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Chemometric Analysis of Antidiabetic Bio-fraction of Banana Peels

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Abstract: Banana (*Musa sapientum*) plant belongs to the family Musaceae. Banana peel, like its pulp counterpart, is rich in organic material (lipids, fiber, carbohydrates, and protein) and is a major source of numerous bioactive substances with a variety of functions and nutritional contents. In addition it contains strong antioxidant, antibacterial, and antibiotic properties. As they are rich in phenolic chemicals and dietary fiber its usage in pharmaceutical and nutraceutical industries is highly recommended. Also the use of viable and environmentally benign agricultural by-products provides a stable foundation for innovation in the production of waste goods and banana by-products makes it widely and affordably available. It's antidiabetic action is also well-known in spite of the fact that it's nutrious pulp not recommended mostly for diabetic patients due to hyperglycemic and weight gain effects even though the latest studies showed the antidiabetic potential of banana fruit. The aim of the current investigation was to identify the phytochemical characteristics of the banana peel aqueous extract. Numerous chemical components were found in the aqueous banana peel extract according to the GC-MS analysis. The substances exhibited antidiabetic properties as well.

Keywords: GC-MS gas chromatography, Phytochemical, Banana peels, Hypoglycemic, Antidiabetic, Aqueous extract

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Introduction

Diabetes mellitus (DM) is a group of metabolic illnesses that alter insulin release or function, making hyperglycemia a prevalent symptom. According to the World Health Organization, diabetes mellitus will be the sixth most frequent cause of death globally by 2030. Diabetes is a national epidemic, primarily due to changes in India's social environment and way of life. Diabetes and its aftereffects continued to be a major health concern even after popular antidiabetic drugs were introduced to the market (Bhattacharya *et al*., 2023). Moreover, using safer

and more environmentally friendly treatments help prevent the negative consequences of taking allopathic medicines.

Medicinal plants with recently reported anti-hyperglycemic (Vadakkan, 2019) effects can either promote the generation of insulin, inhibit the absorption of glucose in the intestine, or aid metabolites in insulin-dependent activities to assist restore pancreatic tissue function. The chemical components glycosides, alkaloids, terpenoids, flavonoids, and cartenoids are present in most of these plants (Ramana Murty *et al*., 2017). Despite the fact that doctors do not recommend banana consumption for patients with diabetes, banana's potential to reduce hyperglycemia has sparked a great deal of interest in further research because of new studies on its antidiabetic qualities. Numerous studies have advised consuming fruit peels because of their high bioactive and antioxidant content, which may increase the nutritional value of meals and help prevent chronic diseases. Peels of commonly consumed fruits and exotic fruit such as mango, pomegranate etc can also be used for the same (Mistry *et al*., 2023, Gull *et al*., 2023, Ginyandev, 2023).

The banana, scientifically known as *Musa Sapientum*, is a member of the Musaceae family. They belong to the same family and are descended from three genera (*Musa*, *Ensette*, and *Musella*), although they are always composed of multiple species under *Musa*. Despite the fact that 36 million tons of banana peels are produced annually, dumping them untreated into the environment is linked to negative environmental effects as well as financial losses. It suggests that turning banana peels into a useful product will be incredibly cost-effective (Ra *et al*., 2023). By reusing banana peels, farmers and manufacturers may reduce waste, preserve resources, and develop durable solutions to a variety of societal problems. Despite the fact that raw banana peels are quite healthy, hardly many people eat them due to the unpleasant taste. It is possible to produce delicious and nourishing food that can be consumed continuously by transforming raw banana peel into a food product (Ansari *et al*., 2023). Studies on the sensory perception of banana peels incorporated into baked goods, such as cakes, have also produced encouraging results (Maschio *et al*., 2023).

The hydrolysis of starch in pulp (about 20%) contributes to the accumulation of sucrose, glucose and fructose during maturation, making it more palatable and sweeter. Conversely, only about 3% of starch is present in unripe peels, which might make the inner peel tasteless because of the low sugar content even after ripening. Numerous studies have suggested that consuming fruit peels is a good idea because of their high bioactive and antioxidant content, which may help prevent chronic diseases and enhance the nutritional value of meals. Based on the latest scientific knowledge of the use of banana peel as a possible source of functional ingredients considering that banana peel extract is non-toxic to normal human cells, it can be used as a natural source of antioxidants (Raj *et al*., 2023). Moreover, due to their widespread availability in our homes, bananas might be considered an inexpensive organic nutraceutical product (Bhavani *et al*., 2023).

It is interesting to note that tests conducted *in vivo* on hypoglycemic and phytochemical activities have demonstrated the potential for barangan banana peel extract to be used as an antidiabetic medication (Gunawan *et al*., 2021). Many ailments, including burns, anemia, diarrhea, ulcers, inflammation, diabetes, cough, snakebite, and heavy menstruation, have historically been treated with peel. Banana peels, like pulp, have a high content of organic matter (lipids, fiber, carbs, and protein) and are a key source of many bioactive compounds that have different nutritional compositions and purposes (Hashim *et al*., 2023).

This study aimed to investigate phyto-chemistry of banana peel extract and its effects on hypoglycemia. The objective of this work was to identify the bioactive components of the aqueous

Table 1: Procedure for Phytochemical Screening and phytochemicals present in banana peel extract

Phytochemical	Procedure	Observation	Result
Flavonoids	1 ml sample+3 ml of dilute NaOH, the sample turns yellow colour. Add dilute HCI	If yellow colour disappears	Presence
Tannin	1 ml $FeCl_3$ to 1 ml of sample solution	A brownish green or blue black coloration	Presence
Terpenoids	1 ml plants extract treated with 3-4 drops of copper acetate	Emerald green colour	Presence
Phenols	3 drops of FeCl to 5 drops sample	Dark green colour	Presence
Coumarins	Take 1 ml of sample in a test tube and add 1 ml of $FeCl_3$. Appearance of dark green and add 5 drops of conc. HNO_3	Turns dark green to yellow color	Presence

extract of banana peels by GC-MS analysis and preliminary phytochemical screening.

Materials and Methods

Extraction of Plant material

The banana peels were collected from local areas of Thrissur, India. Fresh and healthy samples were selected and washed thoroughly first with tap water to remove all the dust and unwanted visible particle, then cut into small pieces and dried. The dried peels were ground in a mixer grinder to get fine powder. The powdered material was stored in tightly closed glass bottles for further use. The crude aqueous extract of were prepared by Soxhlet method.

α-amylase inhibition assay

The assay of α-amylase was done according to the method of Kumar *et al*. (2017). The reaction mixture contained 1 ml of plant extract, 1 ml of α-amylase (1 mg of α-amylase in 10 ml of 0.02 M sodium phosphate at pH 6.9) and soluble starch (0.5 g in 100 ml distilled water) and incubated at room temperature for 2 h. The amount of reducing sugar released in the mixture was determined by the addition of 2 ml of 3,5-dinitrosalicylic acid reagent and was kept in boiling water bath for 20 min. Negative control contained water. The absorbance of the mixture was measured at 540 by using UV spectrophotometer.

Phytochemical analysis

Phytochemical screening was done by using standard method to identify the primary and secondary metabolites. The phytochemicals present in banana peels are illustrated in Table 1.

GC–MS analysis

A combination analytical method called gas chromatography-mass spectroscopy (GC-MS) is used to identify and ascertain the chemicals contained in a plant sample (Vadakkan *et al*., 2021). When it comes to the phytochemical analysis and chemotaxonomic research of medicinal plants with biologically active components, GC-MS is indispensable. In this study, GC-MS analysis was performed at Trichy Institute of Biotechnology at Trichy, Chennai, India.

Results and Discussion

The percentage of inhibition obtained on UV spectrometry of aqueous banana peel extract showed 73.63 for 100 mg/ml. The obtained results

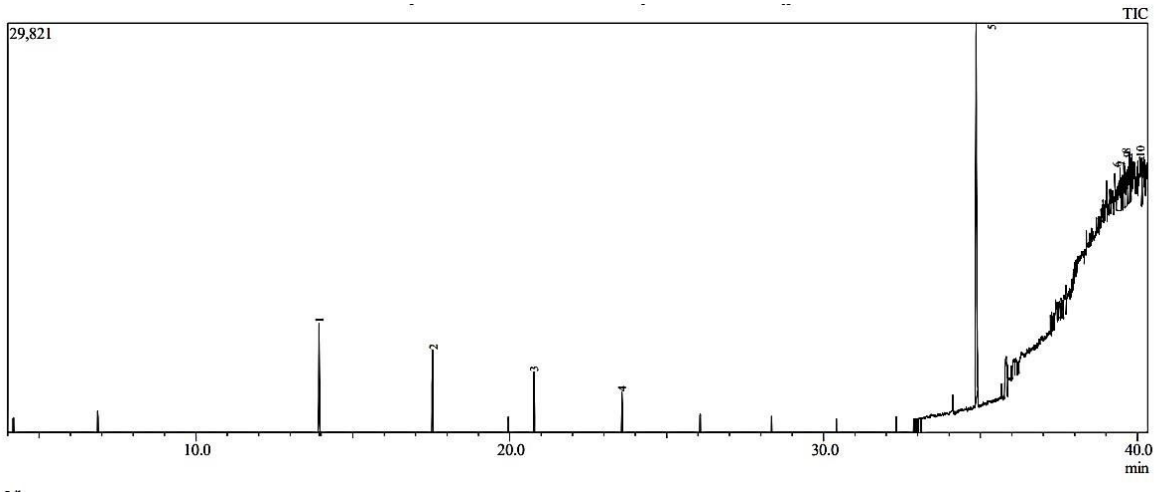

Fig. 1: Bioactive compounds of *Musa sapientum* peel extract.

Table 2: Bioactive compounds of *M. sapientum* peel extract with its activities

S. No.	Compound	Molecular Formula	Molecular Weight	Activities
1	2-Cyclobuten-1-One	$C_{21}H_{28}O_4Si$	372	Used in drug for cancer therapy
2	1,3-Diphenyl-1-((Trimethylsilyl)Oxy)-1(Z)-Heptene	$C_{22}H_{30}OSi$	338	Addictive in lubricants , Catalyst , Surfactant
3	Tri-O-Trimethylsilyl	$C_{24}H_{42}F_5NO_4Si_3$	587	Skin conditioning , Filim forming , Cosmetic colorant
4	(RR)-2,3-hexanediol	$C_6H_{14}O_2$	118	Used in cosmetic industry as a preservative, Used in resin industry as a plasticizer
5	1,2-BenzenedicarboxylicAcid,	$C_{24}H_{38}O_4$	390	Antimicrobial preservative, antifungal tablet, Capsule lubricant
6	2-Octenedial	$C_8H_{12}O_2$	140	Antibacterial , Antifungal , Anti-inflammatory
7	Acetate	$C_{16}H_{30}O_2$	254	Antibacterial
8	Ethanol	$C_{17}H_{34}O_2$	270	Antifungal , Antibacterial, Antiviral

suggested that there was a decrease in the amount of reducing sugars produced probably due to inhibition of α-amylase enzyme by the aqueous banana peel extract. Inhibition of α-amylase enzyme could thus possibly can be used to treat hyperglycaemic conditions in diabetes patients.

GC-MS analysis was carried out to determine the possible chemical compounds in banana peel. In a previously reported study carried out to determine the possible bioactive components from ethanolic extract of banana peel using gas chromatography-mass spectrometry (GC-MS),

eight compounds were identified which included estragole (11.18%), hexadecanoic acid ethyl ester (9.76%), epicatechin (9.97%), gallocatechin (8.58%), p-coumaric acid ethyl ester(4.2%), 1,2 benzenedicarboxylic acid mono (2-ethylhexyl) ester (13.47%), beta-tocopherol (11.37%) and vitamin E (31.35%) (Waghmare *et al*., 2014). From the chromatogram figure of current study, it was observed that there were many compounds present in the bioactive fraction however, the major component was 2-Benzenedicarboxylic acid with molecular formulae $C_{24}H_{38}O_4$ and molecular weight of 390. The peak was found in retention time 34.860 min. The identification was done by the employment of NIST library. Other than this compound there were several other compounds like Ethanol with molecular weight of 270 and Acetate with molecular weight of 254.

Phytochemical screening for aqueous extract of banana peels (Table 2; Fig. 1) indicated the presence of various primary and secondary metabolites such as terpenoids, Tannins, Coumarins, phenol, and flavonoids. In plants, phenols mainly act in plant development, lignin and pigment production. They are important secondary metabolites as they possess anti-oxidant and anti-microbial properties. Flavonoids exhibit anti-oxidant, anti-inflammatory, anti-microbial, anti-agonic, anti-cancer and anti-allergic properties.

The goal of the current study was to use the alpha amylase inhibition assay to analyse the antidiabetic properties of aqueous extract of banana peels. The bioactive components from ethanolic extract of banana peel using GC-MS from previous studies by Waghmare and Kurhade (2014) could identify eight compounds like estragole (11.18%), hexadecanoic acid ethyl ester (9.76%), epicatechin (9.97%), gallocatechin (8.58%), p-coumaric acid ethyl ester (4.2%), 1,2 benzenedicarboxylic acid mono (2-ethylhexyl) ester (13.47%), beta-tocopherol (11.37%) and vitamin E (31.35%). According to the study, at 100 mg/ml, there was a predominate inhibition of the amylase enzyme with a percentage of 73.63. As previously indicated, a variety of primary and secondary metabolites were discovered using phytochemical and GC-MS research. It is anticipated that diabetes patients will benefit from environmentally friendly processes and low-side effect medications. Therefore, more study can be conducted utilizing these preliminary data to utilize these compounds' other pharmacological properties *in vivo* and to show these compounds safety and efficacy in clinical trials. On the other hand, it is yet unknown how the chemical components of banana peels work on it. In addition to offering a thorough understanding of the molecular mechanisms underlying the health-promoting qualities of banana peels, the application of diverse techniques like proteomics, metabolomics, transcriptomics, and genomics along with *in silico* analysis *et al.*, 2024) can also advance our understanding of the phytochemicals found in banana peels as functional ingredients (Grover *et al*., 2002).

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