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Banana Peel: A potential waste product with numerous pharmacological activities

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Abstract

Plants have been used as a traditional medicine for generations. Recently the pharmaceutical industries are showing a great interest in using plant extracts in pharmaceutical product development due to the uses of the plants in the treatment of various diseases. Banana is a world-wide edible fruit which comes from south-east Asia. It belongs to the genus Musa and is of two types, sweet banana, and plantain. It has many different species in the world, which are divided into 50 groups. The scientific names of cultivated bananas are *Musa accuminata*, *Musa balbisiana* and *Musa paradisiaca* belonging to the family Musaceae. The present review discusses the various pharmacological activities of the banana peel.

Keywords: Plant waste; Musa; Phytochemical compounds; Pharmacological activity

1. Introduction

Bananas are one of the most commonly eatable fruits grown in various countries world-wide. The banana plant contains different parts such as stem, leaves, flower and pulp and each part are having a medicinal use. The fruit average is 125 grams, of which approximately 75% is water and 25% dry matter content. Banana peel is a by-product of banana which weighs around 35-38% of the fruit [1]. After consuming bananas, the peels are either used as animal feed, fertilizer or discarded. Banana peel shows different activities, and it has been used as traditional medicine since ancient times. Banana peels are used in as a home remedy for wound healing and overcome illnesses like depression. Banana by-products have been used for wrapping foods, clothes and used in various ceremonial occasions and the usage expands through cultural diversification. [2, 3]. These days, the banana peels are having various industrial applications such as biofuel production [4, 5], bio-sorbents, paper and pulp, cosmetics, energy related activities, organic fertilizer, environmental clean-up, and biotechnology related processes. Many studies have been conducted and proved that banana peel possesses medicinal properties like other parts of the banana plant. The volume of research done on the banana peel inspired the authors to present a comprehensive review on the reported medicinal activities of the banana peel.

2. Chemical composition of banana peel

Banana peel contains primary metabolites like 50% of dietary fiber, 7% crude proteins, 10% crude fat 3% starch, polyunsaturated fatty acids (linoleic acid, α-linoleic acid), essential amino acids (leucine, phenylalanine, threonine, and valine), micronutrients (calcium, iron, magnesium, potassium, zinc [6]. It also contains 10-20% pectin, 6-12% lignin, cellulose 7-9%, 6-9% hemicellulose. Banana peel is a rich source of various phytochemical compounds (Table 1).

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Table 1 Phytochemical compounds present in banana peel

Phytochemical compounds	Concentration	Activity	Reference
Phenolic compounds	0.9 – 3 g/100 g	Antioxidant	[7]
Gallocatechin	160 mg/100 g	Antioxidant	[8]
Anthocyanins	-	Antioxidant	[9]
Carotenoids	300-400 µg/100g	Antioxidant	[10]
Sterols and triterpenes	-	Antioxidant	[11]

3. Pharmacological activities of banana peel

The rich source of phytochemical compounds in banana peel are responsible for pharmacological activities such as antibacterial, antifungal, antioxidant, antiulcer and anticancer.

3.1. Anti-bacterial activity

The need of developing new antibacterial agents is necessary because the bacteria is developing resistance to the current antibacterial agents. Medicines derived from plants are used for treatment of infections [12].

Kavitha et al., [13] studied antibacterial activity of 70% ethanolic extract of dried peel extracts of eight varieties of bananas by well agar diffusion method against gram positive bacteria and gram- negative bacteria using chloramphenicol as the positive control. The minimum inhibitory concentration of the extracts was determined. The banana peel extracts showed significant anti- bacterial activity than the positive control.

Suraj Premal et al., [14] evaluated the anti-bacterial activity of the banana peel extract against the periodontal pathogens, *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans* using well agar diffusion method. The banana peel extract was prepared using 70% isopropyl alcohol and it is assessed for the antibacterial activity. The minimum inhibitory concentration was determined using serial broth dilution method. The significant reduction bacterial growth due to peel extracts is indicated by zones of inhibition.

Ehiowemwenguan et al., [15] studied the antibacterial activity of ethanolic and aqueous extracts of banana peels against gram positive and gram-negative bacteria using agar well diffusion method. The extracts were analyzed for alkaloids, flavonoids, glycosides, resins, steroids, tannins, and volatile oils. The minimum inhibitory concentration was done using tube dilution technique. The extracts were found to be more effective against gram negative bacteria. The ethanolic extract of banana peel showed significant antimicrobial activity.

Ravinder Singh et al., [16] studied antibacterial activity of dried peel extracts of green, red, and yellow bananas against ten bacterial species, *Pseudomonas citrii, Escherichia coli, Shigella sp., Salmonella typhimurium, Klebsiella pneumonia, Salmonella typhi, Staphylococcus aureus, Proteus vulgaris, Aeromonas hydrophilia*, and *Serratia marscens*. Methanol and chloroform in 8:2 ratio were used for the extraction. The banana peels of three different colors showed significant antibacterial activity without affecting the normal flora.

Matook Saif Mokbel et al., [17] studied the antibacterial activity of fresh extracts of green and yellow banana peel using paper disc method and minimum inhibitory concentration. The solvents used for extraction were chloroform and ethyl acetate. The isolated components were β-sitosterol, malic acid, succinic acid, palmitic acid, 12- hydroxystearic acid and glycoside; and among all the isolated components, malic acid and 12- hydroxystearic acid were most effective against gram positive and gram-negative bacteria.

The reported studies on antibacterial activity of banana peel are presented in Table 2.

Table 2 Antibacterial activity of banana peel

Extracts	Organisms	Results
70% ethyl alcohol extracts of dried powder of peels of different varieties of banana Rashthali, Nendran, Kadali, Red banana, Robusta, Poovan, Pachaindan[13]	*Staphylococcus aureus,* *Bacillus subtilis,* *Pseudomonas aeruginosa,* *Escherichia coli*	Rashthali and robusta showed a significant activity against all bacteria. Nendran, kadali, red banana and poovan showed good activity against *S. aureus, B. subtilis* and *P. Aeruginosa* but not against *E. coli*. Pachainadan showed significant activity against *S. aureus, B. Subtilis* and *E. coli*but not against *P. aeruginosa*.
70% iso propyl alcohol extract of fresh peels of *Musa paradisiaca* [14]	*Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans.*	Showed antibacterial activity
Distilled water and ethanol extracts of dried powder of *Musa sapientum* [15]	*Bacillus subtilis,* *Staphylococcus aureus,* *Micrococcus leutus,* *Klebsiella pneumoniae,* *Pseudomonas aeruginosa,* *Escherichia coli,* *Salmonella typhi*	Ethanolic extracts decreasing order of zones of inhibition. *K. pnuemoniae>P. aeruginosa>* *S. typhi>E. coli>S. aureus* Aqueous extracts decreasing order of zones of inhibition. *K. pnuemoniae>E. coli*
Methanol: chloroform (8:2) extract of dried powder of ripened peels of green, red, and yellow bananas [16]	*Pseudomonas citrii,* *Escherichia coli,* *Shigella sp,* *Salmonella typhimurium,* *Klebsiella pnuemoniae,* *Salmonella typhi,* *Staphylococcus aureus,* *Proteus vulgaris,* *Aeromonas hydrophila,* *Serratia marsescens*	Red peel extract *P. citrii>S. aureus>P. vulgaris>S. Marsescens* Green peel extract *S. typhi>S. marsescens>P. vulgaris>S. aureus* Yellow peel extract *A. hydrophila>S. aureus>P. citrii>S. marsescens*
Chloroform, ethyl acetate and water extracts of green and yellow peels of Musa, AAA cv. Cavendish [17]	*Bacillus cereus,* *Salmonella enteritidis,* *Escherichia coli,* *Bacillus subtilis,* *Staphylococcus aureus*	Ethyl acetate extract of green peel showed significant antimicrobial activity while yellow peel extract showed low activity and no activity was recorded by chloroform and water extracts.

3.2. Anti-cancer activity

Cancer is a disease affecting people of all age groups and caused by multiple factors. Anticancer drugs currently used are toxic and nonspecific. Research is being carried out for anticancer agents which can minimize the limitations of existing drugs [18].

Amal MK, et al., [19] studied antitumor activity of 95% ethanolic extract of air-dried banana peel powder. The study was conducted male Swiss mice. It was observed that the extract possesses anticancer agents by improving haematological parameters, inhibiting carcino embryonic antigen and malondialdehyde.

Kumar PS, et al., [20] evaluated anticancer activity of 80% methanolic extract of freeze-dried peel powder of Nendran banana. The anticancer activity of the extract on human breast cell line was determined using 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) and acridine orange/ethidium bromide assay. The cell viability was decreased considerably with an increase in concentration of extract.

Wermerson AB, et al., [21] conducted cytotoxic screening of peel extract of pacovan banana (Musa Cavendish) on hepatocellular carcinoma HepG2, malignant melanoma A-375, breast carcinoma MCF-7 and colorectal adenocarcinoma Caco-2 human cell lines. The extract was obtained from fresh peels using 70% alcohol for extraction by maceration. The effect of peel extract on proliferation was evaluated through apoptosis, necrosis, mitochondrial membrane potential and reactive oxygen species (ROS) content. Banana peel extract was lethal to A-375 and was less effective on Caco-2.

Sobanalakshmi S. et al., [22] studied the anticancer activity of ferulic acid extracted from dried banana peels using *Staphylococccus aureus*. The effect of biosynthesized ferulic acid on cell viability was tested by MTT assay and observed for morphological changes in HeLa cells taking synthetic ferulic acid for comparison.

Munish G, et al., [23] investigated anticancer activity of extracts of dried banana peels along with four other fruits by MTT assay on HepG2 cells. The extracts were prepared using 80 % ethanol as solvent by maceration for 7 days. The banana extract was found to have anticancer activity.

Saad SD, et al., [24] studied anticancer activity of dried banana peel along with pulp. Ethanol, n-hexane, and water were used as solvents for extraction by hot maceration at 40°C. The extracts were tested for their ability to inhibit the growth of human umbilical vein endothelial cell line (HUVEC), human colorectal carcinoma cell line (HCT-116) and human hormone sensitive and invasive breast cancer cell line (MCF-7) using MTT assay. Of all the three extracts, n-hexane extracts have showed highest inhibition of cell proliferation of HCT-116 and MCF-7. There is no inhibition of cell proliferation in normal cell lines. In this study, antitumorogenesis was also evaluated using an ex-vivo rat aorta ring assay. The study of the effect of banana peel extract on angiogenesis (growth of new blood vessels) of thoracic aorta rings of rats. Hexane extract showed the highest antiangiogenic effect when compared to other extracts.

Nessma AZ, [25] studied antitumour activity in ethanolic extract of freeze-dried banana peel along with other fruit peels on breast cancer cell line by sulphorhodamine–B assay using thymoquinone as a positive control. The increasing order of cytotoxic activity is tangerine and orange; kiwi and lemon; goldenberry and banana and carrot and watermelon.

Fatimah CA, et al., [26] studied cytotoxic activity of methanolic extract of fruit (both peel and pulp) of *Musa acuminata malaccensis*. The extract showed moderate cytotoxic activity against cancer cell lines but no such activity on the normal cell line.

Imam MZ, et al., [27] studied the cytotoxic property of different extracts of *Musa sapientum L. subsp. Sylvestris* fruit peels along with pulp and seed. Peel extract exhibited moderate activity against 5 gram-positive bacteria and 8 gram-negative bacteria and 3 fungi.

The reported anticancer activities of banana peel are presented in Table 3.

Table 3 Anticancer activity of banana peel

Extracts	Cell lines and assay	Results
95% ethanolic extract of air-dried peel powder [19]	Complete blood count, Carcino embryogenic antigen, Malondialdehyde	Possess anticancer agents by improving hematological parameters, inhibiting carcino embryonic antigen and malonaldehyde.
80% methanol extract of freeze-dried peel powder of Nendran banana [20]	Human breast carcinoma MCF-7 cell line by MTT assay	Potent cytotoxic activity.
70% ethanol extract of green peels of Musa	Human hepatocellular carcinoma HepG2, Malignant melanoma A-375, breast carcinoma MCF-7, colorectal adenocarcinoma Caco-2 cell lines	Decreased proliferation of HepG2, A-375, MCF-7 and Caco-2. Reduction of mitochondrial

Cavendish (Pacovan banana) [21]	by apoptosis and necrosis cellular assay, mitochondrial membrane potential assay and reactive oxygen species assay	membrane potential and increased generation of reactive oxygen species.
Dried peel [22]	HeLa cell line by MTT assay	Ferulic produced from banana peels using *Staphylococcus aureus* had cytotoxic potential.
80% Ethanol extract of dried peel powder [23]	HepG2 cells by MTT assay	Banana peel extract showed cytotoxic activity but less than papaya and guava.
n-Hexane, ethanol, and water extracts of oven-dried powder of *Musa sapientum* peel and pulp [24]	Human umbilical endothelial HUVEC, colorectal carcinoma HCT-116, breast cancer MCF-7 cell lines by MTT assay. Antiangiogenic activity by rat aorta ring assay.	Highly non-polar solvent n-hexane extract of peel showed highest anticancer activity. No extract was cytotoxic to HUVEC. Only hexane extract of peel and ethanol extract showed antiangiogenic activity.
Ethanol extract of freeze-dried powder of *Musa acuminate* [25]	Breast carcinoma MCF-7 cell line by sulphorhodamine-B assay	Possess cytotoxic activity.
Methanolic extract of *Musa acuminata malaccensis* [26]	Hepatic carcinoma HepG2, Breast adenocarcinoma MCF-7, Foetal hepatic normal cells WRL-68	Moderate cytotoxic activity against cancer cell lines but no such activity on the normal cell line.
Methanol extract of dried powder of *Musa sapeintum L. subsp. sylvestris* [27]	Brine shrimp eggs lethality assay	Cytotoxic activity.

3.3. Anti-diabetic activity

Diabetes is of two types, insulin dependent or non- insulin dependent. There are several diabetic patients present worldwide. Many herbal medicines are used as the source of medication for diabetes [28].

Murthy SSN, et al., [29] conducted a study to evaluate the antidiabetic activity of the acetone extract of dried powder of *Musa sapientum* banana peel by measuring blood glucose, HbA1C and plasma insulin in streptozocin induced male albino wistar rats. The rats were divided into six groups, each group containing six rats and received the treatments in the following manner: first group – normal saline, second group – streptozocin, third group–streptozocin and glibenclamide, fourth group – streptozocin and *Musa sapientum* peel (MSPE) extract 200mg/kg, fifth group - streptozocin and MSPE 400mg/kg, sixth group – normal saline and MSPE 400mg/kg. It was observed that the acetone extract reduced the fasting blood glucose, HbA1c and plasma insulin in diabetic induced rats.Hence, the banana peel extract can also be used as antidiabetic agent.

Hongmei W, et al., [30] used fresh banana (*Musa nana Lour*.) peel extracts of ethyl acetate (EBP) and petroleum ether (PBP) to evaluate antidiabetic activity in alloxan induced diabetic mice. The mice were divided into seven groups each containing ten mice and were treated in the following manner: first group – normal saline, second group – alloxan, third group – alloxan and metformin (300 mg/kg), fourth group – alloxan and EBP (6 mg/kg), fifth group - alloxan and EBP (12 mg/kg), sixth group - alloxan and PBP (6 mg/kg), seventh group - alloxan and PBP (13 mg/kg). The ethyl acetate extracts of banana peel decreased glucose levels in blood to a significant level in alloxan induced diabetic mice.

3.4. Anti- fungal activity

Dandruff is one of the common scalp problems [31]. Natural products are being evaluated for their antifungal activity.

Bharathi P, et al., [32] evaluated antifungal activity of aqueous extract of powdered air-dried peels of *Musa paradisiaca* (kadali), *Musa acuminata Cavendish* and *Musa acuminata Nendra* using agar well diffusion technique. The fungi isolated

from scalp are *Aspergillus niger*, *Aspergillus flavus* and Penicillium spp. The extract of kadali showed zone of inhibition against Aspergillus niger.

3.5. Anti-inflammatory activity

Inflammation is the body's defensive response to physical, chemical, and microbiological substances and destroys both damaging substances and body tissues. Non-steroidal anti-inflammatory drugs reduce the inflammatory response but cause side effects on long term use. Therefore, research on natural medicine is gaining momentum [33].

Gina K, et al., [34] determined the anti-inflammatory activity of methanol extract of Ambon banana (*Musa paradisiaca L.*) by human red blood cell membrane stabilization method.The red blood cell membrane is analogous to lysosomal membrane and the stabilization of the latter is necessary in controlling the inflammatory response. The size of the hemolysis that occurs in the red blood cell membrane induced by the hypotonic solution is used to measure the presence of the anti-inflammatory activity. The absorbance of hemoglobin can be measured at 560 nm using a UV-vis spectrophotometer.Ambon banana peel extract has shown anti-inflammatory activity by the decrease in the absorbance of the test solution.

Pathompong P, et al., [35] evaluated anti-inflammatory activity of fresh and dried peels of ripe and unripe bananas of *Musa sapientum Linn*. Extraction was carried out by maceration in 95% ethanol, 50% ethanol, decoction and soaking in water. The activity was determined by measuring the inhibitory effect on NO production by mouse macrophage leukemia-like RAW 264.7 cells. The water extract of fresh ripe peel showed the highest NO inhibitory effect.

3.6. Anti-microbial activity

The modern antibiotics currently used for treating microbial infections developed resistance in microorganisms against these drugs. Phytoconstituents can fight against human and plant pathogenic bacteria, fungi, and viruses without causing side effects and environmental hazards [36].

Muhammed S, etal., [37] studied antimicrobial activity of banana peel along with orange and yellow lemon. Distilled water, ethanol, ethyl acetate and methanol were used for extraction and the obtained extracts tested against sixgram positive bacteria, six gram negative bacteria two microscopic filamentous fungi and two yeast species using well bore method. The increasing order of antimicrobial activity of the extracts is ethyl acetate<ethanol<methanol<distilled water. The extracts were effective against gram negative bacteria.

Ahmed MA et al., [38] studied antimicrobial activity of banana peel extract obtained using different solvent systems, 80% acetone and 80% ethanol. The antimicrobial activity was tested against gram positive bacteria (*Bacillus subtilis*, *Staphylococcus aureus*), gram negative bacteria (*Escherichia coli*, *Psuedomonas aeruginosa*), fungus (*Aspergillus fluves*), yeast (*Candida albicans*, *Saccharomyces cervesia*) using well diffusion assay. The antimicrobial activity was more with acetonic extract when compared to ethanolic extract due to high concentration by phenolics and tannins.

Nessma AE, [25] studied antimicrobial activity using hole plate method against bacterial cultures of *Staphylococcus aureus*, *Escherichia coli*and *Pseudomonas aeruginosa*, yeast cultures of *Candida albicans* and fungal cultures of *Aspergillus niger*, *Aspergillus flavus*, *Penicillium digitatum* and *Fusarium oxysporum*. The extracts of all the fruit peels showed inhibitory effect against these microorganisms.

Zainab AGC, et al., [39] evaluated antimicrobial activity of aqueous extract of fresh yellow banana peels against gram positive bacteria (*Streptococcus aureus*, *Streptococcus pyogenes*), gram negative bacteria (*Enterobacter aerogenes*, *Escherichia coli*, *Moraxella catarrhalis*, *Klebsiella pneumonia*) and yeast isolates (*Candida albicans*) using agar well diffusion assay. The extract was found to have antibacterial activity against gram positive bacteria and gram- negative bacteria.

Ighodaro OM, [40] studied antimicrobial activity of *Musa paradisica* peels. Aqueous and ethanol were used for extraction. Four bacteria (*Streptococcus aureus*, *Bacillus subtilis*, *Pseudmonas aeruginosa*, *Proteus mirabilis*) and three fungi (*Rhizopis nigricans*, *Fusarium oxysporum*, *Aspergillus niger*) were used for the study. The extracts were found to be effective against bacteria and fungi.

Imam MZ, et al., [27] studied the antimicrobial activity of methanol extract of *Musa sapientum L. sylivestris* peel against five gram-positive bacteria, eight gram-negative bacteria and three fungi. The peel extract showed good antibiotic activity against all microorganisms.

The different studies of antibacterial activity of banana peel are presented in Table 4.

Table 4 Antibacterial activity of banana peel

Extracts	**Organisms**	**Results**
Distilled water, ethanol, ethyl acetate and methanol extracts of oven dried powder of *Musa acuminata* [37]	Gram negative bacteria *Pseudomonas aeruginosa,* *Klebsiella pneumoniae,* *Serratia marcescens,* *Escherichia coli,* *Proteus vulgaris,* *Salmonella typhi* Gram positive bacteria *Staphylococcus aureus,* *Enterococcus faecalis,* *Aeromonas hydrophila,* *Streptococcus pyogenes,* *Listeria monocytogenes,* *Lactobacillus casei* Fungi *Aspergillis niger,* *Penicillium citrinum* Yeast *Candida albicans,* *Saccharomyces cervisiae*	Decreasing order of antibacterial activity of extracts: Distilled water>methanol>ethanol>ethyl acetate. Gram negative bacteria are more sensitive to the extracts.
80% acetone and 80% ethanol extract of dried powder of *Musa paradisica L.* peel [38]	Gram positive bacteria *Bacillus subtilis,* *Staphylococcus aureus* Gram negative bacteria *Escherichia coli,* *Pseudomonas aeruginosa* Fungus *Aspergillus fluves* Yeast *Candida albicans* *Saccharomyces cerviciea*	Acetone extract had good antimicrobial activity against gram positive and gram- negative bacteria
Ethanol extract of freeze-dried powder of *Musa accuminata* [25]	Bacteria *Staphylococcus aureus,* *Escherichia coli,* *Pseudomonas aeruginosa,* Yeast *Candida albicans,* *Fungi* *Aspergillus niger,* *Aspergillus flavus,* *Penicillium digitatum,* *Fusarium oxysporum*	Best antifungal activity

Aqueous extract of fresh peels [39]	Gram-positive bacteria *Staphylococcus aureus,* *Streptococcus pyogenes* Gram-negative bacteria *Enterobacter aerogenes,* *Klebsiella pneumonia,* *Escherichia coli,* *Moraxella catarrhalis* Yeast *Candida albicans*	Good antibacterial activity against both gram positive and negative bacteria.
Aqueous and ethanol extracts of dried powders of ripe and unripe peels of *Musa paradisica* [40]	Bacteria *Staphylococcus aureus,* *Bacillus subtilis,* *Proteus mirabilis,* *Pseudomonas aeruginosa,* Fungi *Aspergillus niger,* *Rhizopus nigricans,* *Fusarisceus oxysporum*	Ethanolic extracts were effective against bacteria and fungi.
Methanol extract of dried powder of *Musa sapientum L. subsp. Sylvestris* [27]	Gram-positive bacteria *Bacillus cereus,* *Bacillus megaterium,* *Bacillus subtilis,* *Sarcina lutea,* *Staphylococcus aureus* Gram-negative bacteria *Escherichia coli,* *Salmonella paratyphi,* *Salmonella typhi,* *Shigella boydii,* *Shigella dysenteriae,* *Pseudomonas aeruginosa,* *Vibrio mimicus,* *Vibrio parahemolytics* Fungi *Aspergillus niger,* *Candida albicans,* *Sacharomyces cerevaceae*	Good antibacterial activity against all organisms.

3.7. Antioxidant activity

Our body produces free radicals continuously either naturally or upon exposure to environmental factors and leads to diseases like cancer, atherosclerosis, arthritis, and others. Antioxidants scavenge the free radicals and prevent the damage caused by them. Antioxidants available in fruits, vegetables and whole grains can be utilized due to their minimal side effects [41].

Table 5 Antioxidant activity of banana peel

Extracts	Methods	Results
Aqueous, 80% acetone, 80% ethanol and 80% methanol extracts of dried powder of *Musa paradisiaca* peel [38]	DPPH assay, Metal chelating activity, $ABTS^{+}$assay, Reducing power assay	Acetone extract showed highest activity.
Water, ethanol, and n-hexane extract of oven dried *Musa sapientum* peel [24]	DPPH assay, FRAP assay	Ethanol extract showed potent antioxidant activity.
Ethanol extract of freeze-dried powder of *Musa acuminata*[25]	DPPH assay	Good antioxidant activity.
95% ethanol, 50% ethanol, decoction and soaking in water extracts of fresh and dried; ripe and unripe peels of *Musa sapientum L.* [35]	DPPH assay	Decoction extract of fresh unripe showed highest antioxidant activity.
Aqueous, ethanol and methanol extract of oven dried peels of *Musa paradisica* varieties cv. Dwarf cavendish, AAA; Ney poovan, AB and Nendran, AAB. [42]	Total antioxidant assay	Water extract>Methanol>ethanol All three varieties of banana peel showed similar activity.
	DPPH assay	Ethanol extract of Nendran exhibited higher activity at lesser concentration.
	Reducing power assay	Methanol and ethanol extracts of Nendran had higher reducing power.
10% ethanol extract of shade-dried *Musa balbisiana* varieties - Monthan, Karpooravalli, Nendran, Kadali, and *Musa acuminate* varieties – Pachainadan, Poovan, Rasthali, Robusta, Sevvazha [43]	Total antioxidant assay	Pachainadan showed highest activity.
	DPPH assay	Moondhan showed highest percentage inhibition of free radicals.
	ABTS assay	Rasthali showed highest percentage inhibition of radicals.
	Lipid peroxidation inhibition assay	Poovan exhibited highest inhibition of lipid peroxidation.
Acetone, ethanol, methanol, water, acetone:water (1:1) ethanol:water (1:1) methanol:water (1:1) extracts of freeze-dried peels of *Musa acuminata* colla AAA Grande Naine and Gruesa varieties [44]	Antioxidant activity, β-carotene bleaching assay, DPPH assay, $ABTS^{+}$ assay, TBARS assay	Acetone:water extract showed highest antioxidant activity.
Chloroform, ethyl acetate and water extracts of fresh green and yellow peels of Musa AAA cv. Cavendish [17]	DPPH assay, β-carotene linoleate assay, ferric thiocyanateassay	Ethyl acetate and water-soluble fractions showed higher antioxidant activity.

Ahmed MA, et al., [38] studied the antioxidant activity of aqueous, 80% acetone, 80% ethanol and 80% methanol extracts of dried powder of *Musa paradisiaca L*. peels. The antioxidant activity was estimated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay, metal chelating activity, scavenging activity on 2,2'-azino-bis(3-ethylybenzothiazoline)-6-sulfonic acid ($ABTS^+$)radicals and reducing power. Acetone and methanol extracts have more antioxidant activity compared to ethanolic and aqueous extracts. Acetone extract showed the highest $ABTS^+$ scavenging activity.

Saad SD, et al., [24] studied the antioxidant properties using DPPH and ferric reducing antioxidant power (FRAP) assay. The extracts were prepared using n-hexane, ethanol, and water. In DPPH scavenging activity, ethanolic extracts of banana peel had more antioxidant activity. Ethanolic extract showed the highest percentage of metal chelating capacity. Acetone extract showed higher reducing power.

Nessma AZ, [25] studied the antioxidant activity of ethanolic extract of freeze-dried banana peel along with other fruit peels by DPPH radical scavenging assay using ascorbic acid as a standard. The secondary metabolites like alkaloids, carotenoids, flavonoids, phenolics, saponins and tannins in the fruit peel extracts were estimated. Maximum antioxidant activity was observed in peel extracts of carrot and watermelon, followed by goldenberry and banana, while medium activity was shown by peel extracts of lemon and kiwi followed by tangerine and orange.

Pathompong P, et al., [35] studied antioxidant activity of *Musa sapientum Linn*. by DPPH assay. The extracts were obtained by maceration in 95% ethanol, 50% ethanol, decoction and soaking in water. Fresh ripe and unripe peels obtained by decoction method showed significant antioxidant activity.

Shyamala BN, et al., [42] investigated antioxidant potential of three varieties of *Musa paradisiaca* cv. Dwarf cavendish, AAA; Ney poovan, AB and Nendran, AAB. The antioxidant activity of aqueous, ethanol and methanol extract of oven dried banana peel was determined using phosphomolybdenum method, DPPH assay and reducing power. Nendran variety showed the highest antioxidant activity.

Ramakrishna B, et al., [43] aimed to evaluate and compare the phytochemical content and the antioxidant activity in the peel extracts of the nine local varieties of the banana i.e., *Musa balbisiana and Musa acuminata* species. The ethanolic extracts of these banana peels have been subjected to in-vitro free radical scavenging assays which includes total antioxidant capacity assay, DPPH, ABTS and lipid peroxidation inhibition assay. It is shown that the peel extracts exhibited significant antioxidant activity.

Rafela G, et al., [44] observed in a study that the extracts obtained from banana peels contained high potential to scavenge 2,2-diphenyl-1-picrylhydrazyl and 2,2'-azino-bis(3-ethylbenzothiazoline)-6-sulfonic acid free radicals and inhibit lipid peroxidation. The influence of various factors on the extraction efficiency were studied: use of different solvents, pH of water, the time for extraction, the temperature at which extraction was conducted and the banana species. The bioactive compounds that might be responsible for antioxidant activity were determined. Banana peel extract extracted using acetone:water contained highest antioxidant activity.

Matook SM, et al., [17] studied antioxidant activity of green and yellow peel of Musa AAA cv. Cavendish using chloroform, ethyl acetate and water for extraction. The antioxidant activity was determined using DPPH, β-carotene linoleate, ferric thiocyanate. Green peel showed higher antioxidant activity than yellow peel.

The antioxidant activity of plant products is associated with their content of phenolics and flavonoids. The degree of antioxidant activity depends on the amount of these substances, and which is affected by several factors like type of peel, type of banana and type of extract. The banana variety, type of peel, solvents used for extraction, method for determining antioxidant assay and results obtained in the above literature is presented in Table 5.

3.8. Anti-psoriatic activity

Psoriasis is a very commonly occurring chronic inflammatory disease which mainly affects the skin [45]. It occurs to human beings of all ages. It is commonly associated with diseases like arthritis, AIDS, enteropathy, myopathy, spondylitic heart disease. Psoriatic arthritis may be mild, but bone changes are seen in rheumatoid arthritis. This psoriasis mainly effects the skin of the elbow, knees, scalp, lumbosacral areas, inter gluteal cleft and glans penis. Mostly psoriasis begins at the age of 10-20 yrs. It mainly affects the body folds of both the sexes. Psoriasis is mainly caused by acceleration in life cycle of skin cells which results in the development of thick scaly white skin patches.

Nithya DE, et al., [46] studied the anti-psoriatic activity of *Musa mysore AAB* (Poovan Banana) peel extract using human keratinocyte cell line. In this the MMT assay was carried out to determine the anti-psoriatic activity of poovan bananas. The results of MTT assay suggest that the extract could reduce cell viability of selected psoriatic cell line.

3.9. Anti-ulcer activity

Ulcer is the major challenge facing by the people which is caused by excessive production of gastric acid and infection by Helicobacter pylori bacteria. The different chemical compounds isolated from plants showed antiulcer activity [47].

Fatimah CA, et al., [26] studied antiulcer activity of methanolic extracts of unripe *M. acuminata Colla. cv Kapas* banana peels using two models, namely, ethanol-induced ulcer and indomethacin-induced gastric lesion. The extracts showed cytoprotective activity in both the models. The flavonoids, saponins and triterpenes present in them are responsible for antiulcer effect.

The banana peel extracts are shown to have significant anti- ulcer activity in a study conducted by Samuel AO, et al., [48]. Antiulcer activity of methanolic extract of dried peels of *Musa sapientum* was evaluated using alcohol induced, aspirin induced, pyloric induced, acetic acid induced in male Sprague Dawley rats. The results revealed that the extract treated rats exhibited good anti-ulcer activity and is dose dependent in all the ulcer induced models.

3.10. Hepatoprotectivity

The liver is a vital organ and jaundice, and hepatitis are major liver disorders that account for high death rates. Liver injury can be induced either by toxic chemicals like carbon tetrachloride (CCl_4) and alcohol or drugs like paracetamol and isoniazid. There is a need to find solutions from natural sources to overcome the side effects of existing drugs [49].

Fatimah CA, et al., [26] carried out studies to investigate the hepatoprotective activity of methanolic extracts of the peel of *Musa acuminate* Colla. cv. Kapas in chloroform and paracetamol-induced hepatotoxicity models in rats. Liver function can be assessed using estimation of enzymes. The extracts showed hepatoprotectivity.

3.11. Inhibition of melanogenesis

Hyperpigmentation is a pigmentary disorder which occurs by the over secretion of melanin which leads to problems like melasma, freckle, ephelides, lentigo and other forms on human skin. Many skin-whitening agents are restricted due to their side effects or stability problems with the kojic acid, ascorbic acid and hydroquinone which acts as cytotoxic substances. These causes problems like dermatitis and skin cancer [50].

Naphichaya P, et al., [51] studied the effect of Sucrier banana peel extracts on inhibitionof melanogenesis process through p38 signaling pathway in B16F10 mouse melanoma cells. Tyrosinase activity and the cellular melanin content were in dose dependent manner which got decreased after the SBP treatment. It also decreased the melanogenesis related protein as microphthalmia–associated transcription factor and tyrosinase protein after the 24 hours of incubation with the alpha melanocyte stimulating hormones. After using this SBP extract since it contained an effective agent which leaded to the decrease in the tyrosinase activity and melanin content. This shows that the Sucrier banana peel extract contains an effective agent which brightens the skin tone.

3.12. Prevention of atherosclerosis

Atherosclerosis is a disease caused by the formation of plaque in the arteries. Atherosclerosis is still treated by inhibiting the progression of plaques but not by preventing the formation [52].

Arlinda SP, et al., [53] studied the capacity of *Musa sapientum* banana peel 80% ethanol extract in preventing atherosclerosis. The animals used in this study are *Rattus norvegicus* strain Wistar. The extracts were administered orally using gastric spuit in 14 days. The aortic endothelial tissue was taken out from the rats on day 15 and were tested using immune histochemical method. It is observed that the NF-Kβ activity has decreased, and the e-NOS activity has increased. Therefore, it is shown that the banana peel has shown a significant effect on atherosclerosis. Hence it is proved that the Ambon banana peel extract can 82.1% lower the nuclear factor kappa beta activity and can 95.2% increase the nitric oxide nitrate activity.

3.13. Radioprotection

One should be protected from radiation, whether it is planned or accidental. Many compounds, synthetic and natural are being explored for their ability to protect the biological systems against radiation [54].

Amaal MK, et al., [19] studied the radioprotective effect of 95% ethanol extract of air-dried powder of banana peel using male mice. A noticeable stimulation for P53 expression level was detected for applying banana peels extract and irradiation as compound dosage.

3.14. Skin hydration

Dryness of the skin is a potential problem in certain countries and increases with increase in age. The dry skin problem can be reduced by using moisturizers. Most of the moisturizers use synthetic ingredients but have side effects on long-term use. Therefore, it is necessary to replace the synthetic ingredients with bioactive compounds of plants [55].

Wianlie C, et al., [56] studied skin hydration activity of 96% ethanol extract of oven dried powder of *Musa paradisiaca L*. Skin hydration was measured using skin analyzer in human volunteers. The skin hydration was improved by using the cream formulated using banana peel extract.

3.15. Wound healing activity

A wound is the damage caused in normal anatomy and physiology of skin due to physical injury. In recent times, wound care professionals are focusing on traditional medicines [57].

Pari T, et al., [58] studied the wound healing activity of 70% ethanol extract of shade-dried banana peels powder in Iranian rabbits of either sex.The animals were divided into six groups like standard, negative control, vehicle control and other three groups for testing wound healing activity in the banana peel extract. The standard group is treated with 1% phenytoin cream, the negative group has not given any treatment and vehicle group was treated with 3%, 5% and 10% creams of the banana peel extract. All the treatments were applied topically twice daily until the complete healing. It was assessed by the wound extraction and re-epithelialization rate and the tensile strength of wound tissue sample. High rate of wound contraction, decreasing epithelization period and high skin breaking strength were seen in animals.These results indicated that banana peels have strong activity of wound healing and can be used for human beings.

4. Conclusion

The review was focused on the different pharmacological activities of banana peel. The increased concern over side effects associated with the current synthetic therapeutic agents remarkably necessitates the need of herbal drugs. It can be used for various benefits instead of being neglected as a waste.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have no conflicts of interest regarding this investigation.

References

[1] Wafaa MH, Hussein AHSA. Amra B, Kirill GT, Javed S, Miroslava K, Mohammed E, Maria A. Banana Peels: A waste treasure for human being. Evidence-Based Complementary and Alternative Medicine. 2022;1-9.

[2] Sampath KKP, Debjit B, Duraivel S, Umadevi M. Traditional and medicinal uses of banana. Journal of Pharmacognosy and Phytochemistry. 2012;1(3):51-63.

[3] Jean K. Bananas and people in the homeland of genus Musa: not just pretty fruit. Ethnobotany Research and Application. 2009;7:179–97.

[4] Youssef MA, Eman A, Abdel K, Abeir MFE. Evaluation the bioactive compounds extracted from dried banana (Musa sp.) peels which obtained by different drying methods. Current Science International. 2018; 07(02):135-148.

[5] Gaddafi ID, Auwal MM, Abdullahi AS, Bashir JU. Bioethanol production from banana peels. Journal of Environmental Science, Toxicology and Food Technology. 2016;10(06):56-62.

[6] Hassan HF, Hassan UF, Usher OA, Ibrahim AB, Tabe NN. Exploring the potentials of banana (Musa Sapietum) peels in feed formulation. International Journal of Advanced Research in Chemical Science. 2018;5(5):10-4.

[7] Nguyen TBT, Ketsa S, van Doorn WG. Relationship between browning and the activities of polyphenol oxidase and phenylalanine ammonia lyase in banana peel during low temperature storage. Postharvest Biology and Technology. 2003;30(2):187–93.

[8] Someya S, Yoshiki Y, Okubo K. Antioxidant compounds from bananas (Musa cavendish). Food Chemistry. 2002;79(3):351–4.

[9] Seymour GB. Banana. In: Seymour G, Taylor J, Tucker G, eds. Biochemistry of fruit ripening. London: Chapman and Hall; 1993. p. 95-8.

[10] Subagio, Morita N, Sawada S. Carotenoids and their fatty-acid esters in banana peel. Journal of Nutritional Science and Vitaminology. 1996;42(6):553–66.

[11] Knapp FF, Nicholas HJ. Sterols and triterpenes of banana peel. Phytochemistry. 1969; 8(1):207–14.

[12] Rustom IA. A brief history of the antibiotic era: lessons learned and challenges for the future. Front. Microbio. 2010;1:1-7.

[13] Kavitha V, Manonmani G. Antimicrobial effects of variety of dried banana peel extracts. International Journal of Pharmaceutical Research and Applications. 2020;5(2):03-06.

[14] Suraj PK, Pushpa SP, Sachin S. Detection of antimicrobial activity of banana peel (Musa paradisica L.) on Porphyromonas gingivalis and Aggregatibacter actinomycetemcomitans: An in vitro study. Contemporary Clinical Dentistry. 2015;6(4):496-9.

[15] Ehiowemwenguan G, Emoghene AO, Inetianbor JE. Antibacterial and phytochemical analysis of banana fruit peel. IOSR Journal of Pharmacy. 2014;4(8):18-25.

[16] Chinnappan RS, Kandasamy K, Natarajan SB, Sekar A, Thangavel G. Evaluation of microbial potential of different colored bananas. International Journal of Preclinical & Pharmaceutical Research. 2013;4(2):62-4.

[17] Matook SM, Fumio H. Antibacterial and antioxidant activities of banana (Musa, AAA cv. Cavendish) fruits peel. American Journal of Biochemistry and Biotechnology. 2005;1(3):125-31.

[18] Temístocles IS, Miria OB, Paulo ATMG, Anne CNC, Teresinha GS, Ana CLL. Synthesis, anticancer activity and mechanism of action of new thiazole derivatives. European Journal of Medicinal Chemistry. 2018;144:874-86.

[19] Amaal MK, Mervat ST, Amr MM. The radioprotective and anticancer effects of banana peels extract on male mice. Journal of Food and Nutrition Research. 2019;7(12):827-35.

[20] Kumar PS, Durgadevi S, Saravanan A, Uma S. Antioxidant potential and antitumour activities of Nendran banana peels in breast cancer cell line. Indian Journal of Pharmaceutical Sciences. 2019;81(3):464-73.

[21] Wermerson AB, Iracelle CA, Larissa SR, Claudia QR, Heraldo PS, Thais ML. Chemical composition and cytotoxic screening of Musa cavendish green peels extract: Antiproliferative activity by activation of different cellular death types. Toxicology in Vitro. 2019;59:179-86.

[22] Sobanalakshmi S, Valamarthi S, Seethalakshmi I, Dhanalakshmi KG. Anticancer activity and DNA fragmentation of ferulic acid from banana peel using HeLa cell line. International Journal for Research & Development in Technology. 2017;7(4):631-35.

[23] Munish G, Kusum L, Saurabh S. Cytotoxic potential of few Indian fruit peels through 3-(4,5-dimethylthiazol-yl)-2,5-diphenyltetrazolium bromide assay on HepG2 cells. Indian J Pharmacol. 2016;48(1):64-8.

[24] Saad SD, Mohamad TA, Yasser MT, Amin MSAM. Antioxidant activities and anticancer screening of extracts from banana fruit (Musa sapientum). Academic J Cancer Res. 2015;8(2):28-34.

[25] Nessma AZ. Antioxidant, antitumor, antimicrobial studies and quantitative phytochemical estimation of ethanolic extracts of selected fruit peels. Int J Curr Microbial App Sci. 2015;4(5)298-309.

[26] Fatimah CA, Lida R, Zainul AZ, Abdul LI. Hepatoprotective, antiulcerogenic, cytotoxic and antioxidant activities of Musa acuminata peel and pulp. In: Ameenah G. Novel Plant Bioresources: Applications in Food, Medicine and Cosmetics. 1st ed. John Wiley & Sons, Ltd.; 2014. p. 371-82.

[27] Imam MZ, Akter S, Mazumder MEH, Rana MS. Antimicrobial and cytotoxic properties of different extracts of Musa sapientum L. subsp. Sylvestris. International Research Journal of Pharmacy. 2011;2(8):62-5.

[28] Shokeen P, Anand P, Murali YK, Tandon V. Antidiabetic activity of 50% ethanolic extract of Ricinus communis and its purified fractions. Food Chem Toxicol. 2008;46(11):3458-66.

[29] Murthy SSN, Christilda F. Antidiabetic activity of Musa sapientum fruit peel extract on streptozotocin induced diabetic rats. Int J Pharm Bio Sci. 2015;6(1):537-43.

[30] Hongmei W, feng X, Junjie H, Ye Y, Xiangpei W. Antihyperglycemic activity of banana (Musa nana Lour.) peel and its active ingredients in alloxan-induced diabetic mice. 3rd International Conference on Material, Mechanical and Manufacturing Engineering. 2015;231-38.

[31] Summera R, Nisha A, Shahina S. Isolation and characterization of fungi from dandruff-afflicted human scalp and antidandruff shampoo. Indian Journal of Applied Research, 2014;4(9):253-5.

[32] Bharathi P, Sumangala CH, Govindappa M, Chidanand G. Evaluation of antifungal activity of banana peel against scalp fungi. Materials Today: Proceedings 4. 2017;11977-83.

[33] Rediske JJ, Koehne CF, Zhang B, Lotz M. The inducible production of nitric oxide by articular cell types. Osteoarthritis Cartilage. 1994;2:199-206.

[34] Gina K, Wikan M, Gina A. Anti-inflammatory activity of the peel extract of ambon bananas (Musa paradisica L.) examined with the human red blood cell membrane stabilization method. The 4th International Seminar on Global Health. 2022;2022:216-33.

[35] Pathompong P, Srisopa R, Arunporn I. Anti-inflammatory and antioxidant activities of extracts from Musa sapientum peel. J Med Assoc Thai. 2012;95(Suppl. 1):S142-6.

[36] Aminov RI. A brief history of the antibiotic era: lessons learned and challenges for the future. Front. Microbio. 2010;1:1-7.

[37] Muhammed S, Mohammed TS. Potential application od waste fruit peels (orange, yellow lemon and banana) as wide range natural antimicrobial product. Journal of King Saud University – Science. 2019;32(2020):805-10.

[38] Ahmed MA, Zeinab AS, Alaa AG, Hanan FA, Faten A, Habiba AA. Identification of phenolic compounds from banana peel (Musa paradisica L.) as antioxidant and antimicrobial agents. Journal of Chemical and Pharmaceutical Research. 2016;8(4):46-55.

[39] Zainab AGC, Alaa HA, Nada KKH, Shatha KKH. Antimicrobial effect of aqueous banana peel extract, Iraq. Research Gate: Pharmaceutical Sciences. 2013;1:73-5.

[40] Ighodaro OM. Evaluation study on Nigerian species of Musa paradisica peels: Phytochemical screening, proximate analysis, mineral composition, and antimicrobial activities. Researcher. 2012;4(8):17-20.

[41] Silva BA, Ferreres F, Malva JO, Dias ACP. Phytochemical and antioxidant characterization of Hypericum perforatum alcoholic extracts. Food Chemistry. 2005;90(1-2):157-67.

[42] Shyamala BN, Jamuna P. Chemical composition and antioxidant potential of peels from three varieties of banana. As. J. Food Ag-Ind. 2011;4(1):31-46.

[43] Ramakrishna B, Selvaraj S, Babu S, Radhakrishnan S, Radhakrishnan N, Palanisamy P. Antioxidant potential of peel extracts of banana varieties (Musa sapientum). Food and Nutrition Sciences. 2011;2:1128-33.

[44] Rafela G, Glorio LM, Monica G. antioxidant activity in banana peel extracts: testing conditions and related bioactive compounds. Food Chemistry. 2009;119(2010):1030-9.

[45] April WA, Charlotte R. Pathophysiology, clinical presentation and treatment of psoriasis: A review. JAMA. 2020;323(19):1945-60.

[46] Nithya DE, Mahesh K. Anti-psoriatic activity of Musa mysore Aab (Poovan banana) peel extract using human keratinocyte cell line. International Journal of Science and Research. 2015;4(3):614-26.

[47] Lewis DA, Hanson PJ. Anti-ulcer drugs of plant origin. Prog Med Chem. 1991;28:201-31.

[48] Samuel AO, Benjamin OE, Austin AA. Anti-ulcer and ulcer healing potentials of Musa sapientum peel extract in the laboratory ridents. Phcog Res. 2012;5(3):173-8.

[49] Saller R, Meier R, Brignoli R. The use of silymarin in the treatment of liver diseases. Drugs. 2011;61:2035–63.

[50] Regnault MR, Gaduad N, Boulinguez S, Tournier E, Lamant L, Gladieff L. Chemotherapy-related reticulate hyperpigmentation: a case series and review of the literature. Dermatology. 2015;231:312-8.

[51] Naphichaya P, Krit T, Khanit S, Uraiwan P, Che-Hsin L, Mullika TC. Effect of banana peel extracts on inhibition of melanogenesis through the ERK signaling pathway. Int. J. Med. Sci. 2019;16(4):602-6.

[52] Curtiss LK. Reversing atherosclerosis. New England Journal of Medicine. 2009;360(11):1144-6.

[53] Arlinda SP, Kartika PR, Eria NP, Dyah PA, Wafiyah H. The effectiveness of Ambon banana peel extract (Musa sapientum) as atherosclerosis prevention through inhibition of NF-Kβ and increased eNOS expression in atherogenic rat model.

[54] Liu, Rui H. Potential synergy of phytochemicals in cancer prevention: mechanism of action. The Journal of Nutrition. 2004;134(12),3479S-85S.

[55] Sethi A, Kaur T, Gambhir M. Moisturizers: The slippery road. Indian Journal of Dermatology. 2016;61(3):279-87.

[56] Wianlie C, Diadora, Albert DS, Ahmad RM, Refi I. Potential effect of Musa paradisica peel extract on skin hydration. In proceedings of the International Conference on Health and Medical Application Technology. 2019;379-86.

[57] Thakur R, Jain N, Pathak R, Sadhu SS. Practices in wound healing studies of plants. Evidence-based complimentary and alternative medicine. 2011;1-17.

[58] Pari T, Aliasghar H, Ali A, Jaber Z, Babak M, Mohammadshafi D, Allahyari N. evaluation of wound healing activity of hydroalcoholic extract of banana (Musa acuminata) fruit's peel in rabbit