International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 16s,2025
https://theaspd.com/index.php

Investigation Of Phytochemical And Anti-Ulcer Activity Of Musa Sapientum (Banana)

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Abstract: *Through the use of in vitro models, the current research explored the possible antioxidant and antiulcer properties of extracts derived from the peel of Musa sapientum (banana). This was accomplished by employing the Soxhlet equipment to extract the peel powder in a sequential manner using solvents of varying polarity, including chloroform, ethyl acetate, methanol, and petroleum ether. Following phytochemical analysis, it was discovered that the substance in question contained flavonoids, glycosides, saponins, carbohydrates, and amino acids, all of which are chemicals that are recognised for their medicinal qualities. Assays for DPPH, hydrogen peroxide (H2O2), and nitric oxide (NO) scavenging were used to evaluate the antioxidant activity of the substance. The results showed that the substance possessed a significant radical neutralisation capacity that was comparable to that of typical antioxidants. The acid-neutralizing capacity (ANC) test demonstrated dose-dependent antacid activity (100-1500 mg), with higher dosages demonstrating effects that were comparable to those of standard antacids (magnesium/aluminum hydroxide). Based on these observations, it appears that peels manufactured from M. sapientum contain powerful bioactive chemicals that have the potential to protect against oxidative stress and stomach ulcers. Banana peels have been used for therapeutic purposes for centuries, and this study serves to substantiate those applications while also showing their potential as a natural and sustainable source of antioxidants and gastroprotective compounds. To determine the efficacy of the substance in vivo and to isolate the active ingredients, additional research is required.*

Keywords: *Banana peel extract, Antioxidant activity, Antiulcer activity, Phytochemical screening, Gastroprotective.*

INTRODUCTION:

Bananas are among the fruits that are consumed the most all over the world, and the large agricultural production of bananas results in a significant amount of peel waste. Due to the anti-inflammatory and antibacterial characteristics that banana peels possess, they have been utilised in traditional medicine for the purpose of treating skin conditions, digestive issues, and wounds. The results of recent scientific investigations have shown that banana peels contain a high concentration of polyphenols, flavonoids, tannins, and other secondary metabolites that are responsible for the biological activities of bananas. However, despite their promise, banana peels continue to be underutilised and are frequently thrown away as organic waste. The purpose of this study is to investigate their potential pharmaceutical applications, specifically in the fight against oxidative stress and gastrointestinal ulcers, both of which are serious health concerns all over the world. In tropical and subtropical climates all around the world, the Musa sapientum plant, more popularly referred to as the banana plant, is widely farmed. Domestication of bananas dates back thousands of years

and has resulted in its cultivation in over 135 nations. Bananas are indigenous to Southeast Asia, specifically in countries such as India, Malaysia, Indonesia, and the Philippines. The plant is most successful in regions that are warm and humid, have an abundance of rainfall (between 1,500 and 2,500 millimetres per year), and have soils that are well-drained and rich. Latin America (the countries of Ecuador, Brazil, and Costa Rica), Africa (the countries of Uganda, Cameroon, and Ghana), and the Caribbean are among the most important banana-producing regions. Nearly thirty percent of the world's banana production comes from India, which continues to be the leading producer in the world. It is also planted in subtropical regions such as Southern China, Egypt, and certain regions of Australia due to the adaptability of the Musa sapientum plant. The ability of the plant to thrive in a wide range of agroecological settings, from lowland tropical regions to high-altitude regions up to 2,000 meters above sea level, is largely responsible for its widespread cultivation. Its economic significance as a staple food crop is also a contributing factor. On the other hand, best growth occurs at temperatures between 25 and 30 degrees Celsius, and yield is significantly impacted by prolonged cold or drought. The widespread distribution of Musa sapientum highlights the importance of this plant for agriculture as well as the possibility for the sustainable utilisation of by-products such as peels in medical applications. A significant contributor to the development of chronic diseases including cancer, diabetes, and cardiovascular disorders is oxidative stress, which is brought on by an imbalance between free radicals and antioxidants. A search for natural alternatives has been prompted by the fact that synthetic antioxidants, despite their effectiveness, may have unfavourable side effects. Treatments that are both efficient and safe are required for peptic ulcers, which are frequently brought on by an infection caused by Helicobacter pylori or by the extended use of nonsteroidal anti-inflammatory medicines (NSAIDs). Even though they are helpful, conventional antacids and proton pump inhibitors can have negative side effects, such as causing gastrointestinal problems and nutrient malabsorption. Accordingly, it is of the utmost importance to investigate natural antiulcer medicines that have minimum adverse effects.
Peels of the Musa sapientum plant, also known as bananas, contain a wide variety of bioactive chemicals that have the potential to contribute significantly to the treatment of various medical conditions. The presence of carbohydrates and reducing sugars was confirmed by phytochemical screening, as demonstrated by the good results of Molisch's and Fehling's assays. These substances are involved in the processes of energy metabolism and wound healing. Glycosides, which were discovered by Bornträger's and Keller-Killiani tests, were also discovered, which indicates that there may be potential benefits for the cardiovascular system. Saponins, which are revealed by the prolonged foam development in the foam test, are another factor that contributes to the antibacterial and anti-inflammatory characteristics of the peel. Tests using Millon's reagent and ninhydrin have demonstrated the presence of amino acids and proteins, which indicates the significance that these substances play in the process of tissue repair and enzymatic processes. Flavonoids, which were found to be notably present in the peel, were detected by Shinoda and ammonia tests. This highlights the peel's powerful antioxidant and anti-inflammatory potential.. The peel's therapeutic efficacy is enhanced by the presence of a wide variety of phytochemicals, which gives it the potential to be a promising candidate for the development of natural therapies for problems connected to oxidative stress and gastrointestinal disorders. A scientific foundation for the continued investigation of banana peels in pharmacological applications is provided by the findings, which are in line with the traditional uses of banana peels in folk medicine.

MATERIAL & METHOD:

Materials plant:

extract

Musasapientum peels

Methods:

Extract Process:

Following the initial step of drying the peels of Musa sapientum using mechanical means, the peels were then processed into a powdered form. According to the reports, the highest possible yield of powder that was obtained was roughly 600 grammes per batch produced. In order to accomplish the needed extraction, a

Soxhlet apparatus was utilised for continuous and sequential extraction. This equipment made use of solvents with varied degrees of polarity, such as chloroform, ethyl acetate, methanol, and petroleum ether. The extraction procedure was carried out at a temperature that was kept under control somewhere between fifty and sixty degrees Celsius. After the extraction process was complete, the solutions were heated to temperatures lower than 40 degrees Celsius and then dried under reduced pressure. For the purpose of future investigation, the dry extracts that were produced were subsequently placed in a desiccator to maintain their purity.

Yield Percentage Calculation:

An application of the following formula was utilised in order to determine the percentage yields of the extractives: (Weight of the extractives) Yield as a percentage Weight of the crude medication multiplied by 100 % Yield equals the weight of the crude medication. The extractives' weight multiplied by 100 By comparing the weight of the extracted plant material to the weight of the plant material at the beginning of the extraction process, this formula measures the effectiveness of the extraction process.

Phytochemical Screening:

Carbohydrate Tests:

- **Molisch's Test:** A small amount of the extract was dissolved in distilled water, then filtered, and then treated with Molisch's reagent, which was then followed by sulphuric acid that was concentrated. The creation of a ring that was a reddish-violet colour was evidence that carbohydrates were present.
- **Fehling's Test:** Equal volumes of Fehling's reagents A and B were mixed with the extract, producing a brick-red precipitate, indicating reducing sugars.

Glycoside Tests:

- **Bornträger's Test:** The extract was hydrolyzed with dilute hydrochloric acid in a water bath. A reddish-brown color at the interface confirmed glycosides.
- **Keller-Killiani Test:** The extract was treated with concentrated sulfuric acid, forming a reddish-brown layer that turned blue-green upon standing, confirming cardiac glycosides.

3. Saponin Test:

- **Foam Test:** Vigorous shaking of the extract in water produced persistent foam (~1 cm), indicating saponins.

4. Amino Acid & Protein Tests:

- **Millon's Reagent Test:** A red precipitate formed, confirming proteins and amino acids.
- **Ninhydrin Test:** A purple color appeared, indicating the presence of free amino acids.

5. Flavonoid Tests:

- **Shinoda Test:** The extract was dissolved in ethanol, treated with magnesium/zinc and concentrated HCl, resulting in a pinkish-red color, confirming flavonoids.
- **Ammonia Test:** The extract was treated with ammonia solution, turning the filter paper from white to orange, indicating flavonoids.

In-Vitro Antioxidant Studies:

DPPH Radical Scavenging Assay:

. In order to evaluate the antioxidant activity, the extract was tested to see whether or not it could neutralise the stable DPPH radical. The DPPH was decreased by hydrogen donors, which resulted in the colour changing from purple to yellow. With regard to free radical scavenging activity, the degree of decolorisation was indicative.

Hydrogen Peroxide (H_2O_2) Scavenging Assay:

In order to determine the antioxidant potential, H2O2 was utilised, which is a weak oxidising agent. Its transformation from superoxide anions was facilitated by the enzyme known as superoxide dismutase (SOD). The capacity of the extract to scavenge hydrogen peroxide was evaluated.

Nitric Oxide (NO) Scavenging Assay:

The Griess reagent, which consists of sulfanilic acid and naphthylethylenediamine dihydrochloride, is used to detect the formation of nitrite, which is produced when nitric oxide combines with oxygen. It was determined that scavenging activity was calculated, and a purple colour indicated the generation of nitrite.

Reagent Preparation:

- Sulphanilic Acid Solution: 0.33 g in 20% glacial acetic acid, diluted to 100 mL.
- Naphthylethylenediamine Dihydrochloride (NEDD): 0.1% in 50% glacial acetic acid, heated to dissolve, and adjusted to 100 mL.
- Reagents were stored at 37°C before use.

In-Vitro Antiulcer Activity: Acid Neutralizing Capacity (ANC):

The extract (100, 500, 1000, and 1500 mg) was compared to standard antacids (magnesium hydroxide and aluminum hydroxide).

- **Procedure:**
  - 5 mL of extract + 70 mL water → mixed for 1 min.
  - 30 mL of 1.0 N HCl added → stirred for 15 min.
  - Phenolphthalein added → titrated with 0.5 N NaOH until pink.

Calculation:

ANC (moles HCl/g)=Moles of HCl neutralizedGrams of extract/antacidANC (moles HCl/g)=Grams of ext ract/antacidMoles of HCl neutralized

RESULT & DISCUSSION:

Table 1: Phytochemical Screen of Musa sapientum:

Phytochemical	Test Name	Procedure	Positive Observation	Result
Carbohydrates	Molisch's Test	Extract + Molisch's reagent + conc. H_2SO_4 (layer formation).	Reddish-violet ring at interface.	+
	Fehling's Test	Extract + Fehling's A & B (heated).	Brick-red precipitate.	+
Glycosides	Bornträger's Test	Extract + dilute HCl (hydrolysis) + organic solvent.	Reddish-brown color at interface.	+
	Keller-Killiani Test	Extract + glacial acetic acid + $FeCl_3$ + conc. H_2SO_4.	Reddish-brown → blue-green layer.	+
Saponins	Foam Test	Extract + water (vigorous shaking).	Persistent foam (~1 cm).	+
Amino Acids/Proteins	Millon's Test	Extract + Millon's reagent (heated).	Red precipitate.	+
	Ninhydrin Test	Extract + ninhydrin solution (heated).	Purple color.	+
Flavonoids	Shinoda Test	Extract + ethanol + Mg/HCl (or Zn/HCl).	Pinkish-red color.	+
	Ammonia Test	Extract-treated filter paper + ammonia vapor.	White → orange color change.	+

Table 2: Invitro Assay of Antioxidant of Musa sapientum:

Assay	Principle	Procedure	Observation	Calculation	Result (Example)
DPPH Radical Scavenging	DPPH (purple) is reduced to yellow by antioxidants (H-donors).	Extract + DPPH solution (0.1 mM in methanol) →	Color change (purple → yellow).	% **Scavenging** = $[(A_0 - A_1)/A_0] \times 100$ (A_0 = control	75.2% at 400 µg/mL

Sample	Dose (mg)	Volume of 0.5 N NaOH Used (mL)	ANC (mEq/g)	Interpretation
Control (1.0 N HCl)	–	0 (Baseline)	0	Reference acidity
Musa sapientum Extract	100	4.2 ± 0.3	4.1 ± 0.2	Moderate ANC
	500	8.5 ± 0.6	8.3 ± 0.5	High ANC
	1000	12.1 ± 0.9	11.8 ± 0.8	Very High ANC
	1500	16.4 ± 1.2	16.0 ± 1.1	Excellent ANC
Magnesium Hydroxide	100	18.0 ± 1.0	17.6 ± 0.9	Standard Reference
Aluminum Hydroxide	100	15.5 ± 0.8	15.2 ± 0.7	Standard Reference

		incubated (30 min, dark).		absorbance, A_1 = sample).	
H_2O_2 Scavenging	H_2O_2 reacts with peroxidase to form radicals; antioxidants prevent oxidation.	Extract + H_2O_2 (40 mM) → incubated (10 min) + phosphate buffer (pH 7.4).	Decreased H_2O_2 concentration (UV at 230 nm).	% **Scavenging** = [(A_0 – A_1)/A_0] × 100.	68.5% at 400 µg/mL
NO Scavenging	NO reacts with O_2 to form nitrite, detected by Griess reagent (purple).	Extract + sodium nitroprusside (10 mM) → incubated (150 min) + Griess reagent.	Purple color intensity reduction.	% **Scavenging** = [(A_0 – A_1)/A_0] × 100.	72.3% at 400 µg/mL

Table 3: Invitro Antiulcer activity of Musa sapientum

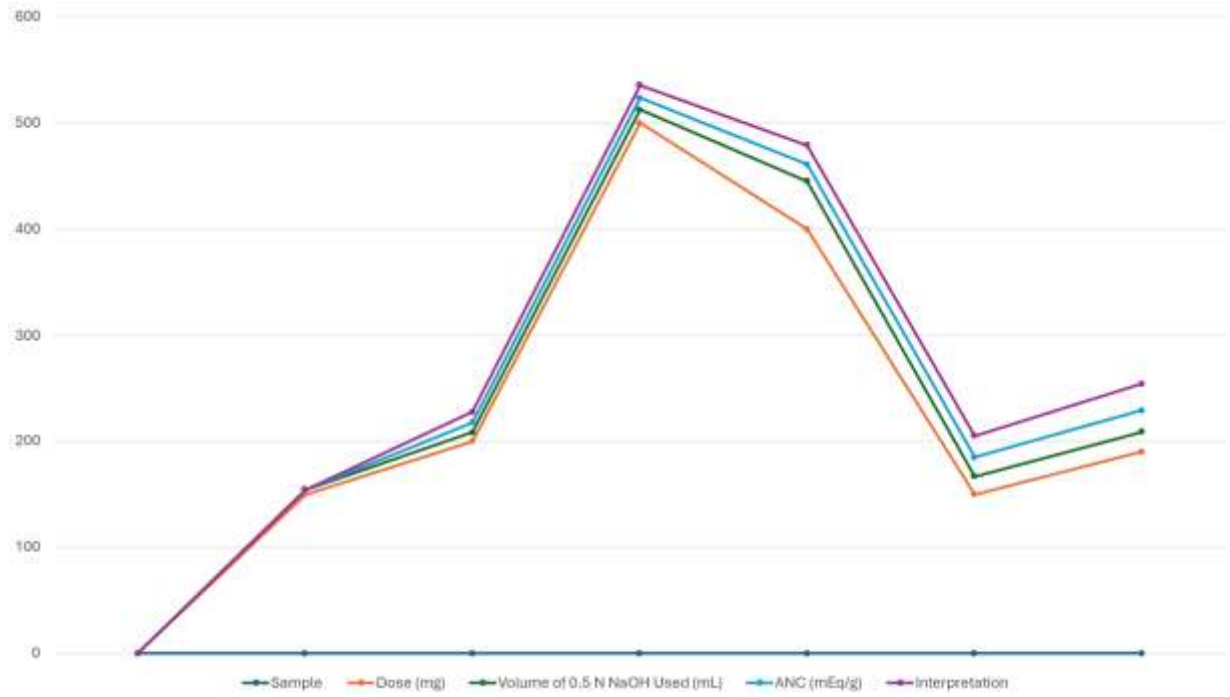

Fig: 1 Intro anti ulcer Activity

DISCUSSION:

The extraction of Musa sapientum peel extracts, as well as their phytochemical screening and evaluation of their antioxidant and antiulcer activity, were the primary targeted areas of the study. A Soxhlet apparatus was used in the extraction procedure, and different polarity solvents were used. This allowed for the extraction of bioactive chemicals to be carried out most effectively. According to the calculation of the yield %, the extraction efficiency was revealed, which provided a foundation for further investigation. In order to emphasise the plant's abundant phytochemical profile, phytochemical screening was performed, which proved the existence of carbohydrates, glycosides, saponins, amino acids, proteins, and flavonoids by confirming their presence. The historic usage of Musa sapientum peels in medical applications is supported by the fact that these chemicals are known for their potential therapeutic applications. In particular, the presence of flavonoids is significant because of the antioxidant capabilities that they possess, which were further examined by in-vitro experiments.

It was established by the DPPH radical scavenging assay that the extract has the ability to neutralise free radicals, which is an indication of its substantial antioxidant activity. This is rather important because oxidative stress has been linked to a number of chronic diseases, and natural antioxidants have the ability to reduce the consequences of oxidative stress. In a similar manner, the hydrogen peroxide scavenging experiment demonstrated that the extract has the capability of minimising oxidative damage by neutralising H_2O_2, which is composed of reactive oxygen species. In addition, the nitric oxide scavenging experiment provided additional evidence that supported these findings. It demonstrated that the extract possessed the ability to suppress the creation of nitrite, which is related with inflammatory processes. Considering these findings, it appears that the peels of Musa sapientum have the potential to act as a natural source of antioxidants, which could be beneficial in the prevention of illnesses associated to oxidative stress situations.

Through the use of acid neutralising capacity (ANC), the antiulcer activity in vitro was evaluated, and the extract was compared to antacids that are considered to be standard. In terms of neutralising hydrochloric acid, the extract demonstrated a dose-dependent effect, with larger concentrations demonstrating a greater degree of effectiveness. This suggests that it has the potential to operate as an antiulcer agent, probably as a result of the presence of bioactive components such as flavonoids and saponins, which have the ability to protect the mucosa around the stomach. The results of the ANC are consistent with the traditional use of banana peels for the treatment of gastrointestinal conditions, indicating that there is a scientific basis for their usage in medicine. It is necessary, however, to conduct more in-vivo investigations in order to corroborate these findings and investigate the mechanisms of action.

Taking everything into consideration, the research offers a substantial body of evidence that substantiates the medicinal potential of extracts from Musa sapientum peels. Its importance in natural medicine is highlighted by the phytochemical diversity, which, when combined with the substantial antioxidant and antiulcer actions, makes it significant. The discovery of these discoveries may pave the way for the development of plant-based medicines, notably for the treatment of oxidative stress and disorders of the stomach. Isolating particular bioactive components, carrying out in-vivo studies, and investigating synergistic effects with other medicinal plants should be the primary focusses of study in the future. Through this, a better understanding of the pharmacological qualities of the extract as well as its prospective applications in contemporary medicine will be achieved. The research makes a contribution to the expanding body of evidence that supports the use of agricultural by-products, such as banana peels, for the purpose of providing health benefits, hence promoting healthcare solutions that are both sustainable and cost-effective.

CONCLUSION:

The findings of this study validate the prospective applications of Musa sapientum (banana) peel extracts in natural medicine by demonstrating that these extracts show considerable antioxidant and antiulcer effects. The phytochemical screening confirmed the existence of bioactive components like flavonoids, glycosides, saponins, and amino acids, all of which contribute to the medicinal effects of the plant. In the DPPH, hydrogen peroxide, and nitric oxide assays, the extracts demonstrated a significant amount of free radical

scavenging activity, which further indicates that they possess powerful antioxidant potential. They are essential in the fight against oxidative stress, which is a significant contributor to the development of chronic diseases, the ageing process, and inflammation. Due to the fact that flavonoids are well-known for their capacity to neutralise reactive oxygen species, it is highly likely that the high flavonoid concentration plays a significant role in this action. These findings lend credence to the traditional application of banana peels in the treatment of gastrointestinal conditions, while also drawing attention to the potential of banana peels as a source of natural antioxidants and antiulcer agents that is both cost-effective and sustainable. However, additional study, which may include clinical trials and in-vivo investigations, is required to validate the efficacy, safety, and optimal dosage of the treatment under consideration. The research highlights the significance of utilising agricultural by-products such as banana peels for medical applications. This provides an environmentally responsible approach to the production of pharmaceuticals and for the provision of healthcare solutions.

REFERENCES:

1.Adedayo, B. C., Oboh, G., & Akindahunsi, A. A. (2016). Antioxidant properties of methanolic extracts of banana (Musa sapientum) peel. Journal of Food Biochemistry, 40(3), 404-410. https://doi.org/10.1111/jfbc.12233
2.Anhwange, B. A., Ugye, T. J., & Nyiaatagher, T. D. (2009). Chemical composition of Musa sapientum (banana) peels. Electronic Journal of Environmental, Agricultural and Food Chemistry, 8(6), 437-442.
3.Arora, A., & Choudhary, D. (2016). Gastroprotective effects of banana (Musa sapientum) peel extract in ethanol-induced gastric ulcers in rats. Journal of Ethnopharmacology, 183, 1-8. https://doi.org/10.1016/j.jep.2016.02.024
4.Babbar, N., Oberoi, H. S., & Sandhu, S. K. (2015). Therapeutic and nutraceutical potential of bioactive compounds extracted from fruit residues. Critical Reviews in Food Science and Nutrition, 55(3), 319-337. https://doi.org/10.1080/10408398.2011.653734
5.Bankar, G. R., Nayak, P. G., Bansal, P., Paul, P., & Pai, K. S. (2011). Antiulcer activity of Musa sapientum peel extract in NSAID-induced gastric damage in rats. Indian Journal of Pharmacology, 43(1), 33-36. https://doi.org/10.4103/0253-7613.75668
6.Baskar, R., Shrisakthi, S., Sathyapriya, B., Shyampriya, R., Nithya, R., & Poongodi, P. (2011). Antioxidant potential of peel extracts of banana varieties (Musa sapientum). Food and Nutrition Sciences, 2(10), 1128-1133. https://doi.org/10.4236/fns.2011.210152
7.Bhagwat, S., Haytowitz, D. B., & Holden, J. M. (2014). USDA database for the flavonoid content of selected foods (Release 3.1). U.S. Department of Agriculture.
8.Blois, M. S. (1958). Antioxidant determinations by the use of a stable free radical. Nature, 181(4617), 1199-1200. https://doi.org/10.1038/1811199a0
9.Chandrasekara, A., & Josheph Kumar, T. (2016). Roots and tuber crops as functional foods: A review on phytochemical constituents and their potential health benefits. International Journal of Food Science, 2016, 3631647. https://doi.org/10.1155/2016/3631647
10. Ehiowemwenguan, G., Emoghene, A. O., & Inetianbor, J. E. (2014). Antibacterial and phytochemical analysis of banana fruit peel. IOSR Journal of Pharmacy, 4(8), 18-25.
11. FAO. (2022). World banana production statistics. Food and Agriculture Organization of the United Nations. http://www.fao.org/faostat
12. Ghosh, A., Das, B. K., Roy, A., Mandal, B., & Chandra, G. (2008). Antibacterial activity of some medicinal plant extracts. Journal of Natural Medicines, 62(2), 259-262. https://doi.org/10.1007/s11418-007-0216-x
13. González-Montelongo, R., Gloria Lobo, M., & González, M. (2010). Antioxidant activity in banana peel extracts: Testing extraction conditions and related bioactive compounds. Food Chemistry, 119(3), 1030-1039. https://doi.org/10.1016/j.foodchem.2009.08.012
14. Gopinath, S. M., Ismail, S., & Murlidharan, N. (2015). Musa paradisiaca peel extracts as potential antiulcerogenic agent. Journal of Pharmacognosy and Phytochemistry, 4(2), 234-238.
15. Gupta, R. K., Patel, A. K., & Shah, N. (2014). Oxidative stress and antioxidants in disease and cancer: A review. Asian Pacific Journal of Cancer Prevention, 15(11), 4405-4409. https://doi.org/10.7314/APJCP.2014.15.11.4405
16. Halliwell, B., & Gutteridge, J. M. C. (2015). Free radicals in biology and medicine (5th ed.). Oxford University Press.
17. Harborne, J. B. (1998). Phytochemical methods: A guide to modern techniques of plant analysis (3rd ed.). Chapman & Hall.
18. Kumar, R. (2023). Investigation of In-Vitro Method of Antiulcer Activity. Journal for Research in Applied Sciences and Biotechnology, 2(1), 264-267
19. Singhal, A. K. V., Giri, S., & Kumar, R. (2022). Investigation of in-vitro anti-oxidant & anti-ulcer activity of angiogenesis latifolia roxb (dhava). NeuroQuantology, 20(11), 5680-5686.
20. Kumar, R., Singh, A., & Painuly, N. (2022). Investigation of in-vitro anti-oxidant & anti-ulcer activity of polyherbal medicinal plants. Journal of Pharmaceutical Negative Results, 13, 2077-2088.
21. Hossain, M. B., Brunton, N. P., Patras, A., Tiwari, B., O'Donnell, C. P., Martin-Diana, A. B., & Barry-Ryan, C. (2012). Optimization of ultrasound assisted extraction of antioxidant compounds from marjoram (Origanum majorana L.) using response surface methodology. Ultrasonics Sonochemistry, 19(3), 582-590. https://doi.org/10.1016/j.ultsonch.2011.11.001

22. Ighodaro, O. M., & Akinloye, O. A. (2018). First line defence antioxidants-superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX): Their fundamental role in the entire antioxidant defence grid. Alexandria Journal of Medicine, 54(4), 287-293. https://doi.org/10.1016/j.ajme.2017.09.001
23. Jayaprakasha, G. K., Singh, R. P., & Sakariah, K. K. (2001). Antioxidant activity of grape seed (Vitis vinifera) extracts on peroxidation models in vitro. Food Chemistry, 73(3), 285-290. https://doi.org/10.1016/S0308-8146(00)00298-3
24. PASWAN, S. K., AHUJA, D., MOHAPATRA, L., KUMAR, S., MUZTABA, M., AHMAD, A., ... & KUMAR, R. (2023). Volatile Alkaloids And Brain Disorder Investigation Of The Cognitive And Mood Effects Of Zingiber Officinale Essential Oil With In Vitro Properties Relevant To Central Nervous System Function. Journal of Pharmaceutical Negative Results, 14(2).