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Formulation And Evaluation Of Herbal Gel With *Musa Paradisiaca* Peel Extract

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Abstract: In response to the growing demand for natural and sustainable therapeutic products, this study innovates by developing a herbal gel formulation incorporating *Musa paradisiaca* (banana) peel extract. The novelty of this research lies in utilizing banana peels, traditionally considered waste, as a source of bioactive compounds with proven antioxidant, anti-inflammatory and antimicrobial properties. The gel was meticulously formulated using advanced preparation techniques and evaluated for its physicochemical properties, including pH, viscosity, and spreadability. Stability assessments were conducted under various storage conditions to ensure product integrity. In addition to standard evaluations, the gel's biological efficacy was explored through cutting-edge *in vitro* assays for anti-inflammatory activity and antioxidant activity. Results reveal that the *Musa paradisiaca* peel extract-enhanced gel not only maintains optimal stability but also exhibits significant biological activity, highlighting its potential as a novel and effective ingredient in topical herbal formulations. This study underscores the innovative use of *Musa paradisiaca* peels, contributing to sustainable practices and advancing the field of herbal product development.

***Keywords*:** Herbal gel, banana peel extract, formulation, evaluation, anti-inflammatory, antioxidant

1. INTRODUCTION

In recent years, there has been a growing interest in utilizing natural sources for the development of pharmaceutical and cosmetic products due to their perceived safety and efficacy. Herbal extracts have gained attention for their potential therapeutic benefits. Banana (Musa spp.) is a widely consumed fruit known for its nutritional value, the original name of the banana is *Musa*, coming from the Musaceae family. Bananas are most commonly grown in Asian countries, especially Malaysia and South America, Central and North America, Africa, Oceania, and European countries follow this continent, respectively All edible banana fruits are seedless and belong to two main species, *Musa acuminate Colla* and *Musa balbisiana Colla*. The hybrid of these two species, *Musa x paradisiaca L* is also available today [(1)] .

Banana peels are often discarded as agri- wastes but it has great potential to be used as functional foods. In some regions of the world, banana peels are consumed as food and employed as medicine. It has huge potential in health promoting properties and it can be used as an essential source in the food industry. Banana peel contains various bioactive compounds that have been reported to possess antioxidant, antimicrobial, and anti-inflammatory properties.Antioxidant Properties help neutralize free radicals in the body, reducing oxidative stress and inflammation. The peel has been traditionally used in some cultures for treating minor skin irritations, cuts, and burns. It is believed that the peel's antimicrobial properties and the presence of certain enzymes aid in wound healing. Compounds like dopamine and lectins found in banana peels have shown anti-inflammatory properties. This could potentially benefit conditions like arthritis and other inflammatory disorders.Rubbing the inner side of a banana peel on the skin has been suggested to help reduce acne inflammation and promote smoother skin. The peel is also used in some skincare products for

its moisturizing effects.Digestive Health: Some studies suggest that the fiber content in banana peels could aid in digestion and help alleviate constipation.[2-9]

These references provide scientific insights into the potential medicinal uses of banana peels, highlighting ongoing research and traditional uses.The formulation of herbal gels using aqueous extracts from dried banana peel presents an innovative approach to harnessing these beneficial compounds. Herbal gels are topical formulations that combine the benefits of herbal extracts or active compounds with the soothing and hydrating properties of gels. These formulations are popular in skincare, wound healing, and various medicinal applications due to their ease of application, ability to deliver active ingredients directly to the skin, better patient compliance and potential for controlled release of active ingredients. By incorporating banana peel extract into a gel base, it is possible to create a topical product that may offer antioxidant protection, promote skin health, or provide therapeutic benefits for various dermatological conditions [10-13].

2.MATERIALS AND METHODS

2.1 Chemicals and reagents:

Banana peel,Carbopol 934, Methyl paraben, Propyl paraben (SD fine-chem ltd) Propylene glycol, triethanolamine, Disodium hydrogen phosphate, Potassium dihydrogen phosphate, Isopropylalcohol, chloroform and Glacial acetic acid, Million's reagent, ferric chloride, Neocuprine, Diclofenac gel, ascorbic acid

3.EXPERIMENTAL WORK

3.1 Preparation of Banana Peel Extract:

Dried banana peel was procured, dried and pulverized. Aqueous extraction was performed by decoction method using distilled water under optimized conditions for a short duration usually about 15 min. The ratio of the solvent to crude drug was 4:1. It is used for extraction of water soluble and heat stable plant material. [14]

3.2 Pre-formulation Studies:

3.2.1 Tests for flavonoids:

Flavonoid presence in the herbal extract gives potent antioxidant activity. Hence tests were executed to validate the presence of flavonoids inthe fresh aqueous extract of dried *Musa paradisica* peel.[15]

3.2.1.1 Alkaline Test: Test solution treated with sodium hydroxide solution.

3.2.1.2 Ferric Chloride test: To the alcoholic solution of herbal extract few drops of neutral ferric chloride solution.

3.2.1.3 Tyrosine test:3 ml of herbal extract was heated and 3 drops of Million's reagent.

3.2.2Drug excipient compatibility studies:

3.2.2.1Test for physical compatibility:

Polymer and drug has been mixed in 1:1 ratio and stored for one month at room temperature(30-32ºC) and scrutinized for any change in colour,odour and physical state of the powder.

3.3 Formulation of Herbal Gel:

Polymer Carbapol 934 was kept aside in distilled water for half an hour to swell. 5ml propylene glycol was added to a mixture of methylparaben and propylparaben and then to the swelled polymer. The content were stirred under a mechanical stirrer. Fresh aqueous extract of *Musa paradisiaca* were added and stirred firmly with glass-rod to uniformly distribute the herbal extract. Make up the volume up to 150 ml using distilled water and added triethanolamine (drop wise) to adjust the pH of the gel to 6.8-7. Multiple batches were prepared by varying the concentration of Carbapol, herbal extract, stirring time, and stirring speed[16-18].

Table 1: Formulation of herbal gel

Formulation	Concentration of Carbapol (g)	Stirring speed (RPM)	Stirring time (min)	Weight of fresh aqueous banana peel extract (g)
F1	1	1000	15	10
F2	2	1000	15	10
F3	3	1000	15	10
F4	2	1200	15	10
F5	2	1400	15	10
F6	2	1200	30	10
F7	2	1200	45	10

F8	2	1200	30	20

3.4 Evaluation of Herbal Gel:

3.4.1 Physicochemical Properties:

3.4.1.2 Organoleptic properties of gel:

Organoleptic properties such as colour, odour, homogeneity and appearance of the herbal gel were observed by visual inspection.

3.4.1.3 pH determination:

A digital pH meter (Vanira 11613) is used to find out the pH of gel formulations. In a clean beaker with 50 mL of distilled water the 1 gm of gel were dissolved properly and kept it in a beaker for 2 hours. The pH of each formulation was investigated in triplicate and the average reading was recorded pH.

3.4.1.4 Viscosity measurement:

Viscosity of gel was measured by use of Brookfield viscometer (Brookfield Ametekivdv). The sufficient quantity of herbal gel was filled in sample holder separately. The height of the gel was filled in the sample holder should sufficiently allow to dip the spindle no.63. Viscosities of the gels were recorded by adjusting the rotating speed of the spindle at 100 rpm.

3.4.1.5 Spreadability assessment:

The spreadability of the gel formulation was analyzed by measuring the spreading diameter of 1g of gel between two horizontal plates (20 cm x 20 cm) after one minute. The standard weight applied on the upper plate was 125 g.

3.4.2 UV-Visible Spectrophotometry:

3.4.2.1 Selection of analytical wavelength:

The standard stock solutions are used to make the suitable dilutions of drug and scanned under UV visible spectrometer from 200-600 nm. The wavelength of herbal gel was recorded by scanned spectrum and the absorbance maxima of drug were noted down.

3.4.2.2 Preparation of standard stock solution of Herbal gel:

100 mg of herbal gel was weighed and transferred into 100 ml volumetric flask and dissolved in 10 mL of methanol as a (co-solvent), after that the flask was shaken and sonicated for 15minutes and maintained the volume up to the mark with 6.8 pH phosphate buffer. 10 ml of solution was pipetted out from volumetric flask and then transferred it into another 100 ml volumetric flask and the 100 mL volume was maintained with6.8 pH phosphate buffer up to the mark. The prepared concentration of stock solution was 100 µg/mL.

3.4.2.3 Selection of analytical concentration ranges:

A standard stock solution of herbal (100 µg/mL), 0.2, 0.4, 0.6, 0.8, 1.0 ml of solution were pipetted out and transferred in to individual volumetric flask of 10 Ml. The volume in each volumetric flask was made up to 10 ml with 6.8 pH phosphate buffer. These concentrations were made in the range of 2, 4, 6, 8 ,10 µg/mL respectively.

For the identification of absorbance, the selected wavelength of herbal gel is used and a calibration curve of absorbance vs. concentration was plotted. Herbal gel follows the Lamberts Beer's law in the range of 2-10 µg/mL.

3.4.2.4 Preparation of calibration curve:

For the quantification of herbal gel at different stages during the development and characterization of formulations, a calibration curve for drug was prepared in analytical solvent methanol as a (co-solvent) with 6.8 pH phosphate buffer. For the estimation of calibration curve, accurately weighed quantity of herbal gel (100 mg) was taken in 100 ml volumetric flask and minimum amount of solvent (methanol) was added into volumetric flask and dissolved properly. Then, volume was made up to the mark with 6.8 pH phosphate buffer. After making the volume up to the mark, the solution serves as standard stock solution. From the stock solution, working standard in the range of 2-10 µg/mL was prepared by suitable dilution with respective analytical solvents. Absorbance of each working standard was measured spectrophotometrically at the respective solvent. Obtained data were recorded by using MS Excel computer software. The extinction coefficient was calculated from the slope of regression line obtained from a plot between concentrations of herbal drug.

3.5 Drug Content:

From each formulation 1 gm of gel was taken in a 100 Ml volumetric flask and made up to volume by pH 6.8 phosphate buffer and shaken well to dissolve the active constituents in solvent. The solution was sonicated for few minutes and filtered it with the help of what man filter paper. After that, 0.1 mL of the filtrate was pipetted out and diluted upto10 mL with pH 6.8 buffer. The content of active constituents was

estimated spectrophotometrically by using 268 nm λmax of herbal gel.The drug content present in the formulation was identified with the help of linear regression analysis of calibration curve.

3.6 *In vitro* Release Studies:

Franz diffusion cell method to determine the release profile of bioactive compounds from the gel. In receptor compartment pH 6.8 phosphate buffer was filled. Cellophane membrane was used as dialysis membrane. The membrane was dip inside the phosphate buffer for overnight swelling and on the donor cell compartment the membrane with gel was tied carefully. Such that the cellophane membrane was in intimate contact with the release surface of the formulation in the donor compartment. The pH 6.8 phosphate buffer was added to a donor compartment attached on the cell. A weighed quantity of formulation equivalent to 1 g of gel was taken on to the cellophane membrane and was immersed slightly in receptor media by continuously stirring.

The whole experiment is done at 37±1 ºC. During the process an equal volume of sample (5 mL) was withdrawn at several intervals of time (1, 2, 3, 4, 5, 6, 7 and 8 hr) and during each withdrawn the donor compartment was replaced with equal volume of phosphate buffer. All the samples were estimated spectrophotometrically at 268 nm. The cumulative percent release was calculated for each time (in hr) interval.30 after that the *in vitro* drug release of optimized formulation was interpreted with Zero order, First order, Higuchi and Korsmeyer Peppas kinetic models.

3.7 Evaluation of *in vitro* anti-inflammatory assay of optimized herbal gel:

Protein (egg albumin) Denaturation Assay method was used for assessing *in vitro* anti- inflammatory activity. The protein denaturation assay evaluates the ability of a substance to inhibit protein denaturation induced by heat or chemical agents. Inflammation can cause protein denaturation, leading to tissue damage and dysfunction.

Mixture of 5ml consist of 0.2ml of egg albumin,2.8ml phosphate buffer saline (pH:6.4) 2ml of herbal gel concentration ranging from 10ug/ml to 50ug/ml were added to each test tube separately. Control consisted of 0.2ml of egg albumin, 2.8ml buffer and 2ml of double distilled water. Mixtures were incubated at 37+/-2 ℃ for 15 minutes and heated at 70℃ for 5 minutes. After cooling, absorbance measured at 660nm by using vehicle as blank. Diclofenac sodium was used as reference drug.

3.8 Evaluation of *in vitro* antioxidant assay of optimized herbal gel:

The CUPRAC (cupric ion reducing antioxidant capacity) assay measures the reducing ability of a substance toward cupric ions.This method involves mixing Cupric Chloride of 1ml (10mM), 1 ml of Neocuproine (7.5Mm) , 1ml of Ammonium acetate buffer of pH 7 solution and were added to test tubes containing 2ml of distilled water. Optimized herbal gel in different concentration ranging from 10 ug/ml to 50ug/ml were added to each test tube separately. These mixtures were incubated for half an hour at room temperature and measured against blank at 450nm. Ascorbic acid was used as positive reference standard.

3.9 Stability Studies:

Optimized formulation kept in a tightly closed airtight container and stored at room temperature of 37±5ºC for 3 months and observed for any possible change in physical stability, appearance and pH.

4. RESULTS AND DISCUSSION

4.1 Pre- formulation Studies:

Table 2. Results of flavonoid test

Test	Observation	Inference
Alkaline Test	Increasing in the intensity of yellow colour which become colourless on addition of dilute acid	Presence of flavanoids
Ferric Chloride test	Green colour observed	Presence of flavanoids
Tyrosine test	Solution shows dark red colour in presence of amino acids	Presence of flavanoids

4.2 Drug excipient compatibility studies:

4.2.1 Test for physical compatibility:

Physical mixture of polymer and drug had shown no observable changes in colour, odour and physical state.

4.3 Formulation of Herbal Gel:

Among the eight batches, formulation F6 was found to possess good homogeneity, texture and physical stability. Hence formulation F6 was selected for further investigations.

4.4 Evaluation of Herbal Gel

4.4.1 Physico-chemical evaluation of gel:

Physio-chemical evaluation of the optimized formulation is tabulated in Table no.3.

Table 3. Physio-chemical evaluation of optimized herbal gel

Parameters	Report
Colour	Colorless
Odour	Odourless
Homogeneity	Homogeneous
Appearance	Translucent
pH	6.78±0.2
Viscosity	825000 ± 5 mcp
Spreadability	8 g.cm/sec.

Results are given in mean ± SD, n=3

4.4.1.2pH determination:

pH of 6.8 in a gel indicates mildly acidic environment, which can have implications for both product efficacy and potential skin compatibility. In skin care applications, this value is beneficial as it may better match the natural pH of the skin.

4.4.1.3 Viscosity measurement:

Viscosity measures the resistance of a fluid or gel to flow and higher values 825000±5 mcp suggest that the gel is thick and resistant to deformation or movement. In rheology, it exhibits as a non-Newtonian flow characteristics under the conditions tested by Brookfield viscometer, which indicates the gel may flow easily during application(shear -thinning behavior), enhances spreadability, but regain its high viscosity when at rest.This helps in maintaining the product's structure on the skin, easy of application, stability and sensory attributes.

4.4.1.4 Spreadability assessment:

A spreadability value of 8 g.cm/sec suggests that the optimized gel can be applied smoothly and efficiently. This positive characteristic of the optimized herbal gel marks its application in cosmetics, pharmaceuticals as well as industrial uses.

4.4.2 UV-Visible Spectrophotometry of Herbal gel:

4.4.2.1 Selection of analytical wavelength

The wavelength of herbal gel was carried out by preparing the dilutions at different concentration and the λmax of herbal gel was selected as 268 nm. The spectrum has been shown in Figure 1.

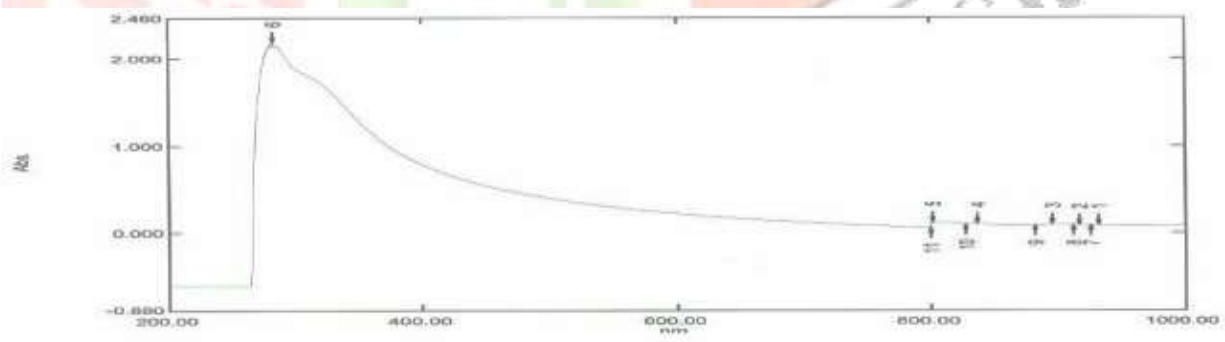

Figure 1: UV-Visible Spectrophotometry of Herbal gel

4.4.2.2 Linearity Curve of herbal gel:

The linearity of herbal gel was found at the concentration range of 2-10 µg/mL at268 nm. The R2 value was at 0.9799 respectively. The linearity curve was made with concentration (µg/mL) on X axis and Absorbance on Y axis in Figure 2.

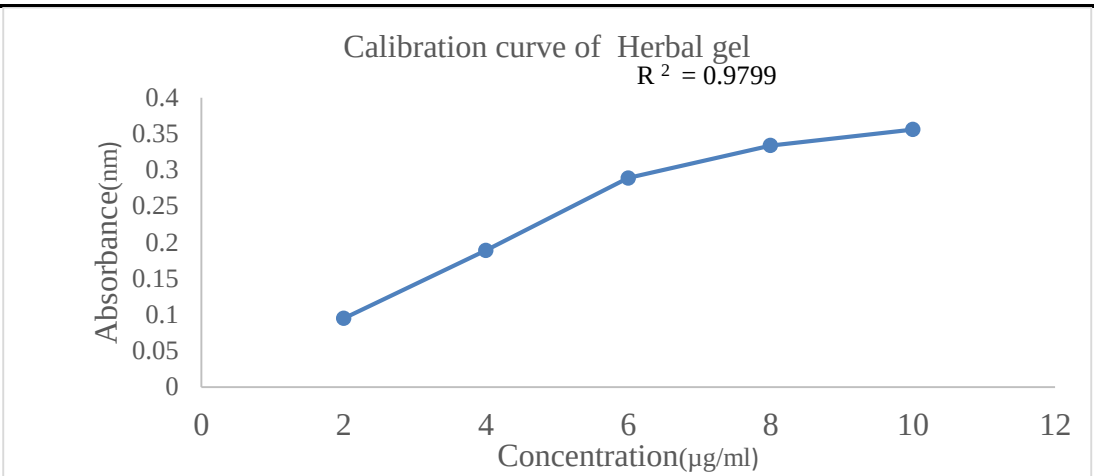

Figure 2: Calibration curve of Herbal gel

4.4.3 Drug content:

The drug content of optimized herbal gel was found to be 99.32%.

4.4.4 *In vitro* drug release study:

In vitro drug release of selected herbal gel formulation was performed and the herbal gel exhibited a drug release of 89.10% at 8 hours indicates a sustained and controlled release profile.This suggests that the formulation is capable of releasing a significant portion of the drug over an extended period, which is desirable for sustained therapeutic effect and potentially improve patient compliance . The obtained results of released drug are represented graphically in Figure3.

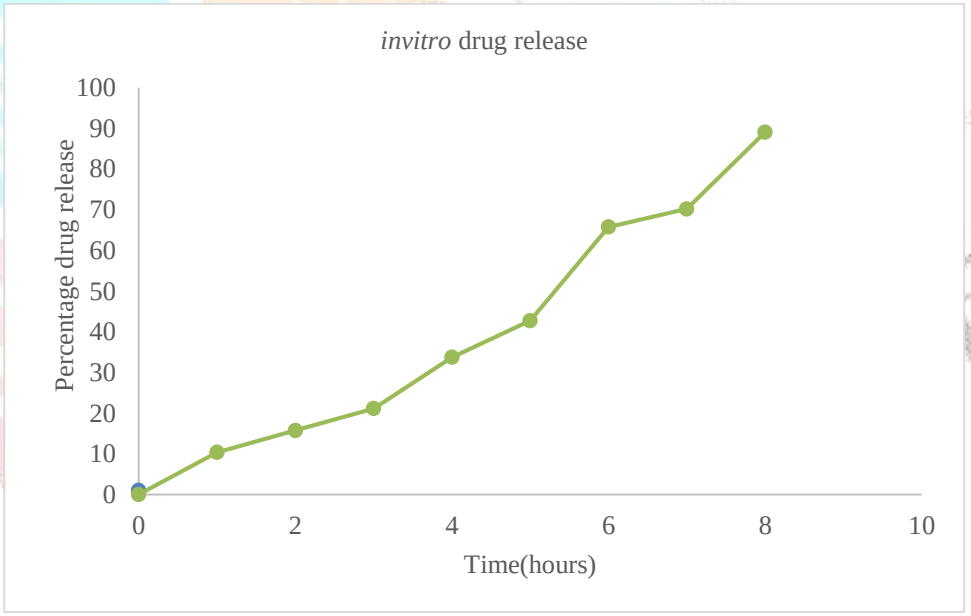

Figure 3:.*In vitro* drug release study

For the identification of release mechanism, the drug release data were explored by kinetic models. The best fit of kinetic model is noticed by observing the R^2 value of the formulation. The highest R^2 coefficient was observed by Higuchi model, zero order models followed by first order model which showed the controlled drug release by diffusion mechanism.

The drug release mechanism is primarily diffusion-controlled, emphasizing the role of the gel matrix in modulating drug release. These findings are consistent with formulations designed for sustained or controlled release applications, offering insights into optimizing dosage for therapeutic efficacy.It highlights the suitability of the formulated herbal gel for achieving desired drug release profiles, supported by rigorous experimental data and model fiting analysis. The obtained results of released drug are tabulated in table 4 and represented graphically in Figure 4 – 7.

Table. 4 Release Kinetics of Optimized herbal gel

Kinetic Model	R^2 Value for Formulation
Zero order model	0.969
First order model	0.8081
Higuchi model	0.9702
Korsmeyer - Peppas model	0.9578

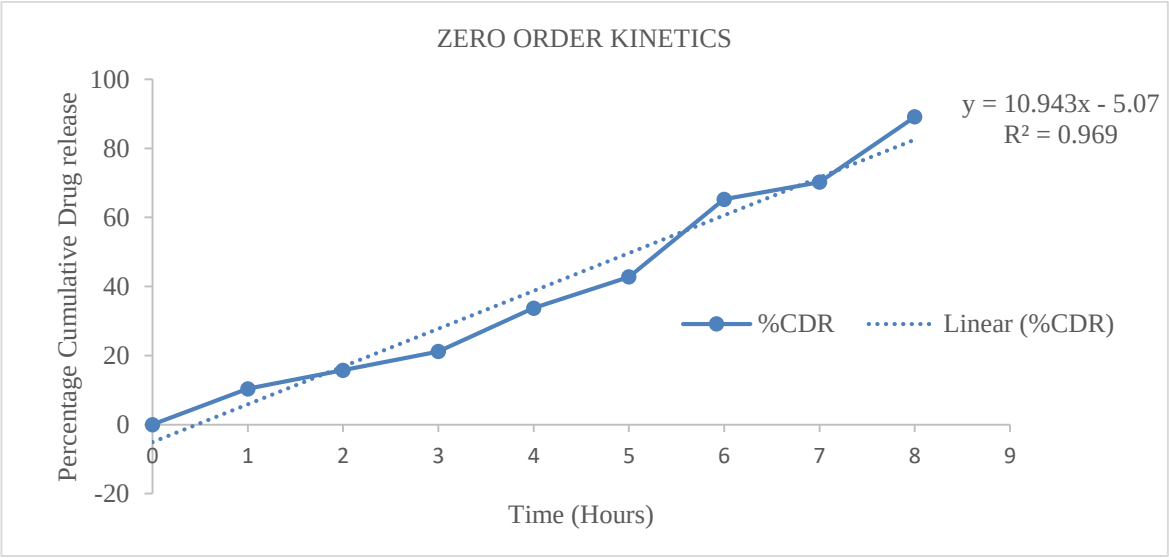

Figure 4: Zero order Kinetics of optimized herbal gel

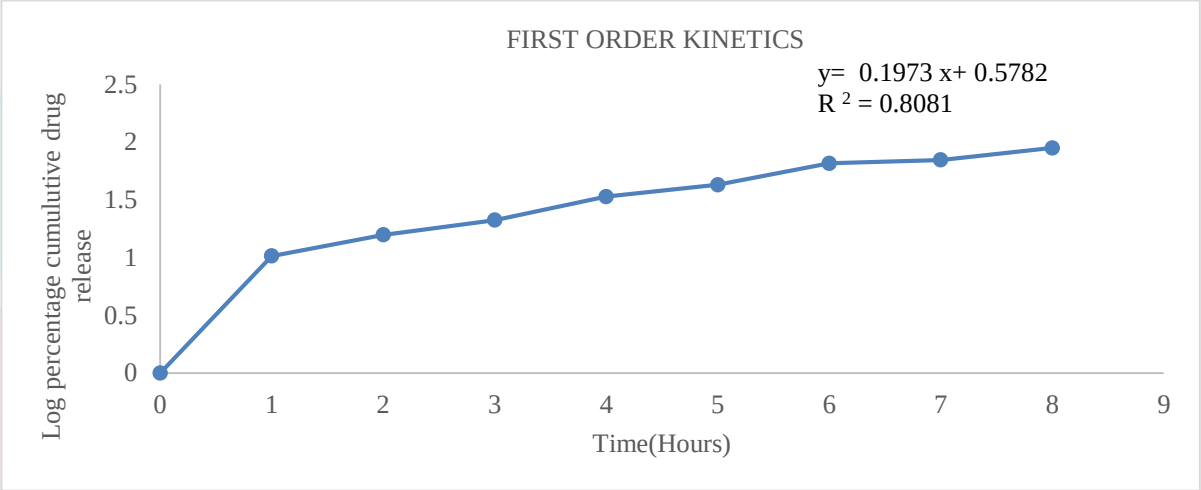

Figure 5: First Order Kinetics of optimized herbal gel

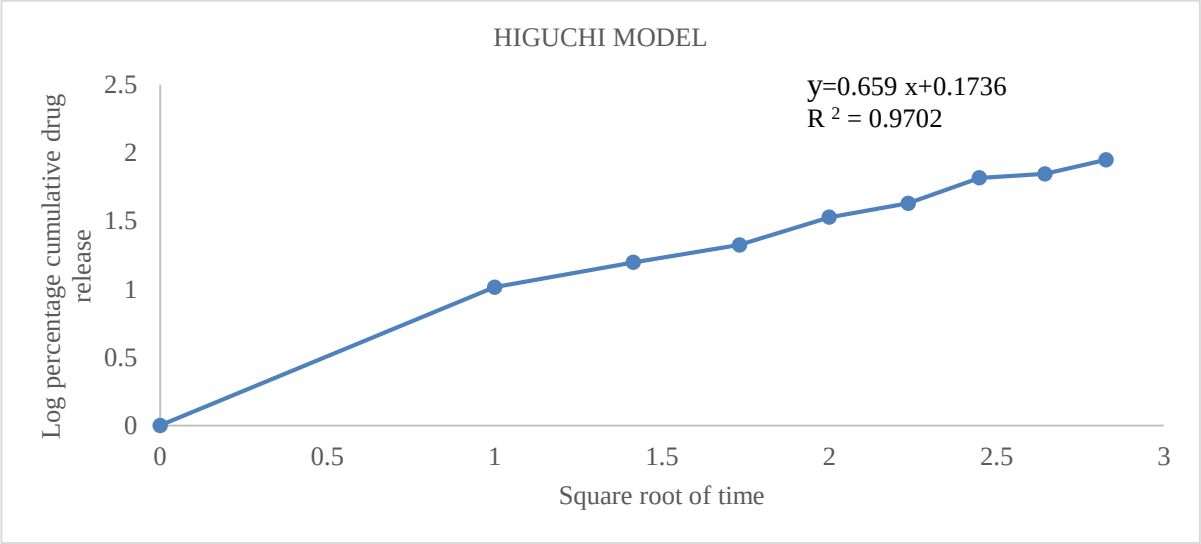

Figure 6: Higuchi Model of optimized herbal gel

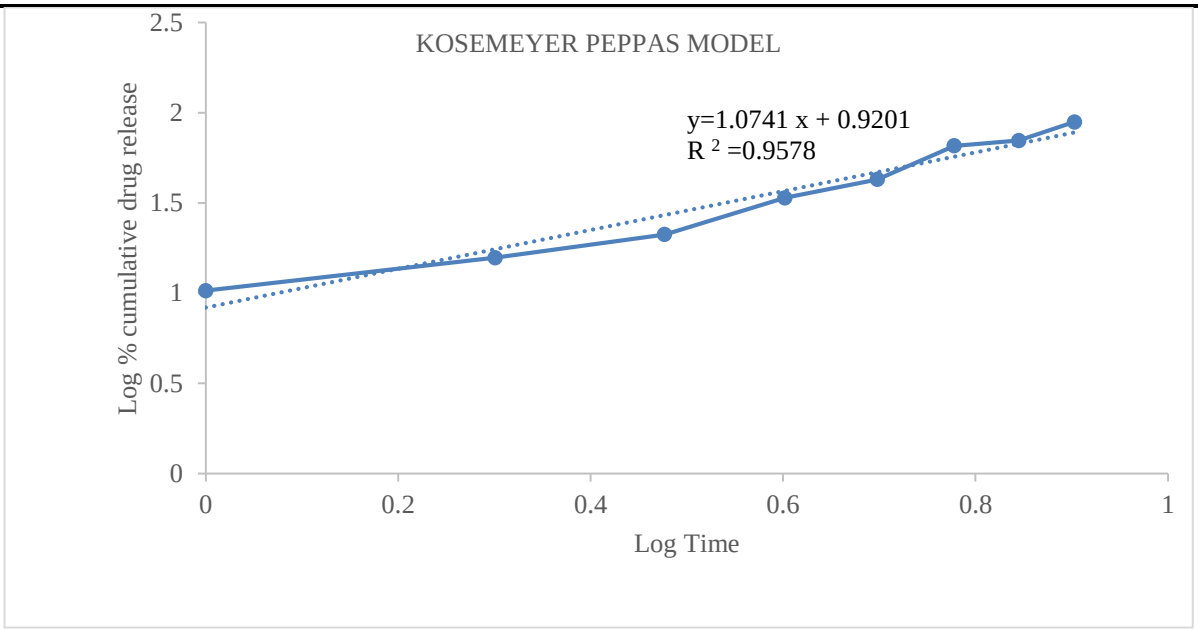

Figure 7: Kosemeyer- Peppas Model of optimized herbal gel

4.4.5 Evaluation of *in vitro* anti-inflammatory assay of optimized herbal gel:

Protein (egg albumin) Denaturation Assay method was used for assessing *in vitro* anti- inflammatory activity of optimized herbal gel with that of Standard gel and the results were tabulated in table.5 and represented graphically in Figure 8 with its percentage inhibition.

Table .5 Evaluation of *in vitro* anti- inflammatory activity of optimized herbal gel with standard drug

CONTENTRATION (µg/ml)	PERCENTAGE INHIBITION %	
	Standard Diclofenac	Herbal gel
10	53.2	61.1
20	69.1	71.1
30	83.1	85.5
40	92.5	94.4
50	98.1	98.8

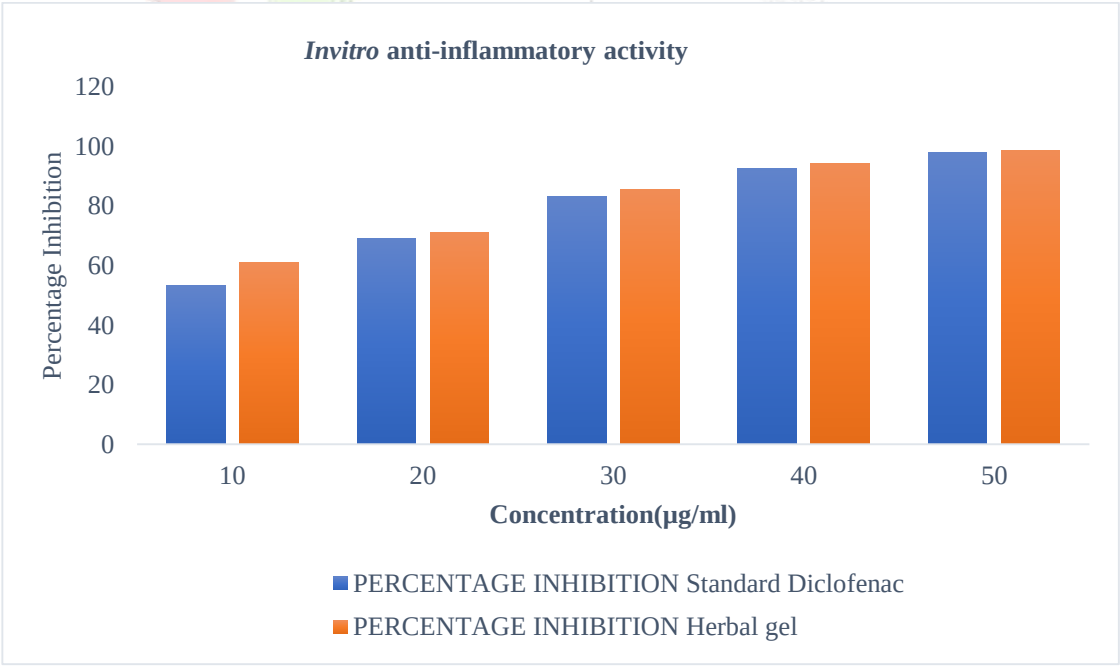

Figure 8: *Invitro* anti-inflammatory activity of optimized herbal gel and standard gel

The results indicate the optimized herbal gel possess strong anti-inflammatory activity**.** Upon comparison with the standard drug Diclofenac gel, the herbal gel exhibited a statistically significant difference, as determined by ANOVA ($P = 0.000477$, $P < 0.05$).

4.4.6 Evaluation of *in vitro* antioxidant assay of optimized herbal gel:

The Total antioxidant capacity (TAC) of herbal gel was evaluated by CUPRAC assay methods. The assay used IC50 value to measure the antioxidant capacity. IC50 value is the concentration of antioxidant needed to decrease the initial concentration by 50 %. Thus, the lower IC50 value the higher the antioxidant activity. IC50 values of herbal gel and ascorbic acid were found to be 31.56 µg /ml and 33.76 µg/ml respectively and represented graphically in Figure 9 and 10. These results indicate that the test compound herbal gel exhibits a slightly higher potency in inhibiting the biological activity compared to the standard compound ascorbic acid.

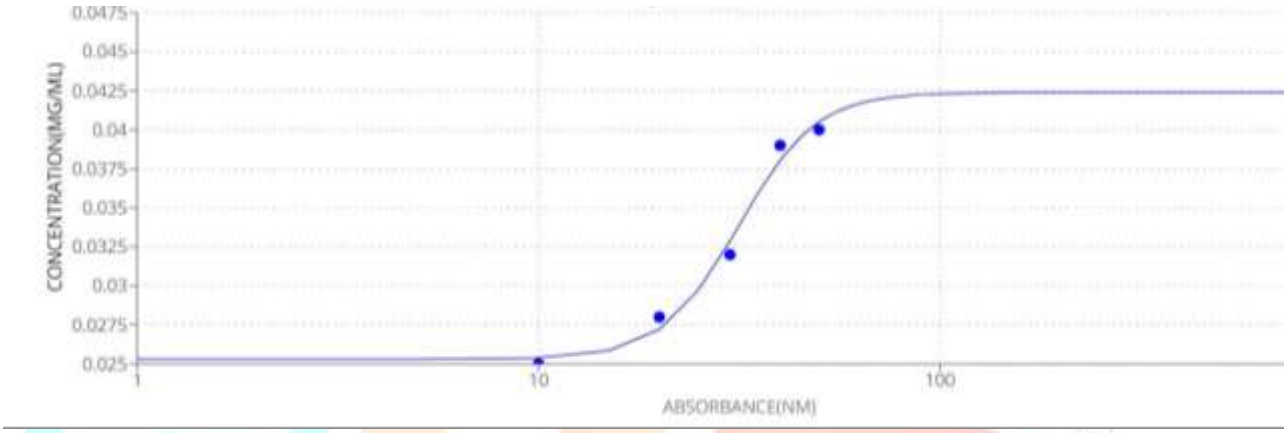

Figure 9: Dose-Response Curve Showing IC 50 of Herbal Gel

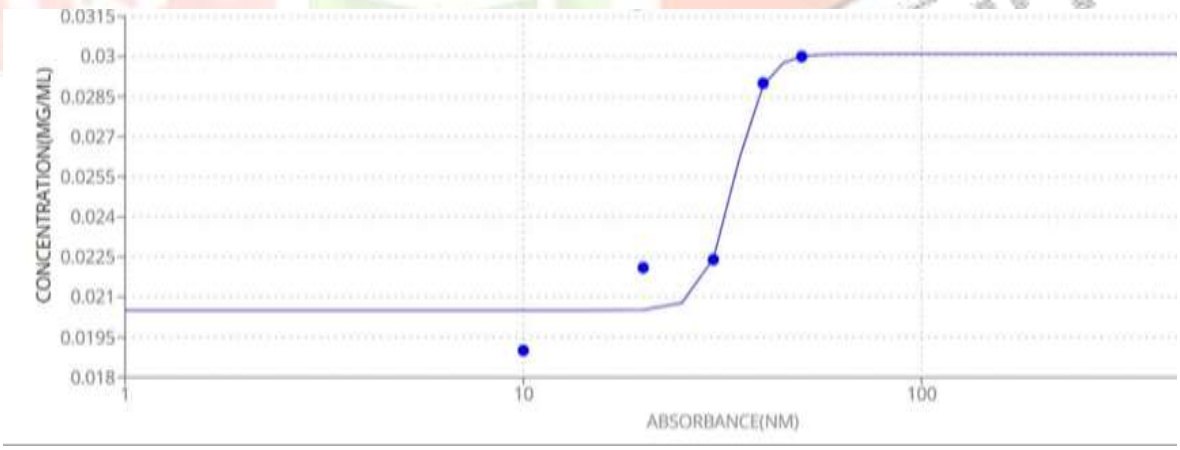

Figure 10: Dose-Response Curve Showing IC 50 of Ascorbic acid

4.4.7 Stability Studies:

Optimized formulation kept in a tightly closed airtight container and stored at room temperature of 37±5ºC for 3 months and observed no change in physical stability – colour,appearance,pH, homogeneity,viscosity and spreadability.Its results were tabulated in Table.6.

Table .6 Stability Studies of optimized Herbal gel

Time interval(days)	**0**	**30**	**60**	**90**
Colour	Colourless	Colourless	Colourless	Colourless
Appearance	Translucent	Translucent	Translucent	Translucent
pH	6.78±0.2	6.78±0.2	6.78±0.2	6.77±0.3
Homogeneity	Homogeneous	Homogeneous	Homogeneous	Homogeneous
Viscosity	825000 ± 5 mcp	825000 ± 5 mcp	824895 ± 5 mcp	824895 ± 5 mcp
Spreadability (g.cm/sec)	8 g.cm/sec.	8 g.cm/sec.	8 g.cm/sec.	8 g.cm/sec.

5.SUMMARY

Formulation and evaluation of the herbal gel containing aqueous extract of dried *Musa paradisiaca* peel have yielded promising results across various parameters relevant to topical applications. The optimized herbal gel demonstrated excellent physicochemical properties, including being colorless, odorless, homogeneous, and possessing a translucent appearance. The pH, viscosity, and spreadability characteristics were measured at 6.78 ± 0.2, 825,000 ± 5 mcp, and 8 ± 0.2 g.cm/sec, respectively, indicating its suitability for effective topical delivery.

The high drug content of 99.32% ensures consistency and potency of the active ingredients within the gel. Furthermore, the herbal gel exhibited a sustained drug release profile with 89.10% release over 8 hours, suggesting potential for prolonged therapeutic effects.

Significant *in vitro* anti-inflammatory activity was observed with a p-value of 0.000477, indicating strong efficacy in mitigating inflammation. This is crucial for its intended therapeutic use in inflammatory skin conditions.Additionally, the herbal gel demonstrated superior antioxidant capacity compared to the standard (ascorbic acid) with IC50 values of 31.56 µg/ml and 33.76 µg/ml, respectively, as assessed by the CUPRAC method. This underscores its potential in combating oxidative stress and protecting the skin from free radical damage.

Overall, the comprehensive evaluation of the formulated herbal gel indicates its promising potential as a novel topical formulation derived from *Musa paradisiaca* peel extract.

6. CONCLUSION

This study successfully demonstrates the potential of *Musa paradisiaca* (banana) peel extract as a valuable ingredient in herbal gel formulations. By repurposing what is traditionally regarded as waste, the research highlights the extract's rich bioactive profile, including anti-inflammatory and antioxidant properties. The developed gel, crafted with precision and rigor, not only showed excellent physicochemical stability but also exhibited significant biological efficacy through *in vitro* assays. These findings suggest that the *Musa paradisiaca* peel extract-enhanced gel could serve as an effective and sustainable addition to topical herbal products. This approach not only fosters the utilization of underappreciated natural resources but also supports the advancement of eco-friendly and innovative therapeutic solutions in the herbal product industry.

7. ACKNOWLEDGEMENT:

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8. CONFLICT OF INTEREST

Regarding the publishing of this article, there is no conflict of interest

9. REFERENCES

1. F. Uckaya Formulation and Evaluation of Ant-Aging Cream Using Banana Peel Extract, International Journal Of Pharmaceutical Science And Research LJPSR 2022, Volume 13, Issue 1.
2. Saleem M., Saeed M.T. Potential application of waste fruit peels (orange, yellow lemon and banana) as wide range natural antimicrobial agent. J King Saud Univ Sci. 2020; 32:805–810.
3. Eddie-Amadi B.F., Ezejiofor A.N., Orish C.N., Rovira J., Allison T.A., Orisakwe E.O. Banana peel ameliorated hepato-renal damage and exerted anti-inflammatory and anti-apoptotic effects in metal mixture mediated hepatic nephropathy by activation of Nrf2/Hmox-1 and inhibition of Nfkb pathway. Food Chem Toxicol. 2022;170
4. Islam M.R., Kamal M.M., Kabir M.R., Md Hasan M., Haque A.R., Hasan S.M.K. Phenolic compounds and antioxidants activity of banana peel extracts: testing and optimization of enzyme-assisted conditions. Measurement: Food. 2023;10
5. Aboul-Enein A., Salama Z., Gaafar A., Aly H.F., Abou-Elella F., Ahmed H. Identification of phenolic compounds from banana peel (*Musa paradaisica* L.) as antioxidant and antimicrobial agents. J Chem Pharmaceut Res. 2016;8(4):46–55.
6. Aquino C. F., Salomão L. C. C., Ribeiro S. M. R., de Siqueira D. L., Cecon P. R. Carbohydrates, phenolic compounds and antioxidant activity in pulp and peel of 15 banana cultivars. *Revista Brasileira de Fruticultura* . 2016;38 doi: 10.1590/0100-29452016090.
7. Rita W. S., Swantara I. M. D., Asih I. A. R. A., Puspawati N. M. Antibacterial activity and antioxidant capacity of selected local banana peel (*Musa* sp.) methanol extracts cultivated in Bali. International Journal of Agriculture Environment & Biotechnology. 2020;5(03):242–251. doi: 10.35410/ijaeb.2020.5519.
8. Okorondu S. I., Mepba H. D., Okorondu M. M. O., Aririatu L. E. Antibacterial properties of *Musa paradisiaca* peel extract. Current Trends in Microbiology. 2010;6:21–26.
9. P.Anandhi, Banana Peel Extract Has Antimicrobial, Antioxidant, Antiinflammatory And Wound Healing Potential, Jounrnal Of Survey In Fisheries Science 2023, Volume 10, 39-48.
10. Hermendrasih J Rathod, A Review on Pharmaceutical Gel, International Journal of Pharmaceutical Sscience Oct 2015 1(1) 33-47.
11. Abdul Wadood Khan.Formulation Development, Optimization and Evaluation of Aloevera Gel For Wound Healing, National Libaray Of Medicine Pub Med Central, Pharmacogn Mag 2013 Oct-Dec 9; 56-510.
12. Rai VK. Mishra N, Yadav KS, Yadav NP. Systematic review on cosmetic potential of banana and its phytochemicals. J Pharmacogn Phytochem. 2017:6(3):1686- 1693.
13. Abhishek soni, Review on Novel Approach in Pharmaceutical Gel, Journal of pharma Research 2019 8(6): 429-435
14. Abdullahi R. Abubakar And Mainul Haque.Basic Extraction and Fractionation Procedures For Experimental Purposes. National Library of Medicine Pub Med Central J Pharm Bioallied Science 2020 January 29, 12(1); 1-10.
15. Kancherla N, Dhakshinamoothi A, Chitra K, Komaram RB. Preliminary Analysis of Phytoconstituents and Evaluation of Anthelminthic Property of Cayratia auriculata (*In Vitro*).Maedica (Bucur). 2019;14(4):350-356.
16. Satyabrata B, P.Kishore K, Muvvala S , Arun kumar D. formulation and evaluation of diclofenac transdermal gel. J. Adv. Pharm. Res.2013;3(3);248-59
17. Missal G, Dixit G, Gulkarni V. Formulation and evaluation of herbal gel. IJNPR 2012;3(4):501-5.
18. Mohsin JJ, Rajmahammad H S. Preparation and evaluation of herbal gel formulation. SGVU Journal of Pharmaceutical research and education2017;2(1):201-24.
19. Pawar DP, Shamkuwar PB. Formulation and evaluation of herbal gel containing *Lantana camara* leaves extract. Asian J Pharm Clin Res 2013;6(3);122-4.
20. Bhramaramba R¸ Babu S , Deepthi DN. . Formulation and Evaluation of Herbal Gel Containing *Terminalia chebula* Retz., Leaves Extract. Sch. Acad. J. Pharm. 2015;4(3): 172-6.
21. A Gupta, AK Mishra, AK Singh, V Gupta et al , 2010. Formulation and evaluation of topical gel of diclofenac sodium using different polymers. Drug invention today;2 (5):250-53.