree, leather, nectar, pickles, canned slices, and pickles, all of which are widely consumed across the world (Ajila, C. M., et. al., 2007). Various antioxidant models, such as reducing power activity, DPPH free radical scavenging activity, soybean lipoxygenase inhibition, and iron-induced lipid peroxidation of liver microsomes, were used to investigate the antioxidant activity of ripe and raw mango peels in acetone extract. The IC50 values were found to be between 1.39 and 5.24 g of gallic acid equivalents. The acetone extract of mango peel contained polyphenols, anthocyanins, and carotenoids, according to phytochemical analysis (Kim et al., 2010).

2.6. Pineapple (AnanasComosus):

The antibacterial effectiveness of pineapple peel extract against a range of plant and animal illnesses was investigated. Antimicrobial activity was determined based on the inhibition zone produced around the wells, which was measured in millimeters (mm). Xanthomonas, Bacillus subtilis, Azotobacter, Pseudomonas, and Klebsiella pathogenic bacteria were tested using pineapple peel extracts. The maximum zone of inhibition (27mm) was detected in pineapple peel extract dissolved in ethanol against Klebsiella, and the lowest was recorded in pineapple peel extract dissolved in ethanol against Bacillus subtilis (17 mm). All of the test pathogens were inhibited the most by the pineapple peel sample dissolved in ethanol. In comparison to ethanol extract samples, methanol extract samples showed a lower zone of inhibition in all test pathogens. When the ethanol and methanol extracts were combined and evaluated separately against pathogenic bacteria, they exhibited the same maximum or equal zone of inhibition as the individual samples (Gunvantrao et al., 2016).

2.7. Grapes (VitisVinifera):

B. cereus and S. aureus ATCC 21293 showed the most inhibition, whereas E. faecalis showed the least. Positive control antibiotics (Ciprofloxacin) inhibited each isolates the most, except for S. aureus ATCC 21293 and B. cereus, which had stronger inhibition than Ciprofloxacin therapy (Okunowo et. al., 2013). Grapes are high in phenolics, flavonoids, and resveratrol, all of which are thought to contribute to their health advantages (Yang et al., 2009). Grape seeds are a complex matrix containing 40% fiber,11% protein, 16% oil, and 7% complex phenols such as tannins. Monomers, dimers, trimers, oligomers, and polymers, as well as flavonoids, may all be found in grape seeds. (positive)-catechins, (negative)-epicatechin, and (negative)-epicatechin-3-O-gallate are among the monomeric molecules (Ma and Zhang, H., 2017).

2.8. Pomegranate (PunicaGranatum):

Pomegranates are only found in Asia and the Middle East. Western scientists have shown little interest in this tree, but the antioxidant molecules in pomegranate fruit, such as tannins and flavonoids, have recently piqued the curiosity of many academics. These phenolic compounds are responsible for their amazing healing powers. (Adhami et al., 2009). Using both in-vitro agar diffusion and in-situ approaches, the antibacterial activity of various extracts produced from pomegranate fruit peels was evaluated against many food-borne pathogens. An 80 % methanolic extract of peels was shown to be a potent inhibitor of Yersinia enterocolitica, Listeria monocytogenes, Staphylococcus aureus, and Escherichia coli. The presence of active inhibitors in peels, including phenolics and flavonoids, was discovered in a phytochemical investigation (Al-Zoreky, 2009).

2.9. Apple (Malus Domestica):

After citrus, Vitis, and banana, apples are the fourth most important fruit crop on the planet. It is the most widely farmed and well-adapted temperate fruit crop species, spanning from high latitudes in the world where temperatures can reach –40 ℃to high elevations in the tropics where two crops can be grown in a single year (Farrokhi, et al., 2013). Apple peels from rome beauty, Idared, cortland, and golden delicious were compared to meat, flesh-peel combination components, and apple peels for phytochemical content and antioxidant activity. The peels contained the most overall phenolic and flavonoid content, followed by the flesh-peel combination, and finally the flesh. Apple peels' high phenolic content and antioxidant activity indicate that they are a good source of antioxidants and can provide health advantages when consumed (Wolfe and Liu, 2003).

2.10. Dragonfruit (HylocereusUndatus):

Maceration with ethanol 96 percent yielded red dragon fruit peel and pulp extract, as well as pathological isolates S. mutants. The well diffusion method was employed for the inhibition tests. The treatment began with the addition of 100 %, 50 %, 0.2 % chlorhexidine, and aquadest sterile to each of the wells, which were then incubated for 24 hours, and the results were measured using a digital caliper. After incubating the plates at 37 °C for 24 hours, the antibacterial activities were evaluated by the presence of inhibitory zones. According to the findings of the inhibition zone calculation, the positive control group had the largest inhibition zone (16.84 mm), followed by peel 100% (10.34 mm), peel 50% (8.57 mm), pulp 100% (6.79 mm), and pulp 50% (8.57 mm, 5.93 mm). The larger the inhibition zone diameter, the higher the concentration on the fruit's peel and pulp. The Kruskall-Walli’s test revealed a significant difference, while the Mann-Whitney test revealed a significant difference (Rahayu et al., 2019).

2.11. Lichi (Litchi Chinensis):

The phytochemical content and antioxidant activity of the peels of rome beauty, idared, cortland, and golden delicious apples were compared to the meat, flesh-peel combination components, and apple peels. The peels contained the most overall phenolic and flavonoid content, followed by the flesh-peel combination, and finally the flesh. Apple peels high phenolic content and antioxidant activity indicate that they are a good source of antioxidants and can provide health advantages when consumed. The aqueous extract of L. chinensis seeds showed moderate growth inhibition against Staphylococcus aureus, Streptococcus pyogenes, Bacillus subtilis, Escherichia coli, and Pseudomonas aeruginosa, according to Bhat and Al-daihan (2014). The results showed that L. chinensis had the strongest inhibitory action against S. pyogenes (MIC 15 0.55 mg/mL) (Ibrahim and Mohamed, 2015).

2.12. Jamun (Syzygiumcumini):

Jamun (Syzygiumcumini) is native to tropical America and Australia, but it can also be found in other tropical and subtropical locations around the world. This plant can be found throughout the Indian plains from the Himalayas to the south (Ayyanarand Subash-Babu, 2012). The antioxidant activity of the fruit peel was assessed using a variety of assays, including the DPPH radical-scavenging assay, the superoxide radical-scavenging assay based on photochemical reduction of nitroblue tetrazolium in the presence of a riboflavin light-NBT system, the hydroxyl radical-scavenging assay based on the benzoic acid hydroxylation method, and the lipid peroxidation assay using the assay was used to measure total antioxidant capacity by reducing Molybdenum (VI) to Molybdenum (V) and forming a green phosphate/Molybdenum (V) complex. There was a strong association between the concentration of the extract and the % inhibition of free radicals and lipid peroxidation in all of the various systems. The fruit peel's antioxidant properties were derived in part from antioxidant vitamins, phenolics or tannins, and anthocyanins found in the fruit (Banerjee et al., 2005).

3. ANTIMICROBIAL ACTIVITIES OF VEGETABLES:

3.1. Lemon (Citrus Lemon):

Lemon is a valuable medicinal plant of the Rutaceae family. It is grown primarily for its alkaloids, which have anti-cancer properties. The antibacterial capabilities of citrus peel oils are rather strong. (Dhanavade, et al., 2011). Antimicrobial activity was assessed using different solvents against microorganisms such as Pseudomonas aeruginosa NCIM 2036, which had a minimum inhibitory concentration of 1:20 in the presence of methanol, Salmonella typhimurium NCIM 5021, which had a minimum inhibitory concentration of 1:20 in the presence of acetone, and Micrococcus aureus NCIM 5021, which had a minimum inhibitory concentration of 1:20 GC/MS of lemon peel extract identified chemicals such as tetrazene and coumarin. It has also been discovered to have antioxidant properties (Guimarães et al., 2010).

3.2. Tori (Luffa Cylindrica):

Luffa cylindrica, often known as sponge gourd, loofa, vegetable sponge, bath sponge, or dishcloth gourd, is a subtropical plant in the Cucurbitaceae family. This plant is grown commercially in China, Korea, India, Japan, and Central America, where the warm summer temperatures of tropicals and the extended frost-free growing season of temperate climates are ideal for its growth (Partap et al., 2012). In liver lipid peroxidation generated by hydrogen peroxide, ferrous sulfate, and carbon tetrachloride, the antioxidative potential of Luffa cylindrica peel extract was investigated. The antioxidant impact was compared to a typical antioxidant, butylated hydroxy anisole. The results showed that all three types of hepatic lipid peroxidation, $FeSO_4$, H_2O_2, and CCl_4 were inhibited in a dose-dependent manner. Sponge plant Luffa cylindrica Polyphenols and flavonoids found in the peels of Luffa cylindrica have been found to reduce lipid peroxidation (Dixit and Kar, 2009).

3.3. Eggplant (Solanum Melongena):

Antibacterial activity in the anthocyanin-rich sample was assessed using disc diffusion and micro-well dilution tests (which included high levels of both anthocyanin and phenolic content). The antibiotics gentamicin and rifampin were used as positive controls. (Akhbari et al., 2019). gram-negative Enterobacter cloacae (ATCC—American type culture collection 35030), Escherichia coli (ATCC 35210), and Salmonella Typhimurium (ATCC 13311) and gram-positive (Listeria monocytogenes) (NCTC—National collection of type cultures 7973) bacteria strains were used to test the antibacterial activity (ATCC 6538). The minimum inhibitory (MIC) and minimum bactericidal (MBC) concentrations were used to calculate antimicrobial potential; the microdilution technique was used, and the findings were reported in mg/mL. Aspergillus fumigatus (ATCC 1022), Aspergillus niger (ATCC 6275), Aspergillus versicolor (ATCC 11730), Penicillium funiculosum (ATCC 36839), Penicillium ochrochloron (ATCC 9112), and Trichoderma viride (IAM 5061) strains were utilized to test antifungal activity. A modified microdilution method was used to determine the minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC), with the results given in mg/mL (Carocho et al., 2015).

3.4. Beetroot (Beta Vulgaris):

Under all extraction solvents, the beetroot peel had a greater number of total polyphenols, total flavonoids, and reducing power activity. The maximum chlorogenic acid (78.24 mg/100 g) was extracted from the dried beetroot peel using a 50 % v/v mixture of methanol and water, while the most notable phenolic compound (42.52 mg/100 g) in the beetroot peel methanolic extract was 1,2- dihydroxybenzene. The 50 % methanolic extract of both peel and pulp had the best antibacterial and anticandidal properties. The quantity of total phenolics in the extract was spectrophotometrically determined using the Folin–Ciocalteu method (Singleton et al., 1999). To assess the flavonoid content, a colorimetric technique was developed (Zhishen et al., 1999). A UV-1800 spectrophotometer was used to determine the amount of betalains (betacyanins and betaxanthins) in the extract (Vulić et al., 2013).

The characteristics of beetroot were dramatically affected by all extraction solvents. The 50 % methanolic extract has the best bioactive properties among the solvents. In comparison to the beetroot peel, the beetroot pulp has lesser antioxidant activities. Only the beetroot peel water extract and the beetroot peel and pulp 50 % methanolic extract contained chlorogenic acid, which was absent from all other extracts. The extracts were bactericidal against all pathogens tested, with the extract prepared in 50% methanol for both peel and pulp having the most activity. Inhibition zones are larger in gram-negative bacteria than in gram-positive bacteria. The extracts had MICs of 4 to 8 mg/mL against bacterial and fungal infections. (Salamatullah et al., 2021).

3.5. Carrot (Daucus Carota):

Hot water extraction followed by isopropanol precipitation yielded the water-soluble crude polysaccharides from the aqueous extracts of the carrot peels by-product (CWSP). A response surface method was used to enhance polysaccharide extraction. To get the best possible combination of extraction duration (X1: 60–100 min), the ratio of water to raw material (X2: 15:1–25:1, v/w), extraction temperature (X3: 60–80 °C), and extraction cycle (X4: 1–3 times), a three-level, four-variable Box-Behnken design was used (Ghazala et al., 2015).

Four gram-negative (E. coli, S. enterica, K. pneumoniae, and Enterobacter sp.) and three gram-positive (E. coli, S. enterica, K. pneumoniae, and Enterobacter sp.) strains were used to test the CWSP's (S. aureus, E. faecalis, and M. luteus). The diameter of the clear zone of growth inhibition was used to determine antibacterial activity. CWSP demonstrated antibacterial efficacy against many microorganisms at the specified concentration (200 mg/dry weight/ml). At a concentration of 100 mg/ml, pumpkin polysaccharides demonstrated strong antibacterial activity against B. subtilis, S. aureus, and E. coli (Qian, 2014). Similarly, pumpkin polysaccharides have been shown to efficiently prevent the growth of E. coli (Quanhong and Caili, 2005). Dendrobium hookerianum polysaccharides inhibited the growth of S. aureus, E. coli, and B. subtilis strains, but D. Officinale polysaccharides only inhibited the growth of E. coli and B. subtilis strains (Xing et al., 2013).

3.6. Tomato (Solanum Lycopersicum):

Carotenoids, polyphenols, tocopherols, terpenes, and sterols have been discovered among the phytochemicals contained in industrial tomatoes and their by-products. These bioactive chemicals appear to be resistant to industrial processes (Trif et al., 2019; Calinoiu and Vodnar, 2018 & 2019; Strati and Oreopoulos, 2014). Tomato peels include lycopene, carotene, lutein, and other phenolic compounds, making them a natural source of bioactive molecules in the food industry, especially for bioactive wrapping. Furthermore, methanolic extracts of tomato peels were found to have antibacterial action against Staphylococcus aureus and Bacillus subtilis (Szabo et al., 2019).

3.7. Cabbage (Brassica Oleracea):

Toluene and chloroform extracts had the highest efficacy against the studied bacteria, followed by dichloromethane, ethyl ether, ethanol, and methanol extracts. The WC toluene extract was most active against only bacterial strains with a zone of inhibition (14–16 mm). The chloroform extract, on the other hand, was active against all bacteria tested, with inhibition zones ranging from 9 to 15 mm, with ATCC 35150 (15 mm) having the highest zone of inhibition (14 mm). The inhibition zone of KCTC 6145 was the smallest (8.50 mm). The inclusion of flavonoid and phenolic content in the extract may be responsible for its antibacterial effect (Rubab et al., 2020).

Isolated cabbage endophytic bacteria (CCEB) were investigated for antibacterial efficacy against food-borne illnesses. Bacillus sp. (TPL08), Bacillus amyloliquefaciens (TPL13), Bacillus pumilus (SSL15, HNL12), and Bacillus subtilis (SSL16, HNL01, HNL10) were among the bacterial isolates from the leaf samples that exhibited excellent antibacterial activity against the majority of the food-borne diseases examined. Bacillus sp. (TPL08), Bacillus subtilis (SSL16, HNL10), and Citreum (TPL16) all showed antibacterial activity against E. coli., P. aeruginosa, S. enterica, S. enteritidis, S. typhimurium, B. cereus, L. ivanovii, and S. aureus, in particular, showed the highest growth inhibition of 56.91%, 56.95 %, 62.2%, 55.91%, 62 %, 61.0%, and 57.5%, respectively, in HN leaf samples. All pathogens evaluated showed less than 10% growth inhibition in SS and TG leaf samples (Haque et al., 2015).

3.8. Ginger (ZingiberOfficinale):

Ginger has antibacterial properties against a variety of gram-positive and gram-negative bacteria, including E. coli, Staphylococcus aureus, Staphylococcus epidermidis, Klebsiella pneumoniae, Enterococcus faecalis, Salmonella typhi, Salmonella typhimurium, Pseudomonas aeruginosa, Proteus sp., Bacillus cereus, Bacillus subtilis, Bacillus megaterium and Streptococcus faecalis (Abdalla and Abdallah, 2018). Pseudomonas aeruginosa and Bacillus subtilis were both inhibited by the ethanol extracts, with zones of inhibition ranging from 7 0.4 mm at 6.25 mg/ml to 23.0 3.2 mm at 100 mg/ml and MICs ranging from 6.25 mg/ml to 12.5 mg/ml against Bacillus subtilis and Candida albicans. At low doses, the aqueous extract had very little activity, but at greater concentrations, it had a lot of it (Lucky et al., 2017).

3.9. Wax Gourd (BenincasaHispida):

Wax gourd (Benincasahispida) is endemic to Malaysia, although it can also be found in the mountains (4000 feet) of India, Burma, and Ceylon. It is one of India's most well-known vegetables (Ghosh and Baghel, 2011). Various sections of the wax gourd were tested for antioxidant activity utilizing ferric reducing antioxidant potential, 2,2-diphenyl-1-picryl hydroxyl, and carotene bleaching tests. Their total phenolic content was also determined using the Folin-Ciocalteu reagent assay. According to the FRAP experiment, the antioxidant activity of peel extract was 21.73 mM Trolox equivalent /g extract weight. The EC50 results for the DPPH assay were 392.21mcg/ml, and the EC50 values for the carotene bleaching assay were 34.39 percent. Using the disc diffusion method, the antibacterial activity of the extracts was tested against six gram-positive and seven gram-negative bacteria, one yeast, and two molds. When compared to gram-positive bacteria, the antibacterial activity of the extracts inhibited gram-negative bacteria (Salmonella typhimurium, Pseudomonas aeruginosa, Proteus vulgaris, Serratia liquefaciens, Cronobactermuytjens, Shigella boydii, and Serratia marcescens) (Abdullah et al., 2012).

3.10. Potato (Solanum Tuberosum):

Antioxidant properties have been discovered in potato peels. In a study, freeze-dried extracts of potato peels were tested for antioxidant effectiveness in various in-vitro systems, including lipid peroxidation in rat liver homogenate, radical scavenging, reducing power, and ferric ion chelation. Aqueous extract of freeze-dried potato peel powder inhibited lipid peroxidation in rat liver homogenate caused by the FeCl2, H2O2, Fruits, and vegetables are widely employed in food production in India. Depending on their nature and cooking procedure, these products are consumed uncooked, half-cooked, or fully cooked, with or without peels. If these peel remnants are not further handled, they become garbage. But different studies conducted on peels revealed the presence of important metabolites, using the polar and carbohydrates, carotenoids, proteins, steroids, flavonoids, alkaloids, tannins, saponins, triterpenoids, and phlobatannin, coumarin, and other nonpolar solvent systems. These extracts are also having potent antimicrobial effects on enteric human pathogens. Various phytochemical elements have antibacterial, antioxidant, antiproliferative, anti-inflammatory properties, etc. The current study examines the medicinal potential of Indian regional fruits and vegetable peels. O2, system and inhibited deoxyribose oxidation with a strong concentration-dependent suppression. In the DPPH radical test technique, potato peel extract also showed significant antioxidant activity. It also demonstrated antioxidant activity in a variety of systems, including superoxide scavenging, reducing power, and ferrous ion chelating ability. The antioxidant efficacy of a freeze-dried extract of potato peel was established based on these findings (Singh and Rajini, 2004).

3.11. Onion (Allium Cepa):

The current research looks at the antibacterial properties of Allium cepa (onion) extract against various bacteria (Staphylococcus aureus). In comparison to the aqueous suspension studied in this work, the antibacterial activities of the methanolic solution demonstrate a high effect at all concentrations. With an inhibitory zone of 29 mm, it was shown that using a 1000 g/ml methanolic suspension of Allium cepa was more effective than the other doses. The other concentrations of the methanolic suspension of Allium cepa (1, 10, and 100 g/ml) resulted in inhibitory zones of 24, 25, and 26 mm, respectively (Eltaweel, 2013).

The antibacterial activity of onion skin and edible portion extracts against B. cereus, E. coli, and P. fluorescens was varied. In general, skin extracts had much stronger inhibitory effects against the three bacteria strains studied than edible component extracts, and the inhibitory activity increased as the content of extracts increased. The growth of B. cereus is strongly inhibited by all of the skin extracts tested at various doses. Even at low concentrations of extracts (5 g/100 mL), inhibition is 83.3±3.1 percent or greater, except for 35 percent ethanol extract, which has the lowest inhibition (52.1±1.3 percent). Edible component extracts, on the other hand, show reasonably robust inhibition activities against B. cereus only at doses of 20 g/100mL, with weak or no inhibition activity at lower concentrations. The 60 percent acetone extract is an outlier, with inhibitory activity ranging from 63.3±3.8 to 98.4±0.4 percent in the concentration range of extract from 5 to 20 g/100mL. The 35 percent ethanol extract had the lowest activity once again (Škerget et al., 2009).

3.12. Ridged Gourd (Luffa Acutangula):

Staphylococcus aureus, Staphylococcus pneumonia, Streptococcus pyogenes, Klebsiella pneumonia, Candida albicans, and Candida tropicalis SSswere tested for antibacterial activity of the dried leaves extract. The maximum zone of inhibition for Luffa acutangula leaves alcoholic extracts was obtained against Streptococcus pyogenes (20.0±0.35 mm), followed by Candida albicans (18.0±0.65 mm). Streptococcus pneumoniae and Streptococcus pyogenes were found to have the lowest combined MIC and MBC values. Candida albicans were found to have the lowest combined MIC and MFC values (Al-Snafi, 2019).

Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, and Candida albicans were tested for antibacterial activity using an ethanolic extract of Luffa acutangula (Harfiani and Pradana, 2021).

CONCLUSION:

The dangers of synthetic antioxidants and antimicrobial drugs, as well as the increasing growth of multidrug-resistant microorganisms, have reemerged the quest for natural antioxidants and antimicrobials. Several research indicates that the peels of many Indian fruits and vegetables have been discovered to have significant potential as a source of newer, more effective, safer, and superior phytochemicals that are responsible for major activities such as antioxidants and antibacterial.

Reference:

Abdalla, W. E., & Abdallah, E. M. (2018). Antibacterial activity of ginger (ZingiberOfficinaleRosc.) rhizome: A mini review. Int J Pharmacogn Chinese Med, 2, 000142.

Abdullah, N., Wan Saidatul, S. W. K., Samicho, Z., Aziman, N., &Zulkifli, K. S. (2012). Evaluation of in-vitro antioxidant and antimicrobial activities of the various parts of Benincasahispida (No. RESEARCH).

Adan, A. A., Ojwang, R. A., Muge, E. K., Mwanza, B. K., &Nyaboga, E. N. (2020). Phytochemical composition and essential mineral profile, antioxidant and antimicrobial potential of unutilized parts of jackfruit. Food Res, 4(4), 1125-1134.

Adhami, V. M., Khan, N., & Mukhtar, H. (2009). Cancer chemoprevention by pomegranate: laboratory and clinical evidence. Nutrition and cancer, 61(6), 811-815.

Ajila, C. M., Naidu, K. A., Bhat, S. G., & Rao, U. P. (2007). Bioactive compounds and antioxidant potential of mango peel extract. Food chemistry, 105(3), 982-988.

Akhbari, M., Kord, R., Jafari Nodooshan, S., &Hamedi, S. (2019). Analysis and evaluation of the antimicrobial and anticancer activities of the essential oil isolated from Foeniculum vulgare from Hamedan, Iran. Natural product research, 33(11), 1629-1632.

Alorkpa, E. J., Boadi, N. O., Badu, M., &Saah, S. A. (2016). Phytochemical screening, antimicrobial and antioxidant properties of assorted Carica papaya leaves in Ghana. Journal of Medicinal Plants Studies, 4(6), 193-198.

Al-Snafi, A. E. (2019). A review on Luffa acutangula: A potential

Al-Zoreky, N. S. (2009). Antimicrobial activity of pomegranate (Punicagranatum L.) fruit peels. International journal of food microbiology, 134(3), 244-248.

Aune, D., Giovannucci, E., Boffetta, P., Fadnes, L. T., Keum, N., Norat, T., ... &Tonstad, S. (2017). Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality—a systematic review and dose-response meta-analysis of prospective studies. International journal of epidemiology, 46(3), 1029-1056.

Ayyanar, M., & Subash-Babu, P. (2012). Syzygiumcumini (L.) Skeels: A review of its phytochemical constituents and traditional uses. Asian Pacific journal of tropical biomedicine, 2(3), 240-246.

Banerjee, A., Dasgupta, N., & De, B. (2005). In vitro study of antioxidant activity of Syzygiumcumini fruit. Food chemistry, 90(4), 727-733.

Calinoiu, L. F., &Vodnar, D. C. (2018). Whole grains and phenolic acids: A review on bioactivity, functionality, health benefits and bioavailability. Nutrients, 10(11), 1615.

Calinoiu, L. F., &Vodnar, D. C. (2019). Thermal processing for the release of phenolic compounds from wheat and oat bran. Biomolecules, 10(1), 21.

Carocho, M., Barros, L., Calhelha, R. C., Ćirić, A., Soković, M., Santos-Buelga, C., ... & Ferreira, I. C. (2015). Melissa officinalis L. decoctions as functional beverages: a bioactive approach and chemical characterization. Food & function, 6(7), 2240-2248.

Cerezal, P., & Duarte, G. (2005). Use of skin in the elaboration of concentrated products of cactus pear (Opuntia ficus-indica (L.) Miller). Journal of the Professional Association for Cactus Development, 7, 61-83.

Chabuck, Z. A. G., Al-Charrakh, A. H., Hindi, N. K. K., & Hindi, S. K. K. (2013). Antimicrobial effect of aqueous banana peel extract, Iraq. Res. Gate. Pharm. Sci, 1, 73-5.

Chan, C. L., Gan, R. Y., Shah, N. P., &Corke, H. (2018). Enhancing antioxidant capacity of Lactobacillus acidophilus-fermented milk fortified with pomegranate peel extracts. Food bioscience, 26, 185-192.

Choudhury, S., Shankar, B., Aleksandrowicz, L., Tak, M., Green, R., Harris, F., ... &Dangour, A. (2020). What underlies inadequate and unequal fruit and vegetable consumption in India? An exploratory analysis. Global Food Security, 24, 100332.

Coelho, E. M., de Souza, M. E. A. O., Corrêa, L. C., Viana, A. C., de Azevêdo, L. C., & dos Santos Lima, M. (2019). Bioactive compounds and antioxidant activity of mango peel liqueurs (Mangiferaindica L.) produced by different methods of maceration. Antioxidants, 8(4), 102.

de MoraesCrizel, T., Jablonski, A., de Oliveira Rios, A., Rech, R., &Flôres, S. H. (2013). Dietary fiber from orange byproducts as a potential fat replacer. LWT-Food Science and Technology, 53(1), 9-14.

Dhanavade, M. J., Jalkute, C. B., Ghosh, J. S., &Sonawane, K. D. (2011). Study antimicrobial activity of lemon (Citrus lemon L.) peel extract. British Journal of pharmacology and Toxicology, 2(3), 119-122.

Dixit, Y., & Kar, A. (2009). Antioxidative activity of some vegetable peels determined in vitro by inducing liver lipid peroxidation. Food research international, 42(9), 1351-1354.

Dwivedi, R., & Pradhan, J. (2017). Does equity in healthcare spending exist among Indian states? Explaining regional variations from national sample survey data. International journal for equity in health, 16(1), 1-12.

El-Desoukey, R. M., Saleh, A. S. B., &Alhowamil, H. F. (2018). The phytochemical and antimicrobial effect of Citrus sinensis (Orange) peel powder extracts on some animal pathogens as eco-friendly. EC Microbiology, 14(6), 312-318

Eltaweel, M. (2013, December). Assessment of antimicrobial activity of onion extract (Allium cepa) on Staphylococcus aureus; in vitro study. In International Conference on Chemical, Agricultural and Medical Sciences (Vol. 1, pp. 60-2).

Evans, W. C. (2002). Trease and Evans Pharmacognosy. 15th (ed.) Saunders Publishers, an imprint of Elsevier Science Ltd.

Farrokhi, J., Darvishzadeh, R., HatamiMaleki, H., &Naseri, L. (2013). Evaluation of Iranian native apple (Malus x domesticaBorkh) germplasm using biochemical and morphological characteristics. Agriculturae Conspectus Scientificus, 78(4), 307-313.

Ghazala, I., Sila, A., Frikha, F., Driss, D., Ellouz-Chaabouni, S., &Haddar, A. (2015). Antioxidant and antimicrobial properties of water-soluble polysaccharide extracted from carrot peels by-products. Journal of Food Science and Technology, 52(11), 6953-6965.

Ghosh, K., &Baghel, M. S. (2011). A PHARMACOGNOSTICAL & PHYSIOCHEMICAL STUDY OF BENINCASA HISPIDA WITH AYURVEDIC REVIEW. International Journal of Research in Ayurveda & Pharmacy, 2(6).

Guimarães, R., Barros, L., Barreira, J. C., Sousa, M. J., Carvalho, A. M., & Ferreira, I. C. (2010). Targeting excessive free radicals with peels and juices of citrus fruits: grapefruit, lemon, lime and orange. Food and Chemical Toxicology, 48(1), 99-106.

Gunvantrao, B. B., Bhausaheb, S. K., Ramrao, B. S., & Subhash, K. S. (2016). Antimicrobial activity and phytochemical analysis of orange (Citrus aurantium L.) and pineapple (Ananascomosus (L.) Merr.) peel extract. Ann. Phytomedicine, 5, 156-160.

Haque, M. A., Lee, J. H., & Cho, K. M. (2015). Endophytic bacterial diversity in Korean kimchi made of Chinese cabbage leaves and their antimicrobial activity against pathogens. Food Control, 56, 24-33.

Harfiani, E., &Pradana, D. C. (2021, April). Literature Review: Potential Pharmacological Activity of Luffa acutangula L. Roxb. In IOP Conference Series: Earth and Environmental Science (Vol. 755, No. 1, p. 012065). IOP Publishing.

Hikal, W. M., & Said-Al Ahl, H. A. (2021). Banana Peels as Possible Antioxidant and Antimicrobial Agents. Asian Journal of Research and Review in Agriculture, 35-45.

Ibrahim, S. R., & Mohamed, G. A. (2015). Litchi chinensis: medicinal uses, phytochemistry, and pharmacology. Journal of Ethnopharmacology, 174, 492-513.

Kim, H., Moon, J. Y., Kim, H., Lee, D. S., Cho, M., Choi, H. K., ... & Cho, S. K. (2010). Antioxidant and antiproliferative activities of mango (Mangiferaindica L.) flesh and peel. Food Chemistry, 121(2), 429-436.

Laura, A., Alvarez-Parrilla, E., & González-Aguilar, G. A. (Eds.). (2009). Fruit and vegetable phytochemicals: chemistry, nutritional value and stability. John Wiley & Sons.

Liu, R. H. (2004). Potential synergy of phytochemicals in cancer prevention: mechanism of action. The Journal of nutrition, 134(12), 3479S-3485S.

Lucky, E., Igbinosa, O. E., &Jonahan, I. (2017). Antimicrobial activity of Zingiberofficinale against multidrug resistant microbial isolates. Health Sciences Research, 4(6), 76-81.

Lydia, E., John, S., Mohammed, R., &Sivapriya, T. (2016). Investigation on the Phytochemicals present in the Fruit peel of Carica papaya and evaluation of its Antioxidant and Antimicrobial property. Research Journal of Pharmacognosy and Phytochemistry, 8(4), 217.

Ma, Z. F., & Zhang, H. (2017). Phytochemical constituents, health benefits, and industrial applications of grape seeds: A mini-review. Antioxidants, 6(3), 71.

MCKEE, M. (2004). Low fruit and vegetable consumption. Comparative Quantification of health risks, 597.

Meenakshi, J. V. (2016). Trends and patterns in the triple burden of malnutrition in India. Agricultural Economics, 47(S1), 115-134.

Mittal, S. (2007). Can horticulture be a success story for India? (No. 197). Working paper.

National Research Council. (1989). Diet and health: implications for reducing chronic disease risk.

New, S. A. (2003). Intake of fruit and vegetables: implications for bone health. Proceedings of the Nutrition Society, 62(4), 889-899.

Okunowo, W. O., Oyedeji, O., Afolabi, L. O., &Matanmi, E. (2013). Essential oil of grapefruit (Citrus paradisi) peels and its antimicrobial activities.

Pallauf, K., Rivas-Gonzalo, J. C., Del Castillo, M. D., Cano, M. P., & de Pascual-Teresa, S. (2008). Characterization of the antioxidant composition of strawberry tree (Arbutus unedo L.) fruits. Journal of Food Composition and Analysis, 21(4), 273-281.

Parashar, S., Sharma, H., & Garg, M. (2014). Antimicrobial and antioxidant activities of fruits and vegetable peels: A review. Journal of Pharmacognosy and Phytochemistry, 3(1).

Partap, S., Kumar, A., Sharma, N. K., & Jha, K. K. (2012). Luffa Cylindrica: An important medicinal plant. Journal of Natural Product and Plant Resources, 2(1), 127-134.

Percival, S. S., Talcott, S. T., Chin, S. T., Mallak, A. C., Lounds-Singleton, A., & Pettit-Moore, J. (2006). Neoplastic transformation of BALB/3T3 cells and cell cycle of HL-60 cells are inhibited by mango (Mangiferaindica L.) juice and mango juice extracts. The Journal of Nutrition, 136(5), 1300-1304.

Peschel, W., Sánchez-Rabaneda, F., Diekmann, W., Plescher, A., Gartzía, I., Jiménez, D., ... &Codina, C. (2006). An industrial approach in the search of natural antioxidants from vegetable and fruit wastes. Food Chemistry, 97(1), 137-150.

Prabhakaran, D., Jeemon, P., Sharma, M., Roth, G. A., Johnson, C., Harikrishnan, S., ... &Dandona, L. (2018). The changing patterns of cardiovascular diseases and their risk factors in the states of India: The Global Burden of Disease Study 1990–2016. The Lancet Global Health, 6(12), e1339-e1351.

Qian, Z. G. (2014). Cellulase-assisted extraction of polysaccharides from Cucurbita moschata and their antibacterial activity. Carbohydrate polymers, 101, 432-434.

Quanhong, L., &Caili, F. (2005). Application of response surface methodology for extraction optimization of germinant pumpkin seeds protein. Food chemistry, 92(4), 701-706.

Quattrucci, A., Ovidi, E., Tiezzi, A., Vinciguerra, V., &Balestra, G. M. (2013). Biological control of tomato bacterial speck using Punicagranatum fruit peel extract. Crop protection, 46, 18-22.

Rahayu, Y. C., Sabir, A. R. D. O., &Setyorini, D. Y. A. H. (2019). Antibacterial Activity of Red Dragon Fruit Extract (Hylocereuspolyrhizus) on Streptococcus mutans. International Journal of Applied Pharmaceutics, 11(4), 60-63.

Rechkemmer, G. (2001). FunktionelleLebensmittel-Zukunft der Ernahrungoder Marketing-Strategie. Molkerei Zeitung Welt DerMilch, 55(12/13), S-332.

Reddy, K. S., Shah, B., Varghese, C., &Ramadoss, A. (2005). Responding to the threat of chronic diseases in India. The Lancet, 366(9498), 1744-1749.

Rubab, M., Chelliah, R., Saravanakumar, K., Kim, J. R., Yoo, D., Wang, M. H., & Oh, D. H. (2020). Phytochemical characterization, and antioxidant and antimicrobial activities of white cabbage extract on the quality and shelf life of raw beef during refrigerated storage. RSC Advances, 10(68), 41430-41442.

Salamatullah, A. M., Hayat, K., Alkaltham, M. S., Ahmed, M. A., Arzoo, S., Husain, F. M., ... & Al-Harbi, L. N. (2021). Bioactive and Antimicrobial Properties of Oven-Dried Beetroot (Pulp and Peel) Using Different Solvents. Processes, 9(4), 588.

Shankar, B., Agrawal, S., Beaudreault, A. R., Avula, L., Martorell, R., Osendarp, S., ... & Mclean, M. S. (2017). Dietary and nutritional change in India: implications for strategies, policies, and interventions. Annals of the New York Academy of Sciences, 1395(1), 49-59.

Shehata, M. G., Awad, T. S., Asker, D., El Sohaimy, S. A., Abd El-Aziz, N. M., & Youssef, M. M. (2021). Antioxidant and antimicrobial activities and UPLC-ESI-MS/MS polyphenolic profile of sweet orange peel extracts. Current research in food science, 4, 326-335.

Singh, N., & Rajini, P. S. (2004). Free radical scavenging activity of an aqueous extract of potato peel. Food chemistry, 85(4), 611-616.

Singleton, V. L., Orthofer, R., &Lamuela-Raventós, R. M. (1999). [14] Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. In Methods in enzymology (Vol. 299, pp. 152-178). Academic press.

Škerget, M., Majhenič, L., Bezjak, M., &Knez, Ž. (2009). Antioxidant, radical scavenging and antimicrobial activities of red onion (Allium cepa L) skin and edible part extracts. Chemical and Biochemical Engineering Quarterly, 23(4), 435-444.

Sofowora, A. (1993). Screening plants for bioactive agents. Medicinal Plants and Traditional Medicinal in Africa. 2nd Ed. Spectrum Books Ltd, Sunshine House, Ibadan, Nigeria, 134-156.

Stavric, B. (1994). Role of chemoprevention in human diet. Clinical biochemistry, 27(5), 319-332.

Strati, I. F., &Oreopoulou, V. (2014). Recovery of carotenoids from tomato processing by-products–a review. Food research international, 65, 311-321.

Szabo, K., Diaconeasa, Z., Cătoi, A. F., &Vodnar, D. C. (2019). Screening of ten tomato varieties processing waste for bioactive components and their related antioxidant and antimicrobial activities.

Temple, N. J. (2000). Antioxidants and disease: more questions than answers. Nutrition research, 20(3), 449-459.

Trif, M., Vodnar, D. C., Mitrea, L., Rusu, A. V., &Socol, C. T. (2019). Design and development of oleoresins rich in carotenoids coated microbeads. Coatings, 9(4), 235.

Vishnoi, R. (1979). Advanced Practical Chemistry, Vikas publication house PVT limited, Ghaziabad-India.

Vulić, J. J., Ćebović, T. N., Čanadanović, V. M., Ćetković, G. S., Djilas, S. M., Čanadanović-Brunet, J. M., ... &Tumbas, V. T. (2013). Antiradical, antimicrobial and cytotoxic activities of commercial beetroot pomace. Food & function, 4(5), 713-721.

Willett, W. C. (1994). Diet and health: what we should eat. Science, 264(5158), 532-537.

Willett, W. C. (1995). Diet, nutrition, and avoidable cancer. Environmental health perspectives, 103(suppl 8), 165-170.

Wolfe, K. L., & Liu, R. H. (2003). Apple peels as a value-added food ingredient. Journal of Agricultural and Food Chemistry, 51(6), 1676-1683.

Xing, X., Cui, S. W., Nie, S., Phillips, G. O., Goff, H. D., & Wang, Q. (2013). A review of isolation process, structural characteristics, and bioactivities of water-soluble polysaccharides from Dendrobium plants. Bioactive Carbohydrates and Dietary Fiber, 1(2), 131-147.

Yang, J., Martinson, T. E., & Liu, R. H. (2009). Phytochemical profiles and antioxidant activities of wine grapes. Food Chemistry, 116(1), 332-339.

Zambrano-Zaragoza, M. L., González-Reza, R., Mendoza-Muñoz, N., Miranda-Linares, V., Bernal-Couoh, T. F., Mendoza-Elvira, S., &Quintanar-Guerrero, D. (2018). Nanosystems in edible coatings: A novel strategy for food preservation. International journal of molecular sciences, 19(3), 705.

Zhishen, J., Mengcheng, T., &Jianming, W. (1999). The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food chemistry, 64(4), 555-559.