Research Article

The Environmentally Friendly Phytochemical, Antibacterial and Antifungal Activity of Plum (*Prunus Domestica* L.) Peel Extracts on Various Animal Microbes in Saudi Arabia

Fawziah M. Albarakaty*

Department of Biology, Faculty of Applied Science, Umm Al-Qura University, Saudi Arabia, Makkah, Al Mukarramah, P.O. Box: 715, Saudi Arabia.

Abstract | **Background:** Numerous plant species have observable effectiveness against bacterial and fungal diseases. Finding a novel antimicrobial chemical with few side consequences is one of the most crucial phases in microbiological research because microbial resistance to chemical antimicrobial is the prevalent crisis in the therapeutic community. **Objective:** Therefore, this work aims to ascertain which phytochemical components can be recycled and added to the diet of animals while also examining the antibacterial, antifungal efficacy of plum (*Prunus domestica L.*) peel extracts on certain crucial animal microbes. **Methodology**: The antibacterial activity of plum (*Prunus domestica L.*) peel extracts in hot and cold aqueous and ethanol extracts against specific medically significant pathogens isolated from cows and poultry farms were assessed. Additionally, the phytochemical composition of the aqueous and ethanol peel extracts was examined. **Results and conclusion**: According to the findings, the plum (*Prunus domestica L.*) peel extracts have alkaloids, flavonoids, tannins, and saponin chemicals. It is, therefore, possible to conclude that plum (*Prunus domestica L.*) peel extracts have great antibacterial action opposed to examined bacteria. Still, their antifungal action *opposed to Candida albicans* has not been identified. Further research is needed, both environmentally and scientifically, as reuse of fruit peels can be used as a fodder additive in the animal ration.

Keywords | Plum, Antimicrobial, *Prunus domestica L.*, Fruits peel, Plum peel, Animal.

Received | July 07, 2022; **Accepted** | August 18, 2022; **Published** | October 15, 2022
***Correspondence** | Fawziah M. Albarakaty, Department of Biology, Faculty of Applied Science,Umm Al-Qura University, Saudi Arabia, Makkah, Al Mukarramah, P.O. Box: 715, Saudi Arabia; **Email:** fmbarakati@uqu.edu.sa
Citation | Albarakaty FM (2022). The environmentally friendly phytochemical, antibacterial and antifungal activity of plum (*prunus domestica* l.) Peel extracts on various animal microbes in saudi arabia. Adv. Anim. Vet. Sci. 10(11): 2328-2334.
DOI | http://dx.doi.org/10.17582/journal.aavs/2022/10.11.2328.2334
ISSN (Online) | 2307-8316

INTRODUCTION

Fruits are well regarded for their capacity to improve health because it contains polyphenolic compounds. Plums (*Prunus domestica L.*) are a great supply of these elements and can play a vital role in preventing many diseases (Slavin & Lloyd, 2012, Noratto et al., 2009). Plums, in particular, are economically significant fruits that are well-liked by customers worldwide. This fruit is grown worldwide, and in the past ten years, more than 11 million tons have been produced (FAOSTAT, 2019). Since plums are a seasonal fruit, their harvest and fresh fruit supply periods are brief. Because plums cannot be eat fresh during the year, novel dried powder products produced using industrial drying procedures offer a solution for year-round use. Plum byproducts, entire fruit, or juices/concentrates can all be used to make powdered plums (Michalska et al., 2016, Michalska et al., 2017, Michalska et al., 2019).

Plums have a variety of phenolic chemicals that have biological consequences, such as antibacterial capabilities

(Valtierra et al., 2010, Khallouki et al., 2012, Hooshmand et al., 2015, Sójka et al., 2015, Kaulmann et al., 2016, Michalska et al., 2017).

These fruits' peel tissue may harbor bacteria or other microbes that are detrimental to human health, as well as significant quantities of pesticide residues (Bassett & McClure, 2008, Claeys et al., 2011). Despite these accusations, peel serves as a physical barrier among the surroundings and fruits, generating defense means in response to various stimuli like an accumulation of anthocyanins. Many healthy compounds, such as carotenoids, are more concentrated in fruit peels than in the flesh (Gonzalez et al., 2013, Li et al., 2019). This includes the peel of the plum.

The development of safe and natural antimicrobials for food items and the treatment of various illnesses have been prompted by antibiotic resistance in some foodborne pathogens and consumer reluctance to consume chemically treated commodities. Plum peel is one type of fruit peel that is thought to be a unique, accessible, effective, economical, environmentally friendly, and natural source of antioxidants and antibacterial agents (Yigit et al., 2009). A severe disposal issue is being addressed as efforts are made regularly to improve methods for the proper utilization of fruit and vegetable wastes. As the manufacturing is more and more mandatory to discover a substitute use for its remaining materials such as seed and peels, as a result of legislation and ecological factors, the reutilization of biological wastes is of great interest.

Whole plum fruit's phytochemical and antibacterial effects on human pathogens have already been studied. Up to this point, much hasn't been reported about the phytochemical and antibacterial effects of plum peel extract, particularly on animal pathogens. The current study's goals were to identify which phytochemicals can be recycled and added to animals' diets while also assessing the effectiveness of plum (*Prunus domestica L.*) peel extracts against several significant animal microbes.

MATERIALS AND METHODS

Materials and reagents

Besides media and antibiotics used in antimicrobial assays (Nutrient Agar, Potato Dextrose Agar, Mueller Hinton Agar, Peptone Water, Mc Farland BSS 0.5, Ciprofloxacin, tetracycline), reagents were obtained from Arkan Group and Fisher Chemical® for extraction (ethanol and distilled water) and phytochemical tests (Ferric Chloride, Glacial Acetic Acid, Alcoholic Potassium Hydroxide, Sulfuric Acid, chloroform, ammonia and Formaldehyde).

.**Plant material collection:** The plum (*Prunus domestica L.*) utilized in this study was purchased from a neighborhood Saudi Arabia markets in 2018.

Bacterial and fungal strains: The bacteria (*Staphylococcus aureus, Escherichia coli, Pseudomonas aerogenes, Bacillus cereus*) and fungi (*Candida albicans*) used in this investigation were obtained from a few infected specimens in chick and dairy farms, belonging to past studies.

Extraction methods

Aqueous extraction: Before being processed into a powder in a blender, the peel from the plum fruits was air-dried in the shade and rinsed three times with pure, distilled water. The infusion method was used to create cold aqueous extracts, whereas the decoction method was used to produce hot aqueous extracts. After that, kept at 4°C until it was needed (Shetty et al., 2008, Rupesh et al., 2011, Nayak et al., 2011, Rehab et al., 2022).

Solvent extraction: Ethanol was accustomed to extract the powdered plum peel then stored at 4°C until it was needed according to (Patil et al., 2009, Kanife, 2012, Rehab et al., 2022).

Phytochemical analysis

Alkaloids Test: Slight drops of the Marqus reagent, a mixture of 0.5 ml of formaldehyde and 5 ml of concentrate Sulfuric acid were mixed with 5 ml extract. Turbidity was used to find alkaloids (Ajoku et al., 2015, Rehab et al., 2022).

Saponins Test: Shake 3 ml of plum peel extracts and 10 ml of DW in a test tube briskly for 5 minutes. After that, wait 30 minutes to perceive the development of honeycomb bubbles in the test tube, which denotes the occurrence of saponins (Clarke, 1975, Cho et al., 2003, Rehab et al., 2022).

Tannins Test: A customized method was used to confirm the existence of tannins in the extracts. Three milliliters of the extract were mixed with little drops of the ferric chloride reagent. The emergence of a blue-black coloring served as a telltale sign that tannins were present (Kanife, 2012, Rehab et al., 2022).

Glygosides Test: 0.5g of crushed plum peel was combined with 2ml glacial acetic acid, one drop of ferric chloride solution, and 1 ml of concentrated H2SO4. A brown ring indicating that the glycosides was present (Antia et al., 2010, Rehab et al., 2022).

Flavonoids Test: The flavonoid test was conducted as follows: (Doss et al., 2011, Rehab et al., 2022). When 2ml of the extract was combined with Alcoholic KOH (0.5 mol.), a yellow color resulted, signifying the existence of flavo-

noids.

Sterols test: The extract got 1 ml of Sulfuric acid added to it. Sterols are present since a brownish-red ring appears in the connection line among the 2 liquids (Senhaji et al., 2005, Bankole et al., 2016, Rehab et al., 2022).

Anthraquinones Test: In a steam bath, 20 mL of chloroform and 1 gram of the powdered plum peel were warmed for 5 minutes. The mixture was then sieved as still warm and let to cool. Add an equal volume of a 10 percent ammonia solution to the rest. When the assortment was shaken, the brilliant pink color that appeared in the top coat of the assortment revealed that anthraquinones were present (Clarke, 1975, Cho et al., 2003, Rehab et al., 2022).

Antimicrobial screening

Pseudomonas aerogenes, Escherichia coli, Bacillus cereus, Staphylococcus aureus, and fungus strain *Candida albicans* obtained from farm animals were the focus of the investigation into the antimicrobial property of plum peel aqueous and solvent extracts (*C. albicans*) 1-2 X 107cfu/ml standard inoculums were produced by inoculating the examined samples on Petri plates including 20 ml of nutrient agar (for bacteria) and malt extract (for fungi) and standardizing using McFarland number 0.5. Drilled holes in the medium with a diameter of about 5 mm were filled with 50 l of extracts at a dilution of 5 mg/ml. At 37°C, all plates were incubated for 1-3 days. The inhibitory zone was measured in millimeters to establish the antibacterial effectiveness. The negative control for antibacterial and antifungal screening (10 ml of distilled water) and (Ciprofloxacin, tetracycline, cefpodoxime, Erythromycin, Gentamycin, Augmentin and Nystatin) were used as control positive (NCCLS, 1993, Rehab et al., 2022).

Determination of Minimum Inhibitory Concentration (MIC)

The bacteria vulnerable to plum peel were loaded addicted to sterilized peptone water and cultured at 37^0 C overnight. Then, 1 ml of the different extract dilutions was added to 9 ml of sterile peptone water and 0.3 ml of the culture of the research samples. Only peptone water and the extract were utilized as control. Before being examined for turbidity, the inoculation and control tubes for bacteria were incubated for 24 and 48 hours at 37^0 C. The lowest dilution that didn't cause turbidity was identified as the MIC (Adetitun et al., 2013, Rehab et al., 2022).

Determination of the Minimum Bactericidal (MBC).

Specimens from the MIC test tubes that did not exhibit turbidity were cultured onto solidified Nutrient Agar (Bacteria) plates and incubated at 37° C, after incubation. MBC was the lowly extract dilution that illustrated non progression on plates after 24 and 48 hr of incubation, indicating a bactericidal (Adetitun et al., 2013, Rehab et al., 2022).

RESULTS

Phytochemical analysis

Table 1 demonstrates that all extracts contained phytochemical components, with ethanol extract having the highest concentration of bioactive chemicals (Alkaloids, Saponins, Tannins, Glycosides, Sterols, Anthraquinones, and Flavonoids). In contrast, Anthraquinones, Tannins, and Saponins were absent from the aqueous extract. The information in Table (1) indicates that ethanol is the most excellent solvent for separating phytochemical components from the plum peel.

Table 1: The phytochemical constituents of plum peel (*Prunus domestica L).*

Plant extracts Phytochemical tests	*(Prunus domestica L)* peel Aqueous Extract	*(Prunus domestica L)* peel Ethanolic Extract
Alkaloids Test	±	+
Saponins Test	_	+
Tannins Test	_	+
Glygosides Test	±	+
Flavonoids Test	+	+
Sterols test	±	±
Anthraquinones test	_	±

*(+) = presence of phytochemical compound, (_) = absence of phytochemical compound), (±) = traces.

The antimicrobial assay, MIC, MBC

Comparing the tested animal microbial strains to the typical antibacterial, Tables (2, 3) demonstrate that all types of (*Prunus domestica L*) peel extracts have potent antibacterial activity. The most substantial antibacterial activity is in ethanol extract, followed by hot aqueous extracts. These results, together with those in Table 1, demonstrated that ethanol is the best solvent for producing peel extracts with strong antibacterial activities (*Prunus domestica L*). The ethanol and aqueous peel extracts from *Prunus domestica L.* have not demonstrated any antifungal activity against the strain of *Candida albicans* that was investigated.

DISCUSSION

For humans and animals, transmittable diseases persist to be one of the highest triggers of death and considerably influence economies and global health (Morens et al., 2004). The extensive and occasionally ineffective use of

Table 2: The antimicrobial activity of *Prunus domestica L* peel extracts against various animal microbes in (mm).

Microorganism		Extract			Control negative	Control positive					
		Organic extracts	Aqueous extract		Distelled water	Cipro floxacin (5µg)	Tetra-cycline (30µg)	Cefpo-doxime (10µg)	Genta-mycin (10µg)	Aug-mentin (30µg)	Eryth-romycin (ERY) (5µg)	Nystatin (30µg)
		Ethanol	Hot	Cold								
Gram negative	*Ps. aerogens*	20	15	10	0	31	19	-(R)	-(R)	-(R)	-(R)	0
	E coli	25	18	14	0	20	31	19	-(R)	-(R)	-(R)	0
Gram positive	*Bacillus*	27	21	17	0	34	17	20	25	14	22	0
	S. aureus	22	16	12	0	25	20	27	31	35	32	0
fungi	*C albicans*	0	0	0	0	0	0	0	0	0	0	16

Table 3: The MIC and MBC of the ethanol extract of the (*Prunus domestica L*) peel.

Bacterial strains	Concentrations of ethanol extract (mg/mL)							
	5	25	50	75	100	150	MIC	MBC
Ps.aerogens	++	++	+	_	_	_	75mg/ml	100mg/ml
E coli	+	+	_	_	_	_	50mg/ml	75mg/ml
Bacillus	+	_	_	_	_	_	25mg/ml	50mg/ml
S. aureus	++	++	+	_	_	_	75mg/ml	100mg/ml

*(++) = very turbid (high microbial growth), (+) = turbid (microbial growth), (_) = no turbidity (no microbial grwoth)

antibiotics in man and animals, that encourages the assortment of resistant pathogen strains because of selective pressure, has been linked to antibiotic resistance by contaminating water, soil, and food which are major genetic reservoirs for the propagation of resistance—antibiotic-resistant bacteria be able to as well spread across the environment (Zhang et al., 2016, Salaheen et al., 2017, Oniciuc et al., 2017, Diniz-Silva et al., 2017, Zwe et al., 2018).

This concern may make it more difficult to treat bacterial diseases and control environmental pathogens with currently available antimicrobials. Therefore, new antibiotics with diverse action modalities on infectious bacteria should be researched and urbanized to overcome the drawbacks or ineffectiveness of many current antimicrobials (Diniz-Silva et al., 2017, Caniça et al., 2018).

Recent researches have demonstrated that fruit phenolic-wealthy extracts or particular Phenolic compounds (PC) frequently present in fruits have antibacterial effects in addition to their well-known health-promoting qualities. According to these studies (Salaheen et al., 2016, Oniciuc et al., 2017, Diniz-Silva et al., 2017, Michailidis et al., 2019). PC present in fruits can be used to suppress pathogenic bacteria, especially that characteristic of antibiotic resistance.

The fruit's peel acts as a normal barrier among the outside surroundings and the fleshy tissue (Gonzalez et al., 2013). It offers mechanical support, guards against impacts from outside factors, and prevents dehydration and pathogen penetration (such as UV (Martin & Rose, 2013, Xu et al., 2019). The external, non-polar coat of the cuticle, which differ equally qualitatively and quantitatively amongst the many fruit species, gives the peel to the fruit all of these advantages (Sonia et al., 2014).

Peels from a variety of fruits and vegetables are typically regarded as squander and generally are discarded by us. However, various research investigations on peels found significant components that have the potential for therapeutic usage. Numerous substances with antioxidant, antibacterial, anti-inflammatory, anti-proliferative, and other properties have been identified from various peels (Sara et al., 2013).

Whole plum fruit's phytochemical and antibacterial effects on human pathogens have already been studied. Up to this point, much hasn't been reported about the phytochemical and antibacterial effects of plum peel extract, particularly on animal pathogens. The current study's goals were to identify which phytochemicals can be recycled and added to animals' diets while also assessing the effectiveness of plum (*Prunus domestica L.*) peel extracts against a number of vital animal microbes.

Fruits have received particular attention as sources of phenolic chemicals (Bi et al., 2019). Considering the earlier findings Table 1 shows that all peel extracts had phytochemical components, with ethanol extract having the highest concentration of bioactive compounds. Aqueous and ethanol extracts contained phytochemical constituents (Alkaloids, Saponins, Tannins, Glycosides, Sterols, Anthraquinones, and Flavonoids). In contrast, Anthraquinones, tannins, and saponins weren't present in the aqueous extract. According to Table 1, ethanol is the most effective solvent for removing phytochemicals from the plum peel. These results are in agreement with the samples' measured phytochemical concentrations from (Lenchyk, 2016, Miljić et al., 2016, Bonesi et al., 2018).

Since many plant species have antioxidant and antibacterial capabilities that enhance resistance to some diseases, they are being exploited as sources of nutritional supplements. This research is the first to examine the in vitro antimicrobial action of (*Prunus domestica L.*) peel extracts against certain significant animal microbes. Comparing the tested animal pathogenic strains to the standard antibacterial, Tables (2, 3) demonstrate that all types of (*Prunus domestica L*) peel extracts have potent antibacterial activity. The most substantial antibacterial activity is in ethanol extract, followed by hot aqueous extracts. These results, together with those in Table 1, demonstrated that ethanol is the best solvent for producing peel extracts with strong antibacterial activities (*Prunus domestica L*). The ethanol and aqueous peel extracts from *Prunus domestica L.* have not demonstrated any antifungal activity against the strain of *Candida albicans* that was investigated. These results are in agreement with the samples' measured phytochemical concentrations from (Belhadj & Marzouki, 2014, El-Beltagi et al., 2019).

Variations in the cell membrane components impact antibacterial behavior. (Sójka et al., 2015, Fattouch et al., 2019). So because the antibacterial action of Plum could vary according to the fruit component being studied, this pattern is not shown in this research. Additionally, the peel's drying process during extraction can alter the extract's polyphenolic content and the antibacterial response.

CONCLUSION

The recycling of fruit waste, particularly the peel, which contains active phytochemical components like tannins, saponins, and other substances that can act as antimicrobial agents, is one of the the majority inventive ways to produce novel and secure additives at little charge, especially in the human, animal, and plant nourishment plus in the pharmaceutical manufacturing. The plum (*Prunus domestica L.*) is an exciting model of a plant used in folk remedy for numerous years. Therefore, the plum (*Prunus domestica L.*) peels can be recycled as a free, efficient, and cost-effective antibacterial agent for humans and animals that are regarded as waste and are also thought to be environmentally friendly. In accordance with the results of the present study, eating plums (*Prunus domestica L.*) whole would be healthier because discarding the peeling results in a significant loss of beneficial compounds.

CONFLICTS OF INTEREST

The author declare no conflict of interest.

NOVELTY STATEMENT

In accordance this is the first time to recycle the plum peel to be used as antibacterial in animal fodder as recommended in this study.

REFERENCES

Adetitun D.O., Araoye H.K., Akinyanju J.A., Anibijuwon I.I. (2013). The antimicrobial effects of the leaf extracts of Moringaoleifera on selected clinical Bacterial isolates. Agrosearch. 13 (1): 95 -113. http://dx.doi.org/10.4314/agrosh.v13i1.10.

Ajoku G.A., 2Ugbabe G.E., 3Kalpana J. (2015). Foliar Ultra-Structure and Antimicrobial screening of the Leaf Extracts of Panicum maximum Jacq. (Family: Poaceae/Graminae) Schol. J. Biolog. Sci. 4(3): 19-22. http://scholarlyjournals.com/sjbs/archive/2015/March/pdf/Ajoku%20et%20al.pdf.

Antia B.S., Okokon J.E., Umoh E E., Udobang J.A. (2010). Antidiabetic activity of Panicum maximum. Int. J. Drug Dev. Res. 2(3): 488 – 492. [Google Scholar].

Bankole A.E., Adekunle A.A, Sowemimo A.A., Umebese C.E, Abiodun O, Gbotosho G.O. (2016). Phytochemical screening and in vivo antimalarial activity of extracts from three medicinal plants used in malaria treatment in Nigeria. Parasitol. Res. 115: 299–305. [Google Scholar] [CrossRef].

Bassett J.; McClure P (2008). A risk assessment approach for fresh fruits. J. Appl. Microbiol. 104: 925–943. [CrossRef] [PubMed].

Belhadj J, Marzouki MN (2014). Antioxidant, Antihemolytic and Antibacterial effects of dried and fresh Prunus domestica L. Int. J. Pharmaceut. Res. Bio-Sci. 3(6): 191-207.

Bi Y, Zhu C, Wang Z, Luo H, Fu R, Zhao X, Jiang L (2019). Purification and characterization of a glucose-tolerant β-glucosidase from black plum seed and its structural changes in ionic liquids. Food Chem. 274: 422-428.

Bonesi M, Tenuta M, Loizzo M, Sicari V, Tundis R (2018). Potential Application of Prunus armeniaca L. and P. domestica L. Leaf Essential Oils as Antioxidant and of Cholinesterase's Inhibitors. Antioxidants. 8(2):1-8.

Caniça M. V. Manageiro H. Abriouel J. Moran-Gilad C.M.A.P (2018). Franz, Antibiotic resistance in foodborne bacteria, Trends Food Sci. Technol. https://doi.org/10.1016/J.TIFS 2018.08.001

Cho EJ, Yokozawa T, Rhyu DY. (2003). Study on the

inhibitory effects of Korean medicinal plants and their main compounds on the 1, 1-diphenyl-2-picrylhydrazyl radical. Phytomed. 10(6-7):544–551. [PubMed] [Google Scholar].

Claeys W.L., Schmit J.-F., Bragard C., Maghuin-Rogister G, Pussemier L., Schiffers B (2011). Exposure of several Belgian consumer groups to pesticide residues through fresh fruit and vegetable consumption. Food Cont. 22: 508–516. [CrossRef].

Clarke EGC. (1975). Isolation and identification of drugs. Vol. 2. UK: Pharmaceutical Press; p. 905. [Google Scholar].

Diniz-Silva H.T.M., Magnani S., de Siqueira, E.L. de Souza, J.P. de Siqueira-Júnior (2017). Fruit flavonoids as modulators of norfloxacin resistance in Staphylococcus aureus that overexpresses norA, LWT - Food Sci. Technol. (Lebensmittel-Wissenschaft -Technol.) 85: 324–326, https://doi.org/10.1016/J.LWT 2016.04.003.

Doss A., Parivuguna V., Vijayasanthi M., Surendran S. (2011). Antibacterial evaluation and phytochemical analysis of certain medicinal plants. J. Res. Biol. 1: 24-29. [Google Scholar].

El-Beltagi HS, El-Ansary AE, Mostafa MA, Kamel TA, Safwat G (2019). Evaluation of the Phytochemical, Antioxidant, Antibacterial and Anticancer Activity of Prunus domestica Fruit. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 47(2): 395-404.

FAOSTAT (2019). Food and Agriculture Organization Corporate Statistical Database. Production. Available online:http://www.fao.org/faostat/en/#data/QC/visualize (accessed on 20 November 2019).

Fattouch S., Caboni P., Coroneo V., Tuberoso C.I, Angioni A., Dessi S, Marzouki N, Cabras P (2007). Antimicrobial activity of Tunisian quince (Cydonia oblonga Miller) pulp and peel polyphenolic extracts. J. Agric. Food Chem. 55: 963–969. [CrossRef].

Gonzalez-Talice J., Yuri J.A., Del Pozo A (2013). Relations among pigments, color and phenolic concentrations in the peel of two Gala apple strains according to canopy position and light environment. Sci. Hortic. 151: 83–89. [CrossRef].

Hooshmand S., Kumar A., Zhang J.Y., Johnson S.A., Chaid S.C., Arjmandi B.H (2015). Evidence for anti-inflammatory and antioxidative properties of dried plum polyphenols in macrophage RAW 264.7 cells. Food Funct. 6: 1719–1725. [CrossRef].

Kanife U.C. (2012). Potentials of alkaloids from Panicum maximum florets infected with the fungus Tilletia ayresii in controlling uterine contraction in Sprague- dawley rats, Ph.D Thesis University of Lagos, 181. https://ir.unilag.edu.ng/handle/123456789/4200.

Kaulmann A., Legay S., Schneider Y.J., Hoffmann L., Bohn T (2016). Inflammation related responses of intestinal cells to plum and cabbage digesta with differential carotenoid and polyphenol profiles following simulated gastrointestinal digestion. Mol. Nutr. Food Res. 60: 992–1005. [CrossRef].

Khallouki F., Haubner R., Erben G., Ulrich C.M., Owen R.W (2012). Phytochemical composition and antioxidant capacity of various botanical parts of the fruits of Prunus domestica L. from the Lorraine region of Europe. Food Chem. 133: 697–706. [CrossRef].

Lenchyk LV (2016). Determination of phenolic compounds in prunus domestica leaves extract. Scripta Scient. Pharmaceut. 2(2): 31-35.

Li D., Zhang X., Li L., Aghdam M.S., Wei X., Liu J., Xu Y., Luo Z (2019). Elevated CO2 delayed the chlorophyll degradation and anthocyanin accumulation in postharvest strawberry fruit. Food Chem. 285: 163–170. [CrossRef].

Martin L.B.B., Rose J.K.C (2013). There's more than one way to skin a fruit: Formation and functions of fruit cuticles. J. Exp. Bot. 2013, 65, 4639–4651. [CrossRef].

Michalska A., Wojdyło A., Lech K., Łysiak G.P., Figiel A (2016). Physicochemical properties of whole fruit plum powders obtained using different drying technologies. Food Chem. 207: 223–232. [CrossRef] [PubMed].

Michalska A., Wojdyło A., Łysiak G.P., Figiel A (2017). Chemical composition and antioxidant properties of powders obtained from different plum juice formulations. Int. J. Mol. Sci. 18: 176. [CrossRef] [PubMed].

Michalska A., Wojdyło A., Majerska J., Lech K., Brzezowska J (2019). Qualitative and quantitative evaluation of heat-induced changes in polyphenols and antioxidant capacity in Prunus domestica L. by-products. Molecules. 24: 3008. [CrossRef] [PubMed].

Miljić U, Puškaš V, Velićanski A, Mašković P, Cvetković D, Vujić J. (2016). Chemical composition and in vitro antimicrobial and cytotoxic activities of plum (Prunus domestica L.) wine. J. Instit Brewing. 122(2): 342-349.

Morens DM, Folkers GK, Fauci AS (2009). The challenge of emerging and reemerging infectious diseases. Nature. 430(6996):242–9. 40. Woodford N, Livermore DM. Infections caused by Gram-positive bacteria: a review of the global challenge. J. Infect. 2009;59:S4–S16.

Nayak S. B., J. Kanhai, D. M. Milne, L. P. Pereira, W.H. Swanston. (2011). Experimental evaluation of ethanolic extract of Carapa guianensis L. leaf for its wound healing activity using three wound models. Evidence-Based Complement. Alternat. Med. Article ID 419612, 6 pages. https://dx.doi.org/10.1093%2Fecam%2Fnep160.

NCCLS (1993). Performance Standards Antimicrobial Disc Susceptibility Tests. Approved Standard Fifth Edition. NCCLS Document M2-A5, Villanova, PA, USA.

Noratto G., Porter W., Byrne D., Cisneros-Zevallos L (2009). Identifying peach and plum polyphenols with chemopreventive potential against estrogen-independent breast cancer cells. J. Agric. Food Chem. 57: 5219–5226. [CrossRef] [PubMed].

Oniciuc E.-A., Nicolau A.I., M. Hernández, D. Rodríguez-Lázaro (2017), Presence of methicillin-resistant Staphylococcus aureus in the food chain, Trends Food Sci. Technol.61 (2017) 49–59. https://doi.org/10.1016/J.TIFS 2016.12.002.

Patil D. N., A. R. Kulkarni, A. A. Shahapurkar, B. C. Hatappakki. (2009). Natural cumin seeds for wound healing activity in albino rats. Int. J. Biolog. Chem. 3, 4, 148–152. https://dx.doi.org/10.3923/ijbc.2009.148.152.

Rehab M.A. El-Desoukey, Fawziah M. Albarakaty, Nurah M. Alzamel, Mashail N. AlZain (2022). Ethnobotanical, phytochemical and antimicrobial activity of Halexylon salicornicum (Ramth) as a graze and promising shrub against selected animal microbes, Saudi J. Biolog. Sci., 29 (7), 2022.

Rupesh Thakur, Nitika Jain, Raghvendra Pathak, and Sardul Singh Sandhu. (2011). Practices in Wound Healing Studies of Plants Evidence-Based Complementary and Alternative Medicine. Article ID 438056, 17 pages. https://doi.org/10.1155/2011/438056.

Salaheen S. M., Peng, J., Joo H., Teramoto D., Biswas (2017). Eradication and Sensitization of methicillin resistant

Staphylococcus aureus to methicillin with bioactive extracts of berry pomace. Front. Microbiol. 8 :253. https://doi.org/10.3389/fmicb.2017.00253.

Salaheen S.E., Jaiswal J., Joo M., Peng R. Ho, D. OConnor, K. Adlerz, J.H. Aranda Espinoza, D. Biswasn (2016). Bioactive extracts from berry byproducts on the pathogenicity of Salmonella Typhimurium, Int. J. Food Microbiol, 237 (2016) 128–135, https://doi.org/10.1016/J.IJFOODMICRO 2016.08.027.

Sara J, Abdolrasoul HE, Fereshteh JK (2013). Evaluation of antimicrobial activity of Malus domestica fruit extract from Kashan area Avicenna J. Phytomed. 2013 Winter.; 3(1): 1–6.

Senhaji O., Faid M., Elyachioui M., Dehhaoui M. (2005). Étude de l'activité antifongique de divers extraits de cannelle. J. Mycol. Méd. 15: 220–229. [Google Scholar] [CrossRef].

Shetty S., S. Udupa, L. Udupa. (2008). Evaluation of antioxidant and wound healing effects of alcoholic and aqueous extract of Ocimum sanctum Linn in rats. Evidence-Based Complement. Alternat. Med. 5, 1, 95–101. https://dx.doi.org/10.1093%2Fecam%2Fnem004.

Slavin J.L., Lloyd B (2012). Health Benefits of Fruits and Vegetables. Adv. Nutr. 3: 506–516. [CrossRef] [PubMed].

Sójka M., Kołodziejczyk K., Milala J., Abadias M., Viñas I., Guyot S., Baron A (2015). Composition and properties of the polyphenolic extracts obtained from industrial plum pomaces. J. Funct. Foods. 12: 168–178. [CrossRef].

Sonia P, Hitender S, Munish G (2014). Antimicrobial and Antioxidant activities of fruits and vegetable peels: Rev J. Pharmacog. Phytochem. 3 (1): 160-164

Valtierra-Rodriguez D., Heredia N.L., Garcia S., Sanchez E (2010). Reduction of Campylobacter jejuni and Campylobacter coli in poultry skin by fruit extracts. J. Food Prot. 73: 477–482. [CrossRef].

Xu Y., Charles M.T., Luo Z., Mimee B., Tong Z., Véronneau P.-Y., Roussel D., Rolland D (2019). Ultraviolet-C priming of strawberry leaves against subsequent Mycosphaerella fragariae infection involves the action of reactive oxygen species, plant hormones, and terpenes. Plant Cell Environ. 42: 815–831. [CrossRef].

Yigit D, yigit N, Mavi A (2009). Antioxidant and antimicrobial activities of bitter and sweet apricot (Prunus armeniaca L.) kernels. Braz J. Med. Biol. Res. 42:346–352. [PubMed].

Zhang S. Q., Wu J., Zhang Z., Lai X., Zhu (2016). Prevalence, genetic diversity, and antibiotic resistance of enterotoxigenic Escherichia coli in retail ready-to-eat foods in China, Food Control 68: 236–243, https://doi.org/10.1016/J.FOODCONT 2016.03.051.

Zwe Y.H., Tang V.C.Y., Aung R.A., Gutiérrez L.C., Ng H.-G., Yuk, (2018). Prevalence, sequence types, antibiotic resistance and, gyrA mutations of Salmonella isolated from retail fresh chicken meat in Singapore, Food Control 90 (2018) 233–240. https://doi.org/10.1016/J.FOODCONT 2018.03.004.