Naveen Shodh Sansar (An International Refereed / Peer Review Multidisciplinary Research Journal)
RNI No.- MPHIN/2013/60638, ISSN 2320-8767, E- ISSN 2394-3793, Scientific Journal Impact Factor (SJIF)- 8.054,
April to June 2025, E-Journal, Vol. I, Issue L (50), ISO 9001:2015 - E2024049304 (QMS)

Chemical Composition and Applications of the Banana Tree

Akhilesh Chandra Verma*

***Department of Chemistry, Government Naveen College, Kui-Kukdur, Kabirdham (C.G.) INDIA**

Abstract: The banana tree (*Musa spp.*), commonly known for its fruit, is a chemically rich plant with diverse applications in agriculture, medicine, and industry. This paper explores the banana tree's constituents—including the fruit, peel, pseudo stem, leaf, and root—from a chemical perspective. Each part contains valuable organic compounds such as polyphenols, flavonoids, cellulose, lignin, starch, and various bioactive phytochemicals. By understanding these chemical properties, we can better utilize the banana tree for bioplastics, textiles, natural dyes, biofertilizers, pharmaceuticals, and waste management. This study highlights the potential for sustainable and value-added applications rooted in the tree's biochemistry.

Introduction - The banana tree is not just a source of edible fruit but also a valuable biomass resource. It grows in tropical and subtropical regions and is rich in bioorganic compounds. A chemist's interest lies in the diverse chemical compounds present in different parts of the plant, which offer possibilities for green chemistry, sustainable development, and functional material synthesis.

Chemical Composition Of Banana Tree Parts

Banana Fruit

Carbohydrates: Mainly sucrose, glucose, and fructose. Ripe bananas are ~22% carbohydrates.

Starch: Unripe bananas are rich in resistant starch (~70-80% of dry matter).

Vitamins & Minerals: High in potassium, magnesium, and vitamin B6.

Phenolic Compounds: Catechins, gallic acid, and dopamine with antioxidant properties.

Banana Peel

Lignocellulosic Material: Contains cellulose (~10-15%), hemicellulose (~6-10%), and lignin (~12-20%).

Polyphenols & Flavonoids: Useful in natural antioxidant and antimicrobial formulations.

Pectin: Important for biodegradable film formation.

Tannins and Alkaloids: Provide astringency and medicinal potential.

Banana Pseudostem

Cellulose and Hemicellulose: Excellent fiber source, used in biodegradable textiles.

Starch and Sugars: Used for bioethanol production.

Ash and Silica: Impart strength to the fibers; used in composite materials.

Water Content: ~90%, which makes it ideal for juice and pulp-based extraction for chemicals.

Banana Leaves

Polyphenols and Flavonoids: Used in traditional medicine and antioxidant research.

Waxy Cuticle: Provides a hydrophobic layer for natural packaging materials.

Proteins and Chlorophylls: Offer scope for natural dye and pigment extraction.

Roots

Phytochemicals: Alkaloids, saponins, and glycosides with anti-inflammatory properties.

Absorption Elements: Capable of metal uptake, useful in phytoremediation.

Applications Based On Chemical Composition

Bioplastics and Packaging

Pectin and starch from peels and pseudostems are processed into biodegradable plastics.

Lignocellulosic fibers are blended with polymers for strength enhancement.

Bioethanol and Biogas Production

Fermentation of banana pseudostem juice and peel starch can yield ethanol.

Anaerobic digestion of waste biomass provides methane for energy.

Water Purification

Banana peel powder binds heavy metals ($Pb^{2}z$, $Cd^{2}z$, Crv z) through functional groups such as hydroxyls and carboxyls.

Lignin and pectin complexes serve as low-cost adsorbents.

Medicinal and Cosmetic Use

Dopamine and serotonin from the fruit and peel help in neuroprotective applications.

Antioxidant compounds from leaves and peels are used in skincare.

Natural Dyes and Pigments

Banana leaves and stems yield chlorophyll-based green pigments.

Peel extracts are used as pH-sensitive natural indicators.

Conclusion: From fruit to root, the banana tree offers a wealth of chemical compounds that support multiple industries. The chemical richness—especially in starches, lignocellulosic fibers, and polyphenols—makes the banana tree an ideal subject for sustainable chemistry research. Continued exploration can unlock newer applications in biopolymer development, nanomaterials, green fuels, and environmental remediation.

References :-

1. M. Happi Emaga, R. Andrianaivo, M. Paquot, J. T. Tchango, and B. Wathelet (2007) "Effects of the stage of maturation and varieties on the chemical composition of banana and plantain peels." Food Chemistry, 103(2), 590–600.DOI: 10.1016/j.foodchem.2006.09.006
2. D. Mohapatra, S. Mishra, and N. Sutar (2010)"Banana and its by-product utilization: An overview."Journal of Scientific and Industrial Research (JSIR), 69, 323–329.Available at: http://nopr.niscpr.res.in/handle/123456789/8897
3. B. S. Padam, H. S. Tin, F. Y. Chye, and M. I. Abdullah (2014)"Banana by-products: an under-utilized renewable food biomass with great potential."Journal of Food Science and Technology, 51(12), 3527–3545.DOI: 10.1007/s13197-012-0861-2
4. M. G. Kulkarni, J. A. Staden (2013)"Plant-derived smoke: Old technology with possibilities for economic applications in agriculture and horticulture."South African Journal of Botany, 84, 138–144.DOI: 10.1016/j.sajb.2012.10.014
5. R. A. Kareem, A. O. Sulaimon, and O. O. Balogun (2017)"Utilization of banana (Musa spp.) peels and stalks as bioadsorbents for removal of heavy metals in industrial wastewater."Journal of Applied Sciences and Environmental Management, 21(3), 491–495.DOI: 10.4314/jasem.v21i3.21
6. L. M. S. Larrauri, E. Rupérez, and F. Saura-Calixto (1997)"Effect of drying temperature on the stability of polyphenols and antioxidant activity of red grape pomace peels."Journal of Agricultural and Food Chemistry, 45(4), 1390–1393.DOI: 10.1021/jf960282f
7. K. Hossain, M. M. Rahman, and N. Nahar (2015)"Characterization of Banana (Musa spp.) Pseudostem and its Fiber for Biocomposite Development." International Journal of Engineering and Technology, 7(3), 227–232.Available at: https://www.enggjournals.com/ijet/docs/IJET15-07-03-076.pdf
8. Nandhini, M. Prakash (2014)"Study on biochemical constituents of banana pseudostem juice and its potential as a functional food ingredient." International Journal of Current Microbiology and Applied Sciences, 3(4), 884–891.Available at: https://www.ijcmas.com/vol-3-4/A.Nandhini%20and%20M.Prakash.pdf
9. M. A. Hossain, M. I. Hossain, et al. (2014) "Utilization of Banana Peels in the Production of Bioethanol." International Journal of Engineering and Technology, 4(3), 89–94.Available at: http://www.ijetch.org/papers/669-C00003.pdf
10. M. A. Mohamed, A. M. El-Sherbiny (2019)"Preparation and characterization of biodegradable banana starch-based films reinforced with cellulose nanocrystals." International Journal of Biological Macromolecules, 128, 750–758.DOI: 10.1016/j.ijbiomac.2019.01.113

****