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Original Article

Antimicrobial potential of banana peel: A natural preservative to improve food safety

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Abstract

The bacterial pathogens not only cause food borne illness and disturbance in the metabolic process of human body rather also cause the severe disorders leading to mortality. The present research was designed to investigate the antimicrobial potential of aqueous and ethanolic extracts of banana peel against food borne pathogens including *Staphylococcus aureus*, *Bacillus subtilis*, *Salmonella typhus* and *Escherichia coli*. The results showed that the extracts possessed significant antimicrobial potential against both Gram-negative (*S. typhus* & *E. coli*) and Gram-positive (*B. subtilus* & *S. aureus*) strains. The ethanolic extracts revealed maximum antimicrobial potential against *S. typhus* (16.27±0.01 mm zone of inhibition) and *S. aureus* (17.15±0.01 mm zone of inhibition) at 40°C, which was very close to the antimicrobial potential of the standard antibiotics (Amoxicillin & Ciprofloxacin). The results concluded that banana peel would be a suitable choice to use as a natural preservative in food items to enhance the food safety.

Keywords: Antimicrobial activity, Banana peel, Food borne pathogens, Antibiotic.

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Introduction

Emerging infectious diseases (EIDs) are one of the major burdens on worldwide economies and public health. In developing countries infectious disease are the main cause of morbidity and death in the children (WHO, 2002). Globally the leading causes of death are infectious diseases due to multidrug resistance in the pathogenic microorganisms (bacteria) because of excessive and illegal use of medications in human as well as the food sources of human like poultry and animals. The under or low dosing of antibiotics to treat

the pathogens also causes resistance in the microorganism. Millions of people are affected by infectious diseases caused by bacteria and fungi every year all over the globe (Hancock, 2005). Various studies has also documented that the small intestine effected by the pathogens could not perform proper functioning due to the attachment of the pathogens with mucosa (Berkes et al., 2003). The food borne pathogens cause severe public health issues in developing countries and symbolize a constant concern for the food industry (Mastroeni, 2002).

Due to raising ratio of infectious disorders, there are high usage of antibiotics including antifungal, and antibacterial agents (Allen et al., 2004; Nussbaum, 2006). Mahida and Mohan (2006) reported that the emergence of microbial resistance to antibiotic had rapidly overturned the advances of earlier 50 years of research on antibiotics. This pandemic condition is compelling towards a search for new antimicrobial compounds and due to this, researchers are progressively revolving their interest to develop better drugs against the pathogens (Shan et al., 2007).

Plant extracts are gaining more importance because of having abundant potential sources for inhibition of microbes. Banana belongs to the family of Musaceae and is considered a valued medicinal plant with more than hundreds of varieties (Someya et al., 2002; Karuppiah and Mustaffa, 2013).

Several studies have been indicated significant antioxidant and antiseptic effects of banana peel (Mokbel and Hashinage, 2005). The banana peel possess strong human physiological benefits like anti-cancerous, anti-microbial, anti-diabetic and anti-mutagenic. The peels of banana have good potential for maintaining the human health and due to the presence of bioactive compounds, the extracts of banana peel may have significant antimicrobial potential against various microorganisms (Chabuck et al., 2013; Abiramji et al., 2014). The presence of carotenoids and fatty acids in peel of banana reflects abundant importance in the management of disease because of their action against microbes (Sumathy et al., 2011). Keeping in view the idea regarding the presence of potential sources of bioactive compounds in the food wastes especially the banana peel which can be used to control the growth of microorganism with a strong antimicrobial and antioxidant potential at lower cost and easy availability (Babbar et al., 2011; Sindhu et al., 2019). The research was planned to investigate the antimicrobial potential of the banana peel extracts against specific food borne human pathogens.

Material and Methods

The extracts (aqueous and ethanolic) of banana peel were prepared and then used in order to check antimicrobial activity against food borne pathogenic microorganisms (*Staphylococcus aureus, Bacillus subtilis, Salmonella typhus* and *Escherichia coli*).

Banana peel powder preparation

Fresh banana peel was collected from local market (juice venders), washed to remove the dust and dirt and then dried for 7 to 10 days under the sunlight to reduce its moisture contents to desirable level (5-10%). The commercial grinder with 0.50 mm mesh sieve was used for grinding the banana peel and the peel powder was kept in air tight plastic jar for further use.

Extraction Process

Ethanolic and aqueous extraction

Twenty (20) gram powder of banana peel was taken with the help of electric weighing balance (SHIMADZU) and then the powder of banana peel was shifted into a conical flask of 500mL volume having 200 mL distilled water and ethanol (for aqueous and ethanolic extraction respectively). Different combinations of water and ethanol were used for extraction as given in Table 1. Then the flask was shifted into the shaking incubator (SHING SAENG SKIR-601L) at 25ºC, 40ºC and 60ºC for 2 hours for extraction. After the preparation of extracts, these were filtered and then concentrated through rotary evaporator (ethanol and water) under the vacuum (HEIDOLPH LABOROTA 4001) to have a final volume of the extract up to 20 mL.

Table-1. Ratio of water and ethanol for preparation of extracts

Treatments	Water	Ethanol
T_1	0%	100%
T_2	25%	75%
T_3	50%	50%
T_4	75%	25%
T_5	100%	0%

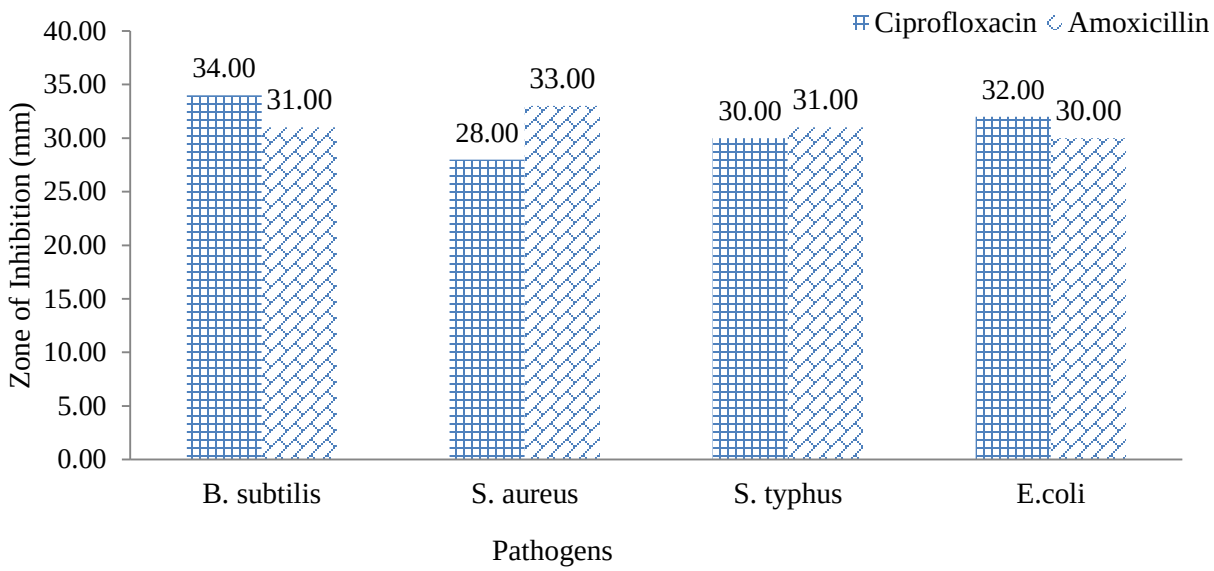

Figure 1: Antimicrobial potential of Ciprofloxacin and Amoxicillin against the pathogens

Assessment of antimicrobial activity

The antimicrobial activity of the extracts was assessed through disc diffusion method. The results were compared with the antimicrobial potential of commercially available broad-spectrum antibiotics (Ciprofloxacin and Amoxicillin). The antimicrobial potential of the selected antibiotics against the tested pathogens are given in Fig. 1.

Statistical analysis

The date obtained during whole study was statistically analyzed by using STATISTIX software version 8.2.

Results

Antibacterial potential of extracts against Gram-positive bacteria

The representative strains from Gram-positive bacteria to assess the antibacterial potential of banana peel extracts were *B. subtilis* and *S. aureus*. The results showed significant inhibition of the pathogen due to difference in type of extracts used. The highest zone of inhibition against *B. subtilis* was observed from extract of banana peel while using 100 % ethanol as solvent followed by the extracts obtained by using a combination of ethanol and water (75:25 ratio) as extraction medium with 13.96 mm and 12.12 mm mean zones of inhibition, respectively. In case of *S. aureus*, the highest zones of inhibition were observed from extract of banana peel while using 100% ethanol as solvent with 12.41 mm and 10.68 mm mean zones of inhibition. The results clearly indicated that the ethanolic extracts showed better antimicrobial potential as compared to water extracts.

Similarly, the highest antimicrobial activity against *B. subtilis* and *S. aureus* was observed under the extract obtained at 40ºC with 11.16 mm and 10.03 mm mean zones of inhibitions, respectively. The results further indicated that the highest inhibition of *B. subtilis* was observed from extract obtained at 40ºC while using pure ethanol as extraction medium with 14.65 mm zone of inhibition whereas 12.96 mm zones of inhibitions were observed against *S. aureus* from extracts obtained at 40ºC while using pure ethanol as solvent (Table 2).

Antibacterial potential of banana peel extracts against Gram-negative bacteria

E. coli and *S. typhus* both are gram-negative with respect to their cell structure and were used as standard strains to represent the Gram-negative group of the pathogens. The extracts showed reasonable antibacterial activity of banana peel against the pathogens. The highest antimicrobial activity against *E. coli* was observed from extract of banana peel while using 100% ethanol as solvent followed by the extracts obtained by using a combination of ethanol and water (75:25 ratio) as extraction medium with 12.41 mm and 10.68 mm mean zones of inhibition, respectively. In case of *S. typhus*, the highest zones of inhibition was

observed from extract of banana peel prepared by using 100% ethanol as solvent with 15.76 mm and 14.04 mm mean zones of inhibition. The results clearly indicated that the ethanolic extracts showed better antimicrobial potential against Gram-negative bacteria as well than that of the water extracts.

Similarly, the extract prepared at 40ºC showed the highest antimicrobial potential against *E. coli* and *S. typhus* with 10.03 mm and 13.16 mm mean zones of inhibitions, respectively. The highest inhibition of *E. coli* was also observed from extract obtained at 40ºC while using pure ethanol as extraction medium with 12.96 mm zone of inhibition whereas 16.27 mm zones of inhibitions were observed against *S. typhus* from extracts obtained at 40ºC while using pure ethanol as solvent (Table 3).

Table-2. Antimicrobial potential of banana peel extracts against Gram-positive bacteria

Pathogen	Treatments	Temperature (˚C)			Mean
		25	40	60	
S. aurous	**T_1**	11.79±0.067	12.96±0.015	12.48±0.017	**12.41±0.033^{A}**
	T_2	10.28±0.012	11.38±0.031	10.38±0.021	**10.68±0.021^{B}**
	T_3	08.95±0.038	09.68±0.021	09.28±0.015	**09.30±0.024^{C}**
	T_4	07.72±0.043	08.75±0.024	08.17±0.035	**08.21±0.034^{D}**
	T_5	06.40±0.050	07.36±0.038	06.78±0.026	**06.85±0.038^{E}**
	Mean	**09.03±0.042^{C}**	**10.03±0.026^{A}**	**09.42±0.023^{B}**	
B. subtilus	**T_1**	13.42±0.060	14.65±0.061	13.82±0.047	**13.96±0.056^{A}**
	T_2	11.56±0.030	12.64±0.041	12.18±0.032	**12.12±0.034^{B}**
	T_3	10.07±0.037	10.82±0.033	10.43±0.047	**10.44±0.039^{C}**
	T_4	08.70±0.153	09.54±0.047	08.96±0.097	**09.07±0.099^{D}**
	T_5	07.13±0.033	08.16±0.106	07.58±0.023	**07.62±0.054^{E}**
	Mean	**10.18±063^{C}**	**11.16±0.058^{A}**	**10.59±0.049^{B}**	

Table-3. Antimicrobial effect of banana peel extracts against Gram-negative bacteria

Pathogen	Treatments	Temperature (˚C)			Mean
		Room	40	60	
E. coli	**T_1**	11.79±0.084	12.96±0.090	12.48±0.075	**12.41±0.083^{A}**
	T_2	10.28±0.036	11.38±0.015	10.38±0.023	**10.68±0.022^{B}**
	T_3	08.95±0.086	09.68±0.020	09.28±0.041	**09.30±0.049^{C}**
	T_4	07.72±0.015	08.75±0.023	08.17±0.067	**08.21±0.035^{D}**
	T_5	06.40±0.052	07.36±0.015	06.78±0.012	**06.85±0.026^{E}**
	Mean	**09.03±0.052^{C}**	**10.03±0.033^{A}**	**09.42±0.043^{B}**	
S. typhus	**T_1**	15.39±0.012	16.27±0.058	15.62±0.015	**15.76±0.028^{A}**
	T_2	13.45±0.033	14.77±0.026	13.90±0.027	**14.04±0.029^{B}**
	T_3	12.24±0.043	13.27±0.029	12.64±0.038	**12.72±0.037^{C}**
	T_4	10.32±0.018	11.71±0.012	11.30±0.015	**11.11±0.015^{D}**
	T_5	08.59±0.032	09.76±0.018	08.93±0.021	**09.09±0.024^{E}**
	Mean	**12.00±0.028^{C}**	**13.16±0.028^{A}**	**12.48±0.023^{B}**	

Discussion

Food borne pathogens are major cause of infectious diseases and a challenge for the food industry from not only the point of food preservation but also for the insurance of food safety in order to meet the local as well as international standards. The results of present study showed that the antimicrobial action of water and ethanol extract of banana peel against *B. subtilis*, *S. typhus*, *E. coli* and *S. aureus* was significant. The average zone of inhibition as a measure of antimicrobial potential of the extracts was ranged from 6.30 mm to 17.17 mm.

The antibacterial potential of banana peel extracts was relative better against Gram-positive microbes rather than the Gram-negative. The results were in line with the studies of some other researchers (Lisgarten et al., 2002; Sawer et al., 2005; Zuo et al., 2008) who also reported that the Gram-negative bacteria are more resistant than Gram-positive bacteria. The results are also justified by the findings of other microbiologists who also reported more affective antimicrobial results of banana peel against Gram-positive bacteria as compared to Gram-negative microorganism (Ahmad and Beg, 2001; Nair and Chanda, 2005; Costa et al., 2008).

Ehiowemwenguan (2014) demonstrated that the ethanolic extract of banana peel showed various zone of inhibitions for *S. aureus*, *B. subtilis*, *S. typhus* and *E. coli* (8 mm, 12 mm, 30 mm and 26 mm, respectively) and for aqueous extracts the zone of inhibitions were found to be up to 12 mm only while working on antimicrobial potential of banana peel extracts against pathogens. The antimicrobial potential of banana peel extracts might be due to the presence of bioactive compounds like phenolic (Baskar et al., 2011), flavonoids (Akiyama et al., 2001; Cushine and Lamb, 2005), saponins (Avato et al., 2006) and steroids (Taleb-Contino et al., 2003).

The results are also related to the findings of Mohamed et al. (1994) who also found similar results especially with respect to the zone of inhibitions against similar pathogens while working on antimicrobial potentials of various plant extracts. The differences in the results observed in the current study and the previous work might be due to the variation in extraction techniques, variety, agricultural practices and the environmental conditions of the growing area of the plants (banana) as well as the type of bacterial strain being used for the studies.

Conclusion

The finding of present study indicated that banana peel extracts possess significant antimicrobial properties. The banana peel extract could be a potential natural antimicrobial agent to inhibit the growth of pathogenic microorganism in the food commodities to meet the challenges of food safety along with other promising health benefits as well.

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Shaukat N: Performed research work
Farooq U: Conceived idea and supervised the research work
Akram K: Co-supervised the research work
Shafi A: Manuscript writer
Hayat Z: Contributed in write-up
Naz A: Write-up and proofreading
Hakim A: Write-up and proofreading
Hayat K: Contributed in write-up
Naseem S: Statistically analyzed the data
Khan MZ: Contributed in write-up