

Banana peel: precious waste & its astounding properties

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Abstract

This review paper examines the uses and properties of banana peels as a valuable resource. The first section provides an overview of banana cultivation, including state-wise production in India. The second section explores the potential uses of banana peels in various fields, including skincare, water treatment, textile dyeing, and paper-making. Banana cultivation is a significant agricultural activity in India, with various states contributing to the overall production. However, banana peels are often discarded as waste despite their incredible properties. Recent research has highlighted the potential of banana peels in various fields, including skincare, where they are rich in antioxidants and vitamins. In addition, banana peels have been used in water treatment due to their ability to absorb heavy metals and other pollutants. They can also be used as a natural dye in textiles, providing an eco-friendly alternative to synthetic dyes. In the paper-making industry, banana peels have shown promising results as a raw material due to their high cellulose content.

Overall, this review highlights the potential of banana peels as a valuable and underutilized resource in India. By repurposing banana peels, farmers and manufacturers can reduce waste, conserve resources, and develop sustainable solutions to various societal challenges. The results of this study suggest that banana peels represent a precious waste with astounding properties, which can contribute to a more sustainable and eco-friendly future.

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Graphical abstract



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1 INTRODUCTION

Banana belongs to genus *Musa*, which belongs to Musaceae, flowering plant family and is characterized by an above-ground pseudostem (false stem) with a terminal crown of large leaves and hanging bunches of eatable, lengthened fruit, is referred to as a "banana", which is very important in the commercial sector. Bananas have numerous culinary, commercial, and environmental benefits. (32)The majority of culinary bananas do not contain seeds in their fruits; or wild varieties. The fruits can be consumed raw, cooked, or ground for use in baking. In addition, green or unripe bananas can be used to make starch and add flavor to a variety of dishes. (15; 18)During transportation to the markets, bananas can easily be damaged, and some ripe bananas are damaged and lost. The animal feed contains plant materials and banana peel. (15)

Banana is one of the greatest consumed fruit globally. The peel is discarded after the fruit is consumed. However, the banana and its peels are equally useful. They are identified to have antibiotic, enzymatic, and antifungal properties. Vitamins and fiber are abundant in them. It was also used as a mask for the hair and face. The peel has recently been used

to treat a variety of conditions, including warts and acne. Biofuel production, organic fertilizer, biosorbents, environmental clean-up, pulp and paper, energy-related activities, cosmetics, and biotechnology-related processes are just a few of the many industrial uses for the banana peel. (1) Bananas are now the fourth most important commodity in the climate that can be used for both domestic consumption and export. (20)

Since banana is the second most cultivated fruit after citrus and accounts for approximately 16% of the world's total fruit production. (10) All the palatable banana natural products are seedless (parthenocarpic) and have a place with two primary species, *Musa acuminata* Colla and *Musa balbisiana* Colla. Today, *Musa x paradisiaca* L., a hybrid of these two species, is also available. Papua New Guinea was the first country to domesticate the banana, even though it is native to Indomalaya and Australia. The banana now exists in nearly 135 nations all over the world. (18)

Mulberry or banana (*Musa* spp.), one of the main fruit crops grown for their edible fruits in tropical and subtropical regions is the Musaceae family. The average weight of the fruit is 125 grams, with approximately 75% water and 25% dry matter. (15) When ripe, banana fruits range in size and color from yellow to red. (32; 15) Numerous nutrients and minerals have been demonstrated to be present in the banana peel (*Musa sapientum*). The banana peel contained crude proteins of 1.95 ± 0.14 percent, crude fat of 5.93 ± 0.13 percent, and 11.82 ± 2.17 percent carbohydrates. Phosphorus, iron, calcium, magnesium, and sodium made up the banana peel's mineral makeup. Manganese, copper, zinc, and potassium were found in very low amounts of mg/100 g. (15)

Consuming fruits and fruit products is known to not only improve overall health but also to reduce the risk of a number of chronic illnesses, including heart disease, stroke, gastrointestinal problems, certain types of cancer, hypertension, age-related macular degeneration, cataracts of the eye, skin conditions, a decrease in low-density lipoprotein (LDL) cholesterol, and improved immune function. (18) The peel of a banana is said to have antifungal and antimicrobial properties that could be used to stop microorganisms from growing. Anti-aging products rely on the antioxidant properties of banana peel. Additionally, banana peel can be utilized as an effective bio-adsorbent due to its UV protection property. It is said that the pulp of the banana peel contains lipids and a lot of potassium, both of which are useful for hydrating the skin. The banana peel extract demonstrated healing from sunburns, itching, pain, swelling, bruising, and wrinkles. (6) In conclusion, chitosan and gelatin wound dressings were made, and potato starch, sesame oil, and banana peel powder were used to test their properties, cytocompatibility, and ability to heal wounds. (3) Mucus density and thymidine incorporation

into cell DNA are both increased by green banana extract, demonstrating its influence on cell multiplication. (4) A severe ailment that has spread around the globe is wound infection, using banana peels combined with chitosan as a wound dressing to provide quick assistance therapies for such infections. (5) The dried banana peel powder and ash extract had antifungal and anti-dandruff effects. (1; 2) Herbaceous plants are commonly referred to as bananas. It is one of the oldest plants that have been grown. The banana plant's various parts can be used for medicinal purposes: the flowers on ulcers, dysentery, and bronchitis; Diabetes patients receive cooked flowers; the astringent plant sap is used to treat epilepsy, hysteria, leprosy, hemorrhages, acute dysentery, fevers, and diarrhea. It is also used to treat insects and other stings and bites, hemorrhoids, and diarrhea. (30)

The banana has a lot of nutrients. It has a rare combination of protein, vitamins, minerals, energy, and building materials for tissues. Because it has more solids than any other fresh fruit and less water, it is a good source of calories. Vitamin C, which helps to rebuild the immune system, is abundant in bananas. Compared to other foods, bananas are also relatively easy to digest, making them useful for people whose immune systems are weak. Because they contain potassium, which helps to reduce and control high blood pressure, bananas can also be included in a diet for high blood pressure. Because the health benefits of ripe bananas are so diverse, they should be taken into consideration when choosing a diet. (15; 30)

Bananas are one of the most popular fruits in the world, with global production reaching 117 million metric tons in 2020. According to the Food and Agriculture Organization (FAO), the top five banana-producing countries in the world are India, China, the Philippines, Ecuador, and Indonesia. (34)

In India, bananas are grown in almost every state, but the major banana-producing states are Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, and Karnataka. In 2019-2020, India produced 30.9 million tons of bananas, making it the largest producer of bananas in the world. (34; 35)

State-wise banana production in India in 2019-2020 (in metric tons) are as follows: (34)

2 BANANAPEEL & BEAUTY CARE

Banana is an herbaceous plant that has different varieties and is native to Southeast Asia and India. Banana contains no cholesterol or fat and has sugars like glucose, fructose, sucrose, and fiber. It also reduces blood pressure if eaten every day and is one of the best sources of vitamin B6 and potassium. (1; 13) A compound called Tumor Necrosis Factor (TNF) is produced by yellow-

TABLE 1
State-wise banana production in India in 2019-2020 (in metric tons)

Tamil Nadu	50,25,900
Maharashtra	47,61,700
Gujarat	44,98,500
Andhra Pradesh	38,36,100
Karnataka	31,93,800
Telangana	19,96,000
Madhya Pradesh	13,74,000
Bihar	12,38,200
Uttar Pradesh	11,66,100
West Bengal	10,59,100

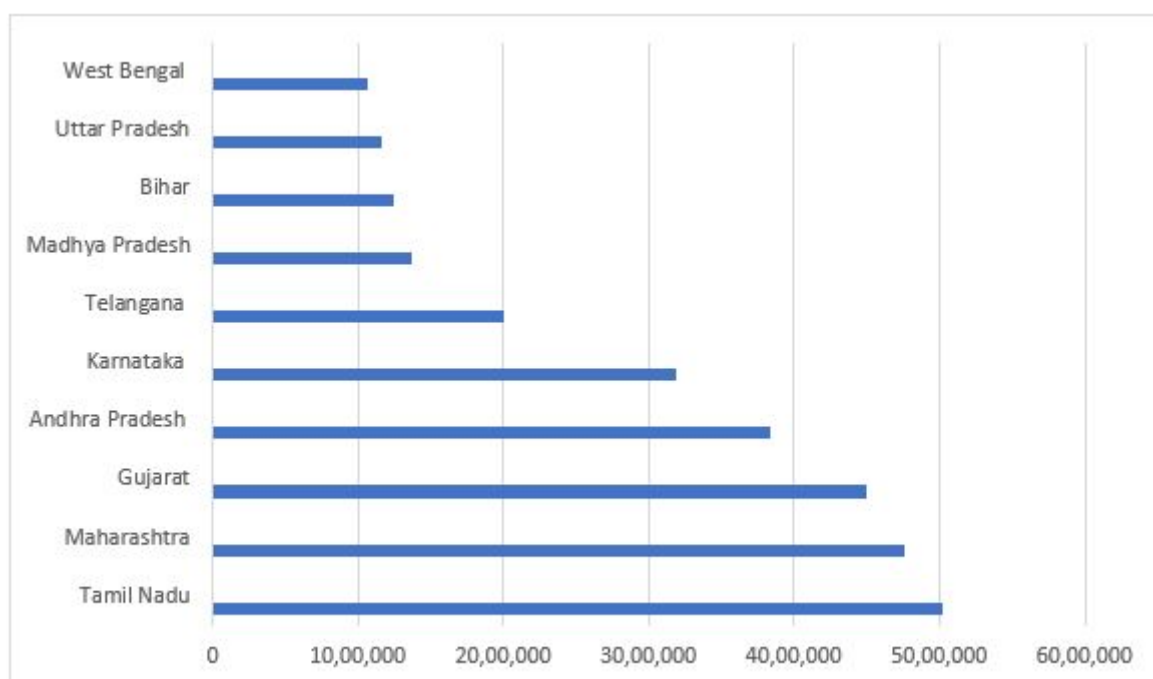


FIGURE 1

Graphical representation of state-wise banana production in India in the year 2019-20 (in metric tons)

skinned dark-spotted bananas that enhance immunity by increasing white blood cell count and can reduce the formation of ulcers in the stomach. Banana also contains probiotic bacteria and helps in bone strengthening. Banana peel has anti-aging and acne-treating properties due to the presence of compounds like zeaxanthin, lutein, and carotenes. Smashed bananas can act as moisturizers when applied to cracked heels. (6; 13) Solvents like water, acetone, ethanol, methanol, etc can be used to develop extracts of banana peel. (6)

According to a report by Research and Markets, the Indian skincare market is expected to grow at a rate of 7.4% per year between 2020 and 2025, with an increasing demand for natural and organic products. The use of banana peels in skincare products can provide a sustainable and eco-friendly alternative to synthetic ingredients. (38)

2.1 Antiaging

The aging of the skin is a natural process. ^(14; 23) The reduction of physiological functions of the skin leads to aging of the skin where the elasticity is lost and wrinkling in the skin increases. Aging of skin can not only caused by age but also could be by harsh environmental conditions and increased exposure to UV radiation. The collagen in the skin can be degraded by UV radiation when exposed for too long. ^(14; 23) In a study conducted, it was found that banana leaf extract could increase the production of collagen in the skin when it was applied regularly on either wrinkled skin or healthy skin and that polysaccharide-removed banana leaf extract showed the highest antiwrinkle property. (14) Hyperpigmentation could also be a sign of aging or prolonged exposure to UV radiation. Hyperpigmentation is due to the melanin produced by the skin where premature melanin gets converted to active melanin by an enzyme called tyrosinase. The carotenoid and phenolic compounds in the banana peel hinder the function of this enzyme resulting in the reduction of dark spots and dark pigmentation of the skin. ⁽²³⁾ the pulp of banana peel can be used as a moisturizer due to its potassium and lipid content. (6)

2.2 Antioxidant and antimicrobial activity

In banana peel extract, there are several active secondary compounds present such as saponins, flavonoids, alkaloids, etc that has antioxidant property. These compounds, especially flavonoids prevent tissue damage in organs by reducing free radicles and mature banana peel showed lesser antioxidant activity than raw banana peel. ^(15; 23) A study reported that the higher the flavonoid and phenolic compounds in the banana peel extract, the higher its antioxidant activity. The antimicrobial activity of banana peel extract is due to the tannins present in the

extract. Tannins have an astringent action that inhibits the growth of microorganisms. (15) Various parts of the banana plant, especially water extracts of banana peel if found to have an antibacterial activity that helps in inhibiting the growth of microorganisms that has the potential to cause acne and rashes or blemishes. (23)

2.3 Preventing dental plaques

Plaque is a biofilm formed by bacteria that breaks down the food particles that are accumulated between teeth and gums. Increased bacterial growth and decreased oral hygiene can result in infections such as gingivitis and periodontitis and could even lead to loss of teeth. This can be prevented by good oral hygiene and with the help of extracts of banana peel that contain several compounds like terpenoids, alkaloids, flavonoids, etc. (23) Mild oral infections may be treated using banana peel but advanced infections should be treated by a medical professional.

2.4 Anti-inflammatory activity

The cytokines produced after an insect bite, a cut or a small wound, or an infection are the cause of inflammation around the affected area. Redness, swelling, itching, and other symptoms can be seen in the affected area. The symptoms of inflammation can be subsided by the extract of banana peel as tannins are present. (1; 6; 23) Vitamin B6 can increase the number of white blood cells and boost the immune system resulting in the reduction of swelling. (6)

2.5 A remedy for cracked heels

Cracked heels are the result of skin cells that lost their elasticity due to the loss of water and thickening of the skin. The crack in the heels poses a high risk of infections as it allows the entry of bacteria and other microorganisms into the skin. This can be often seen in diabetic patients and people who are obese. The pulp of banana peel can be useful in this case to heal the crack with its moisturizing ability as it contains lipids and the extract of banana peel has antibacterial activity as tannins and flavonoids are present that can inhibit the growth of microorganisms. In a study, it was reported that leucocyanidin and flavonoids in the banana peel extract help in healing wounds. (6)

3 BANANA PEEL IN BIO-ETHANOL PRODUCTION

Due to a flaw in the grading process, banana waste is thrown away which is one of the world's most important fruit crops. ^(19; 29) It produces a lot of lignocellulosic residues after it is harvested, which could be used to make second-generation ethanol. (19; 29) 4.1 to 7.1% bioethanol was produced from the fermented fruit waste of bananas. With a longer fermentation time, the mixture of rotten banana fruits produced more bioethanol. ⁽¹⁹⁾ In the transportation sector, ethanol has been acknowledged as a suitable substitute to partially replace fossil fuels. ⁽¹⁹⁾ Global production of ethanol rose by 4% ⁽¹⁹⁾. Due to its abundance and availability, lignocellulosic biomass is a promising feedstock for ethanol production. (29) Indeed, agricultural residues do not create a fuel-versus-food competition and can be utilized locally. ⁽²⁹⁾ The improvement of the process for making bioethanol from staple crops lignocellulosic waste like rice husk, corn stover, and wheat straw. ⁽²⁹⁾ Due to the fact that bioenergy is primarily powered by organic waste, it is gaining popularity. ⁽³¹⁾ Biotechnological bio processes like anaerobic digestion (AD) and microbial fuel cells (MFC) have emerged as novel alternatives due to their ability to combine treatment with the production of bioenergy and/or electricity. (33)

4 REPURPOSING BANANA PEEL

Banana, having high nutritional content is also one of the most popular fruits annually produced and consumed as fresh fruits or processed as chips, ice cream, flour, bread, and as an ingredient for functional foods. Annually about 102 million tonnes of bananas are produced and out of which 35% of whole fruit weight accounts for the peel that is, about 36 million tonnes of banana peel is generated annually. Most of the time, the peel gets discarded along with the general waste or lands up in landfills. ⁽²⁴⁾ Banana peel contains about 60% dry matter and is very rich in carbohydrates. During harvest, the estimated weight of a banana plant is about 100 kg, out of which 50 kg corresponds to pseudo-stalks, 33 kg to fruits, 15 kg to leaves, and 2 kg to rachis. For example, the waste from both, banana farming and commercial packaging in Central America are generally in open-air dumps present in the same plantation. The absence of appropriate treatment and poor disposal of these wastes which are bio-degradable causes the proliferation of pathogenic organisms and the liquid separated from the waste negatively affects the soil and groundwater. (12) Additionally, elements like magnesium, manganese, and potassium found in banana peels can aid in tooth enamel lightening. A banana peel is also added to the roast, which adds moisture as it cooks. Banana peels are repulsive to aphids, thus shove the peels around plants like cauliflower and roses to keep them away. Psoriasis may be

treated with a banana peel applied to dry skin, and acne may also be treated with a banana peel. The nutrients in a banana peel are important and degrade swiftly. ⁽²⁶⁾

4.1 Banana Peel in Water Treatment

Water pollution has become a global threat to the environment and aquatic life. Heavy metals, dyes, pharmaceuticals, radioactive substances, oil contaminants, and chiral chemicals are various sources of water pollution. Heavy metals are non-biodegradable, toxic, and have a high tendency towards bioaccumulation. Effluents from mining, metal finishing, glass, smelting, steel, and battery manufacturing are various sources of heavy metal contamination of water. At high concentrations, heavy metals become carcinogenic and cause hyperkeratosis, skin lesions, and liver, stomach, liver, brain, and kidney problems. ^(8; 9; 24; 27) The surface characteristics and adsorption capacity of pyrolyzed and dried up activated banana peel with commercial activated carbon (F-400) against an aqueous Cu(II) ion solution were compared. When dried banana peels are pyrolytically activated, they have bigger mesopores (49Å) but a smaller surface area (38.49 m²/g) adsorbent with dominantly negative surface charges than commercial activated carbon (F-400), which has smaller mesopores (30Å) but a high surface area (819 m²/g). The adsorption capabilities of commercial activated carbon (F-400) (2.39 mg/g) and produced activated dried banana peel (38.4 mg/g) were evaluated, and it was discovered that the latter had a higher adsorption capacity. Although the dried banana peel has a lesser surface area, the existence of an opposing charge on the adsorbent's surface explains the higher adsorption capacity. ⁽²⁷⁾ A batch experiment was conducted to investigate the removal of Pb(II) and Cd(II) ions using powdered adsorbent produced from banana peel. To achieve maximal adsorption capacity, experimental factors such as banana peel powder dose, pH, contact duration, and agitation speed were examined. The collected isotherm data were used to characterise the adsorption behaviour of Pb(II) and Cd(II) ions onto banana peel powder using Freundlich, Langmuir, and Temkin isotherms. The Langmuir model was used to analyse the isotherm data, and the maximum adsorption capacity of banana peel powder against Pb(II) and Cd(II) ions was determined to be 2.18 mg/g and 5.71 mg/g, respectively. ⁽²⁷⁾

Natural dyes have a long history of usage, but synthetic dyes are now employed in sectors such as paper and pulp, plastics, textiles, cosmetics, leather, and food. Artificial colours degrade slowly, causing multiple effects on the aquatic environment. Pollution from the release of textile effluent into bodies of water is a widespread problem in many evolving nations. They endanger the environment and ecosystems, causing toxicity in humans and aquatic species. The introduc-

tion of manmade colours into waterways by industrial effluents has an impact on the individuals who use this water for washing, drinking, and bathing in their everyday activities. Water tainted with dye is extremely hazardous to aquatic plants and wildlife. It has the ability to cause mutagenesis and carcinogenic activities within live cells. It has the potential to cause significant harm to the human endocrine systems, including the renal, reproductive, central nervous system, brain, and liver malfunction. As a result, dye treatment from industrial and domestic wastewater is an urgent call to action before they affect our water surface and groundwater sources. Banana waste-derived adsorbents have recently been explored for their adsorption ability against several kinds of synthetic dyes. Apart from heavy metals and dye removal from water, banana-derived adsorbents have been found to be efficient in removing pesticides, organic and inorganic pollutants, and water-soluble radioactive nuclides from water. (27)

4.2 Paper from Banana Peel

Banana fibre is a natural fibre. High-strength natural fibre from bananas can be easily combined with synthetic or cotton fibre to create composite materials. A significant amount of lignocellulosic waste is produced during the fibre extraction process, and its disposal causes issues in the surrounding environment. Waste banana fibre has a very low cellulose content and a high ash content. Waste banana fibre is made up of cells that aren't fibrous, broken fibres, and fibres themselves. Waste banana fibre is defibrillated after 120 minutes of heating with an 8% alkali charge, producing a pulp yield of 35.9%. Extracted banana fibre pulp has a very high initial SR value, which rises to a very high tensile strength. Due to the higher fibre length, the extracted banana fibre has an extremely high tear index. Waste banana fibre has good paper-making qualities for handmade paper. But compared to pulp made from extracted banana fibre, these qualities are significantly less. Banana fibre extraction plant waste may be utilised to make handmade paper, which will reduce pollution and open up job opportunities in rural areas. (22)

According to the Ministry of Commerce and Industry, the paper industry in India has been growing at a rate of 6-7% per annum, with an estimated production capacity of 20 million tonnes per year. The use of banana peels as a raw material in this industry can contribute to reducing the environmental impact of traditional pulp and paper production processes. (37)

4.3 Banana Plant Extract in Dyeing of Textile

The discovery of colourful clothing and madder dye traces in the Indus Valley Civilization's ruins at Mohenjo-Daro and Harappa provide evidence that dyeing was known even during the

Indus Valley period (2600–1600 BC). As ancient as textiles themselves are natural dyes, dyeing, and dyeing materials. The technique of dyeing has a lengthy history, and many of the dyes dates back to prehistoric times. Man has always been fascinated by colour. In Europe, it was used during the Bronze Age. In China, a 2600 BC document detailing the usage of natural colours was unearthed. Till the end of the 19th century, natural dyes derived from plants such as Tamarind, Guava, Onion, Suji, Teak, Mango, Ketapang, Indigofera, Mahogany, Pandan, Banana, and Mangosteen. Synthetic dyes in around 1956, became more important and replaced the nature-derived dyes in the textile industry. (10) As the industry grows, the industrial effluent discharge also increases and the drainage of these effluents containing synthetic chemical-based colourants in the water bodies affects the aquatic system and also the wildlife along with humans who uses the water for drinking, washing, and bathing purposes. Aquatic plants and fauna are especially vulnerable to dye-contaminated water. It has the power to activate carcinogenic and mutagenic processes in living cells. It has the ability to seriously disrupt human endocrine systems, including the liver, kidney, brain, central nervous system, and reproductive systems. (27) products created from natural materials are becoming more and more popular as a consequence of growing public awareness of the negative impacts of synthetic colors. This is because natural dyes have no hazardous or allergic side effects and cause less pollution. Banana dyes have significant textile applications. Investigations into dyeability, colorfastness, and color strength suggested possible applications in the textile sector. The extract may be effectively utilized as binders and mordants, and to remove certain reactive colors from textile effluents. Mordants can be added to the dye solution to enhance dyeability and dye fixing. ⁽¹⁰⁾

The textile industry is one of the largest contributors to water pollution in India, with an estimated 20% of industrial water pollution coming from textile dyeing and finishing. The use of natural dyes, such as those derived from banana peels, can help reduce the environmental impact of the industry. (36)

4.4 Banana peels in asbestos-free eco-friendly brake pad

The braking system is an important part of any vehicle. Braking pads are an integral part of the braking system in vehicles having disc brakes. These pads are steel plates covered with friction material made out of asbestos fibers embedded in a polymeric matrix facing the brake disc. Asbestos being carcinogenic in nature is now been avoided and the industry is moving away from it, even if it is not banned yet, due to worries about airborne particles in workplaces and the disposal of asbestos-containing trash. A novel brake pad was developed utilizing discarded

banana peels to replace asbestos and Phenolic resin (phenol-formaldehyde) as a binder. The resin ranged from 5 to 30 wt%, with 5 wt% intervals. The brake pad's morphology, physical, mechanical, and wear qualities were investigated. The findings showed that the compressive strength, hardness, and specific gravity of the generated samples rose with increasing wt% resin addition, but the oil soak, water soak, wear rate, and percentage burned reduced. The samples comprising 25% uncarbonized banana peels and 30% carbonized banana peels had the best overall attributes. According to the findings of the study, banana peel particles may be efficiently utilized. (11)

4.5 Banana peel in oil spill removal

Oil spills are one of the global threats to the environment and marine life, affecting the lives of shellfish, mosses, sea creatures, and birds. Crude oil is made up of a variety of hydrocarbons ranging from extremely light oil to heavy oil, with hydrocarbon fractions ranging from 50 to 98%. When oil is spilled into the water, it causes weathering processes such as evaporation, dissolution, oxidation, emulsification, sedimentation, spreading, dispersion, and eventually biodegradation. The evaporation process alters the physical properties of the oil, causing changes in density and pour point due to the loss of volatile components. Furthermore, emulsification alters oil composition, resulting in a drop in oil density and a rise in pour point. Spreading speeds vary depending on the oil qualities, with light oil spreading quicker than heavy oil. Water temperature and wind speed have the greatest impact on pollution distribution of all parameters. Oil spreading may occur on a static surface, however, in the case of rivers, spills are carried along the stream. Tidal currents have a significant influence on pollutants in the water, particularly in open seas and areas. The primary limitations of mechanical and chemical treatment for oil spill removal are their high cost and inadequate trace-level adsorption. Mechanical treatment cannot be used in strong seas or heavy winds, although it is effective in totally removing oil. To be successful, chemical treatments such as dispersion must be administered promptly after a spill and might impact marine organisms because of their high toxicity. A comparison of banana peel and other organic sorbents was investigated to assess the effectiveness of banana peel for oil spill recovery. It was discovered that surface qualities, oil type, oil film thickness, sorption duration, temperature, and salinity all had an impact on oil sorption capacity. The experiment findings revealed that the optimal conditions are at a particle size of 0.3625 mm at 25°C, a sorption duration of 15 minutes, 3.5% artificial seawater, and a thickness of 5 mm oil layer. Maximum sorption capacity values for gas oil, 1-day weathered crude oil, and 7-day weathered

crude oil are 5.31, 6.35, and 6.63 g/g sorbent, respectively. It should be noted that the sorbent can be reused more than ten times to achieve 50% of the initial sorption value. Overall, the sorption capability of banana peel yields a positive outcome as a novel and low-cost agricultural waste for oil spill cleaning. As a result, banana peel not only serves to reduce environmental contamination but also helps to reduce agricultural waste. (28)

4.6 Banana Peel in promoting plant growth

Bananas contain critical nutrients that can be recycled into valuable materials that may be utilized for a variety of uses. For characterization, the nano-fertilizer extract was subjected to both physical and chemical analyses. The size of the fertilizer constituents ranged from 19 to 55 nm, and the histogram shows that the primary nanoparticles were 40 nm with an average percentage of 36%, while 55 nm particles had an average percentage of 6%. Chelated potassium, chelated iron, tryptophan, urea, amino acids, protein, and citric acid were all included in the nano-fertilizers created. Nano-fertilizer derived from banana peels was used in the cultivation of two crops: tomato and fenugreek. The findings showed that increasing the dosage of banana peel extract enhanced the percentage of germination in both crops. The germination percentage for tomato crops improved from 14% (control without nano) to 97% after 7 days of planting. The same pattern was observed for the fenugreek crop, with sprouting increasing from 25% (control without nano) to 93.14%. (24; 25; 26)

5 Conclusion

It has become essential to practise sustainable farming to conserve the environment and resources for the future generations. It is necessary to make sure that the agricultural waste materials are used fully to their potential before it's disposal it is best to use the maximum out of waste materials. One such waste is banana peel. Banana peel has lots of vitamins and minerals that is valuable for human use. This could help in reducing the loss of useful substances in banana peel and a huge reduction in the amount of waste disposed. Banana is an herbaceous plant that has several cosmetic and medicinal properties like antioxidant, antimicrobial, moisturizing, antiaging, etc. The extracts of various parts of the banana plant have several of these above-mentioned properties due to substances like lipids, alkaloids, flavonoids, carotenes, potassium, vitamin B6, saponins, tannins, and phenolic compounds. Many of these compounds are secondary metabolites that are found to be good for our body such as reducing wrinkling, moisturizing our skin, reducing/inhibiting the growth of microorganisms, reducing pigmen-

tation on the skin, preventing/reducing the formation of dental plaques, reducing inflammation/redness/swelling/itching caused by insect bite/small injury/infection. Banana peels contain magnesium, manganese, and potassium, all of which can help lighten tooth enamel. It can also be used in the eco-friendly brake pad. Due to the high content of fibre in banana waste, paper is also made from it. Additionally, bananas are excellent adsorbents for dye treatment and heavy metal removal from water. It is also effective at removing radioactive nuclides or pesticides from water and reduces agricultural waste. Nano-fertilizers from banana peel is also used in agricultural field from growing crops like tomato and fenugreek. In dye industries, it is also used for the removal of reactive colour from textiles. Therefore, this all properties make banana peel a real treasure.

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