BANANA PEEL TRANSFORMATIONS UNLOCKING HIDDEN VALUE

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Theme of the Article: Science
Research Objectives: This study investigates the potential for creating value-added products from banana peels, a by-product of the banana processing industry.

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Ullfathnisha A., an award-winning educator and pioneering academician, champions enhanced learning with technology. Founder of eProMentors, she inspires future leaders through innovative teaching and educational excellence. With an M.Phil. in Plant Biology and Biotechnology and a Bachelor's in Education, she guides students to success in exams like NEET. Awarded a prestigious scholarship by Tamil Nadu's Government, she earned her Master's from Anglia Ruskin University, UK. Passionate about integrating AI in education, she develops courses for leaders to enhance personalised learning. Committed to nurturing future leaders, she emphasises cognitive, affective, and psychomotor skills, believing in planting the seeds of knowledge for a brighter tomorrow.

Abstract

This study investigates the potential for creating value-added products from banana peels, a by-product of the banana processing industry. Despite being a popular fruit globally, banana peels are often discarded as waste, constituting approximately 40% of the fruit. This waste poses environmental challenges due to its high nitrogen and phosphorous content, coupled with its susceptibility to microbial degradation. However, banana peels possess significant nutritional qualities, economic value, and medicinal potential, which are largely overlooked.

In this research, banana peels from green, red, and yellow banana varieties were collected and subjected to soxhlet extraction. The resulting banana peel powder extracts were analyzed for total phenolic content, flavonoid content, alpha-amylase inhibition assay, and anti-lipase enzyme inhibition assay. The findings reveal that red banana peel extract exhibits the highest phenolic content (685.33 mg GAE/g DE), flavonoid content (157.25 mg QE/g DE), and crude metabolic content (3.855) among the three varieties tested.

These results suggest promising opportunities for utilizing banana peel powder in the development of value-added products. Specifically, the high phenolic and flavonoid content indicate its potential application in natural tea powder production, while its metabolic content suggests suitability for use as biofertilizer. This research underscores the importance of exploring innovative ways to harness the nutritional and functional properties of banana peels, thus contributing to waste reduction and sustainable resource utilization.

Keywords: Value-added products, Banana peel, Phenolic content, Flavonoid content, Metabolic content

1. Introduction

Bananas, belonging to the genus Musa, are broadly classified into two subgroups: sweet bananas and plantains. They consist of various parts such as the fruit, peel, leaves, roots, and pseudostem, all of which demonstrate a range of pharmacological benefits. Both traditional and modern uses of bananas are attributed to their rich phytochemical composition. Research indicates that the extracts from banana pulp and peel contain fatty acids, steryl esters, sterols, as well as oleic and linoleic acids.

A banana peel, also known as a banana husk or skin (in British English), is the outer layer of the banana. Banana peels serve multiple purposes, including animal feed, water purification, the production of biochemical products, and even for humorous pranks in popular culture.

In terms of animal feed, banana peels are often used to feed livestock such as cattle, goats, pigs, monkeys, poultry, and zebras, especially on small farms in banana-growing regions. However, there are concerns about the tannins present in banana peels, which may affect the health of the animals consuming them.

The nutritional value of banana peels varies with their ripeness and cultivar. For example, plantain peels contain lower fiber levels than dessert banana peels, while lignin content rises as the peel ripens, ranging from 7% to 15% of dry matter. Typically, banana peels comprise 6-9% dry matter protein and 20-30% fiber (as measured by Neutral Detergent Fiber or NDF). While green plantain peels are composed of 40% starch, this starch converts into sugars upon ripening. In contrast, green banana peels have around 15% starch, and this

increases to 30% free sugars when the bananas are ripe.

Banana peels are also utilized in processes like water purification, ethanol production, and as a source of cellulase and laccase enzymes. Additionally, they serve as fertilizers and contribute to composting efforts.

Objectives

To study the biochemical composition of pulp and peel of culinary banana at various developmental stages and to identify the optimum stage of harvesting.

- To study the resistant starch development from pulp and its application in food model.
- To study the isolation and characterization of cellulose nanofiber from peel and it's application in developing nanopaper.
- To study the encapsulation of natural antioxidant from culinary banana pulp and peel.
- To study the drying characteristics by hot air oven, optimization of process parameters in vacuum drying for pulp slices and peel paste and storage study of culinary banana flour.

Pharmacological investigations of different banana peel Methanol extracts.

2. Materials And Methods

- **Soxhlet extraction**

The plant samples collected were thoroughly washed with running tap water followed by deionized water. After washing, the samples were air-dried in the shade until fully dried. The dried samples were then ground into a fine powder using a milling machine and subjected to Soxhlet extraction (Brazil, Mumbai, India) with ethanol as the solvent. Approximately 50g of powdered plant material was placed into a thimble made from handmade filter paper. This thimble was carefully positioned inside the Soxhlet extractor, and ethanol (in a 1:10 ratio) was used as the solvent. The round-bottom flask was heated using a heating mantle at 60°C. A minimum of 15 reflux cycles were performed for each sample to ensure a high-quality extract. The resulting solvent extract was concentrated using a rotary evaporator (Buchi, Bangalore, India) under vacuum at a reduced temperature. The final concentrated extract was collected and stored in glass containers at -20°C for future analysis.

- **Determination of total phenolic contents.**

The total phenolic content of the solvent extracts was determined using a spectrophotometric method based on the colorimetric procedure described by Singleton & Rossi (1965). Each extract (200 µL) was added to test tubes, along with 1.0 mL of Folin-Ciocalteau reagent (diluted 1:1 with water) and 1.0 mL of sodium carbonate solution (7.5%). The mixture was vortexed and incubated for 2 hours. The absorbance was measured at 726 nm using a spectrophotometer (Beckman, USA). The total phenolic content was expressed as milligrams of gallic acid equivalents (GAE) per gram of dry material.

- **Determination of Total Flavonoid Content**

The total flavonoid content was measured using the aluminum chloride colorimetric method as described by Lin and Tang (2007). A 2 mL sample of the plant extract (0.3 mg/mL) was mixed with 0.1 mL of 10% aluminum chloride hexahydrate, 0.1 mL of 1 M potassium acetate, and 2.8 mL of deionized water. The mixture was incubated at room temperature for 40 minutes. After incu-

bation, the absorbance was recorded at 415 nm using a spectrophotometer. Quercetin, in the concentration range of 0.005 to 0.1 mg/mL, was used as the standard, and the total flavonoid content was reported as milligrams of quercetin equivalents (QE) per gram of dry extract.

Alpha amylase inhibition assay

The alpha-amylase inhibition assay was carried out by preparing a mixture containing 200 µL of 0.02 M sodium phosphate buffer, 20 µL of enzyme, and plant extracts at various concentrations ranging from 20 to 100 µg/mL. This mixture was incubated for 10 minutes at room temperature, followed by the addition of 200 µL of starch to all the test tubes. The reaction was stopped by adding 400 µL of DNS reagent, and the tubes were placed in a boiling water bath for 5 minutes. After cooling, 15 mL of distilled water was added to dilute the samples, and the absorbance was measured at 540 nm. Control samples were prepared without the plant extracts.

The % inhibition was calculated according to the formula:

$$\text{Inhibition (\%)} = \frac{\text{Abs 450 (control)} - \text{Abs 450 (extract)}}{\text{Abs 450(control)}} \times 100$$

Anti-lipase enzyme inhibition assay

The lipase inhibitory activity of the plant extracts was as sessed using the method outlined by Mopper and Meriga (2014). An emulsion was prepared by mixing 1% (v/v) triolein and 1% (v/v) Tween 40 in 0.1 M phosphate buffer (pH 8.0). The assay began by adding 800 µL of the triolein emulsion to 200 µL of pancreatic lipase solution (prepared by dissolving 0.5 g of pancreatin in 15 mL of 0.1 M phosphate buffer at pH 8.0) and 200 µL of the plant extract at different concentrations. The mixture was thoroughly mixed, and the absorbance was immediately recorded at 450 nm, labeled as T0. The reaction mixture was then incubated at 37°C for 30 minutes, and the absorbance was recorded again at 450 nm, labeled as T30. The change in absorbance was calculated as the difference between A450(T0) and A450(T30) for both the control and the test samples.

The % inhibition was calculated using the following formula:

$$\text{Inhibition (\%)} = \frac{\text{Abs 450 (control)} - \text{Abs 450 (extract)}}{\text{Abs 450(control)}} \times 100$$

Observation

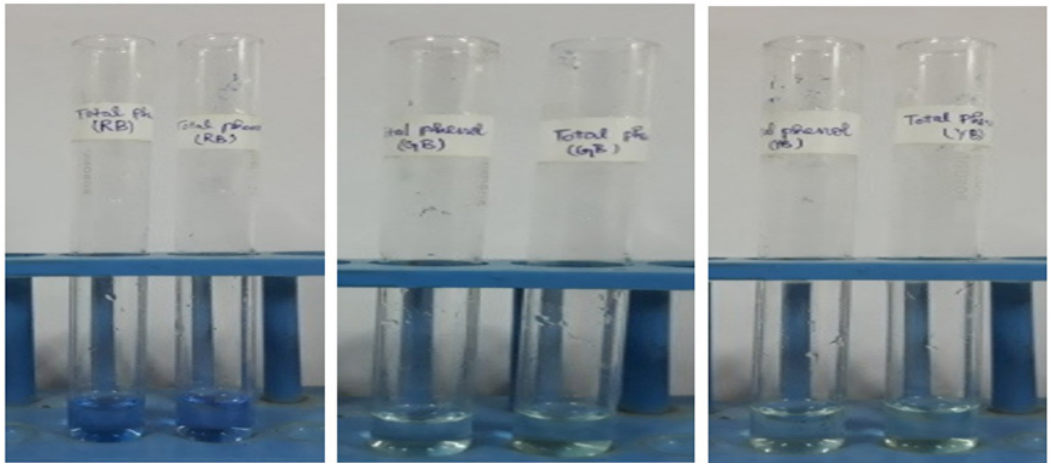
- **Table 1: The extraction of different banana peel methanolic crude metabolites yield**

Name of the Sample	Total crude metabolites Yield Content
Red Banana Peel extract	3.855
Green Banana Peel extract	2.98
Yellow Banana Peel extract	3.07

- **Table 2: The estimation of different banana peel methanolic total phenol content**

Name of the Sample	Total phenol Content
Red Banana Peel extract	685.33 mg GAE/g DE
Green Banana Peel extract	338.67mg GAE/g DE
Yellow Banana Peel extract	264.00mg GAE/g DE

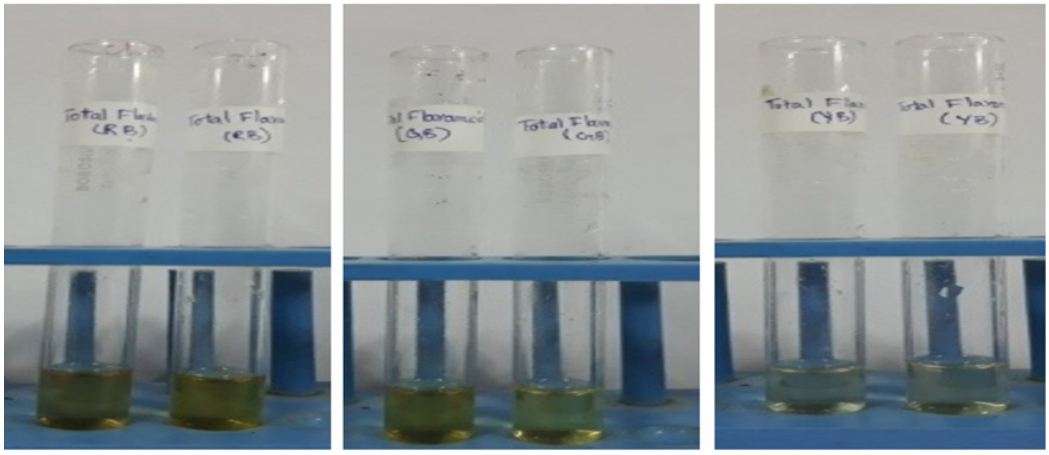
- **PLATE 2: The estimation of different banana peel methanolic total phenol content**



- **Table 3: The estimation of different banana peel methanolic total flavonoids content**

Name of the Sample	Total flavonoids Content
Red Banana Peel extract	157.25 mg QE/g DE
Green Banana Peel extract	105.25 mg QE/g DE
Yellow Banana Peel extract	81.0 mg QE/g DE

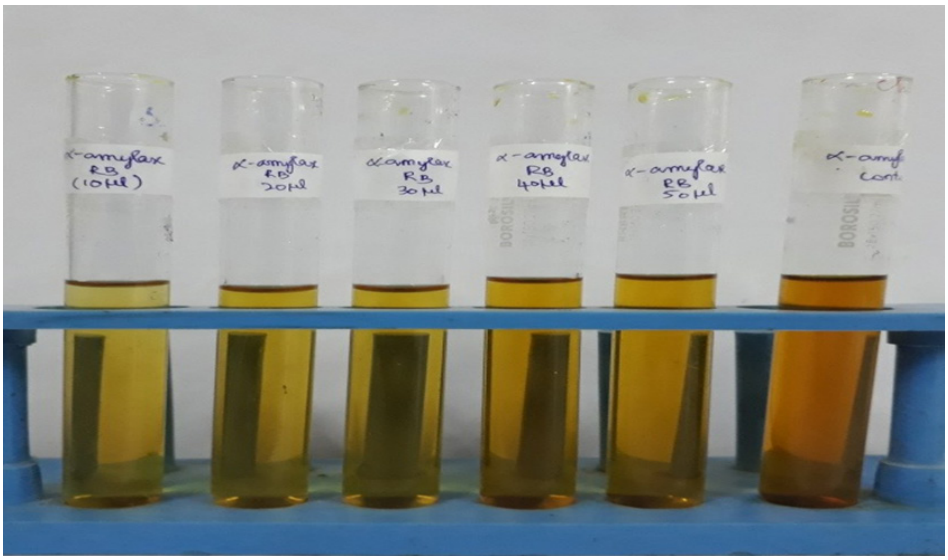
- **PLATE 3: The estimation of different banana peel methanolic total flavonoids content**



- **Table 4: Alpha amylase inhibition activity of RED banana peel methanolic extract**

Concentration (mg)	Optical Density	Inhibition %
0	0.589	0.00
0.1	0.547	7.13
0.2	0.521	11.54
0.3	0.475	19.35
0.4	0.402	31.75
0.5	0.348	40.92

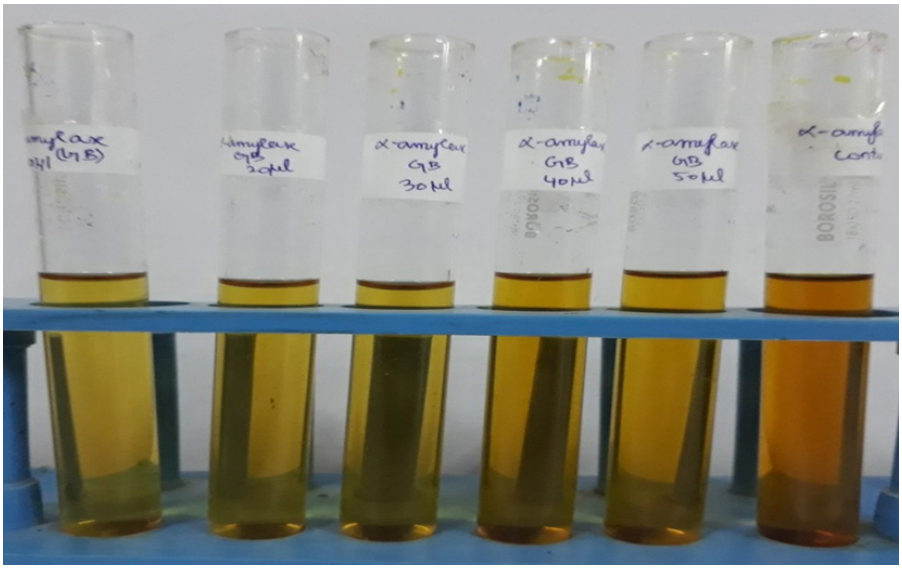
- **PLATE 4: Alpha amylase inhibition activity of RED banana peel methanolic extract**



- **Table 5: Alpha amylase inhibition activity of Green banana peel methanolic extract**

Concentration (mg)	Optical Density	Inhibition %
0	0.589	0.00
0.1	0.577	2.04
0.2	0.542	7.98
0.3	0.501	14.94
0.4	0.482	18.17
0.5	0.426	27.67

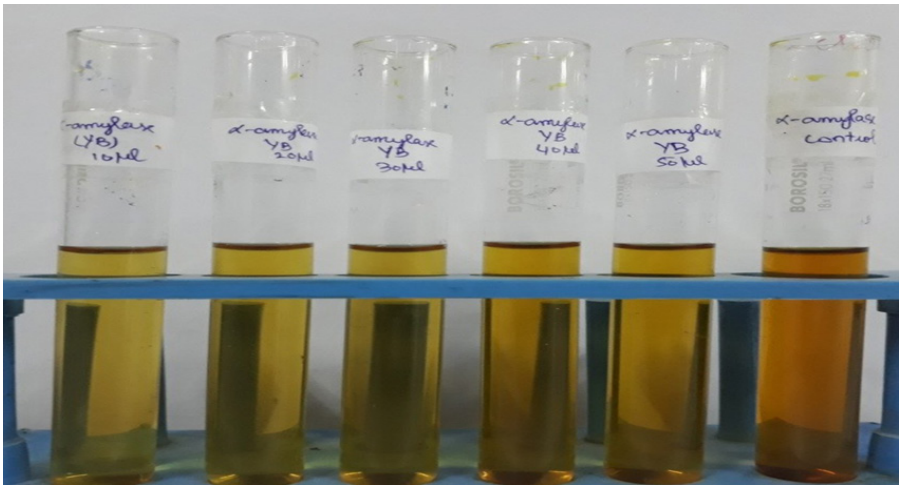
- **PLATE 5: Alpha amylase inhibition activity of Green banana peel extract**



- **Table 6: Alpha amylase inhibition activity of Yellow banana peel methanolic extract**

Concentration (mg)	Optical Density	Inhibition %
0	0.589	0.00
0.1	0.572	2.89
0.2	0.549	6.79
0.3	0.531	9.85
0.4	0.489	16.98
0.5	0.461	21.73

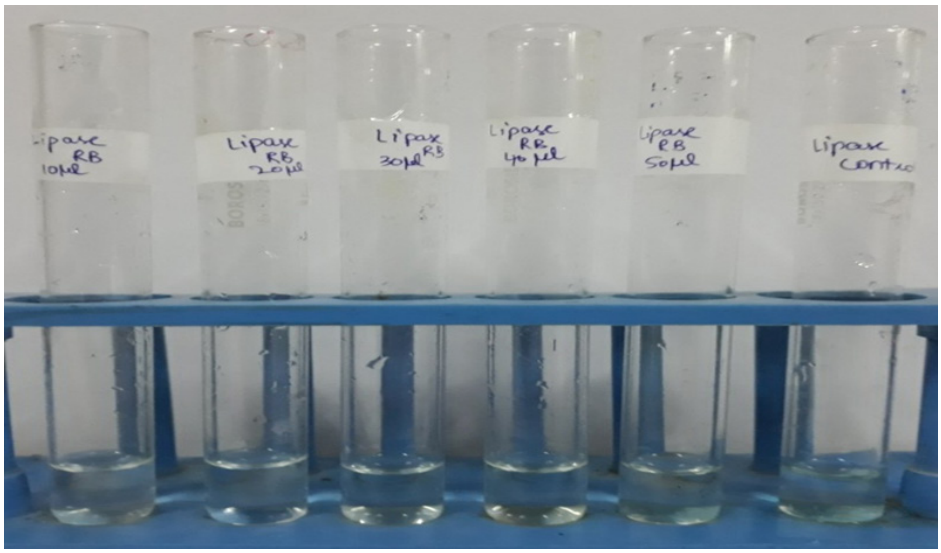
- **PLATE 6 : Alpha amylase inhibition activity of Yellow banana peel methanolic extract**



- **Table 7: Lipase inhibition activity of Red banana peel methanolic extract**

Concentration (mg)	Optical Density	Inhibition %
0	0.487	0.00
0.1	0.457	6.16
0.2	0.439	9.86
0.3	0.421	13.55
0.4	0.401	17.66
0.5	0.389	20.12

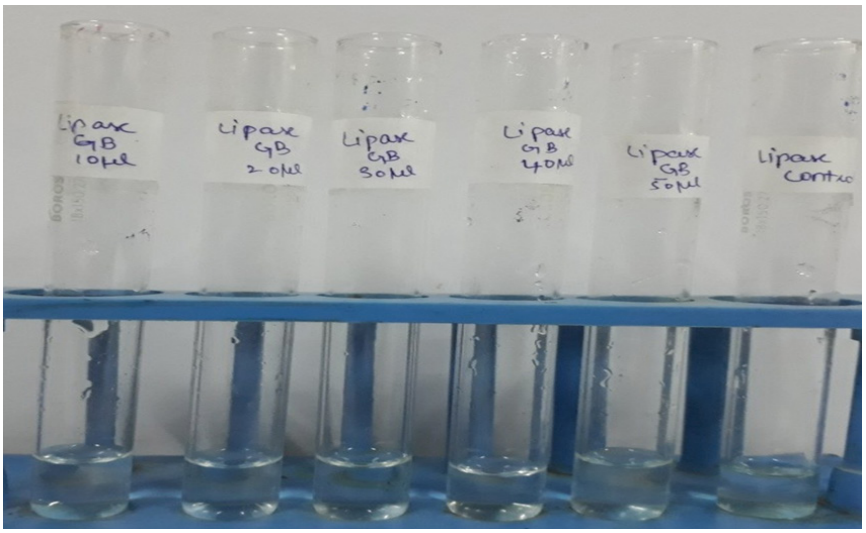
- **PLATE 7 : Lipase inhibition activity of red banana peel methanolic extract**



- **Table 8: Lipase inhibition activity of Green banana peel methanolic extract**

Concentration (mg)	Optical Density	Inhibition %
0	0.487	0.00
0.1	0.459	5.75
0.2	0.439	9.86
0.3	0.424	12.94
0.4	0.412	15.40
0.5	0.397	18.48

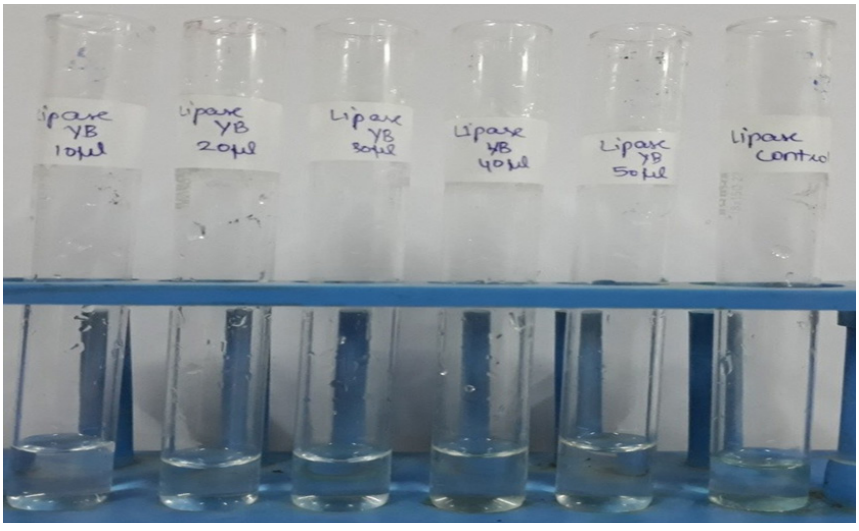
- **PLATE 8: Lipase inhibition activity of Green banana peel methanolic extract**



- **Table 9: Lipase inhibition activity of Yellow banana peel methanolic extract**

Concentration (mg)	Optical Density	Inhibition %
0	0.487	0.00
0.1	0.464	4.72
0.2	0.442	9.24
0.3	0.421	13.55
0.4	0.401	17.66
0.5	0.375	23.00

- **PLATE 9 : Lipase inhibition activity of Yellow banana peel methanolic extract**



3. Results

Total CRUDE Content

			AVG	STD
RB	3.59	4.12	3.855	0.37
GB	2.94	3.02	2.98	0.06
YB	3.14	3.01	3.075	0.09

Total PHENOL Content							
RB	0.514	0.0015	342.67	2000	685333.333	**685.33**	Gallic acid
GB	0.254	0.0015	169.33	2000	338666.667	**338.67**	Gallic acid
YB	0.198	0.0015	132.00	2000	264000	**264.00**	Gallic acid

Total FLAVANOID Content				
RB	0.629	0.02	31.45	**157.25**
GB	0.421	0.02	21.05	**105.25**
YB	0.324	0.02	16.2	**81**

Amylase inhibition

	Concentration mg	**OD**	**Control**	**OD**	**% Inhibition**
RB	0	0.589	0.589	0	0.00
	0.1	0.547	0.589	0.042	7.13
	0.2	0.521	0.589	0.068	11.54
	0.3	0.475	0.589	0.114	19.35
	0.4	0.402	0.589	0.187	31.75
	0.5	0.348	0.589	0.241	40.92
	Concentration mg	**OD**	**Control**	**OD**	**% Inhibition**
GB	0	0.589	0.589	0	0.00
	0.1	0.577	0.589	0.012	2.04
	0.2	0.542	0.589	0.047	7.98
	0.3	0.501	0.589	0.088	14.94
	0.4	0.482	0.589	0.107	18.17
	0.5	0.426	0.589	0.163	27.67

	Concentration mg	OD	Control	OD	% Inhibition
YB	0	0.589	0.589	0	0.00
	0.1	0.572	0.589	0.017	2.89
	0.2	0.549	0.589	0.04	6.79
	0.3	0.531	0.589	0.058	9.85
	0.4	0.489	0.589	0.1	16.98
	0.5	0.461	0.589	0.128	21.73

Lipase inhibition

Concentration mg(RB)	OD	Control	OD	% Inhibition
0	0.487	0.487	0	0.00
0.1	0.457	0.487	0.03	6.16
0.2	0.439	0.487	0.048	9.86
0.3	0.421	0.487	0.066	13.55
0.4	0.401	0.487	0.086	17.66
0.5	0.389	0.487	0.098	20.12
Concentration mg(GB)	**OD**	**Control**	**OD**	**% Inhibition**
0	0.487	0.487	0	0.00
0.1	0.459	0.487	0.028	5.75
0.2	0.439	0.487	0.048	9.86
0.3	0.424	0.487	0.063	12.94
0.4	0.412	0.487	0.075	15.40
0.5	0.397	0.487	0.09	18.48
Concentration mg(YB)	**OD**	**Control**	**OD**	**% Inhibition**
0	0.487	0.487	0	0.00
0.1	0.464	0.487	0.023	4.72
0.2	0.442	0.487	0.045	9.24
0.3	0.421	0.487	0.066	13.55
0.4	0.401	0.487	0.086	17.66
0.5	0.375	0.487	0.112	23.00

4. Discussion

- Many of them have worked in pharmacological activity in banana and some have worked with banana peel .Here we had worked with the peel of the banana. We have collected three different varieties of banana and each contains 1.5 kgs .The banana is washed under a running tap water and the peel is removed from the banana. The removed peel is cut into small pieces and shade dried in sunlight. The dried peel is taken and grind into fine powder. The fine powder is stored in tight container without the moisture content. With the help of powder many pharmacological activities are performed.
- This similar work with banana was performed by Basher Ado Ahmad, Umar Abdullahi Zakariyya, Mujaheed Abubakar, Musbahu Muhammad Sani and Musbahu Adam Ahmad (2011) They had tested different enzyme activities and pharamacological activities in banana.But here we had tested with the banana peel powder.
- Soxhlet extraction is also carried out with the help of fine powder obtained from banana peel. The powder is added into the extractor. The solvent (methanol) is added to the extract and run it for 7 cycles.After repeated cycles we had got a coloured extract on each varieties.
- Determination of total phenolic contents is done with the solvent extracts were used for the determination of the total phenolics by spectrophotometrically according to the Folin-Ciocalteau colorimetric method (Singleton & Rossi, 1965).
- Determination of Total Flavonoid Content is done with the total flavonoid content was determined according to the aluminium chloride colorimetric method [Lin and Tang, 2007].
- Alpha amylase and anti lipase inhibition assay was determined

5. Conclusion

Among three varieties of banana peel powder extracts, (Green banana, Red banana, and Yellow banana) Red banana extract contains high crude metabolic content (3.855), high phenolic content (685.33mgvGAt/gDE), high flavanoid content (157.25mgQE/DE).

This banana peel powder is very good in mineral content and consistent of potassium and manganese. Due to high potassium content in peel, It maintains normal blood pressure. It can be used as a tea powder. It doesn't contains any chemical and fully made up of natural products. Recent studies had proved that it can also be used as a bio fertilizers.

Summary

The experimental work has carried out to determine the pharmacological activity in banana peels extract. To analyses the phenolic and flavanoid content of the extract.

Red banana peel contains high pharmacological activity and also maintains normal blood pressure. It can also be used as tea. This is economically cheap and can be easily prepared by simple methods.

Determination of total phenolic and flavanoid content of methanolic extraction is highly present on Red banana peel extract. Experimental analysis of pharmacological activities is also carried out

Three varieties of (green,red,yellow) banana was collected and washed and the peel is removed and cut into small pieces and shade dried and grind it to fine powder. The powder is stored in tight container and furtherly proceed to analysis.

Future Prospects

- To know about the medicinal qualities of parts of the banana.
- To prepare a tea, free from body pressure
- To know about the knowledge of analysis of banana

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