# FORMULATION AND EVALUATION OF BIODEGRADABLE AGRO-WASTE UTILISED BANANA PEEL EXTRACT SPRAY FOR ANTI-INFLAMMATORY AND ANALGESIC ACTIVITY

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**Abstract**

This study aimed to formulate and evaluate a biodegradable topical spray containing banana peel extract, focusing on its anti-inflammatory and analgesic properties. The formulation was optimized through extensive characterization, ensuring effectiveness, stability, and user-friendly application. Among the three developed formulations (F1, F2, and F3), F2 was identified as the optimized batch based on its ideal viscosity (25 cP), balanced stickiness, quick drying time (25 seconds), and stable physicochemical properties. The stability study, conducted over three months under ICH-recommended conditions (30˚C ± 2˚C / 75 ± 5% RH), confirmed that the formulation remained physically and chemically stable with minimal changes in appearance, pH (6.2 to 6.0), and viscosity (25 cP to 24 cP). The biodegradability assessment using the soil burial method demonstrated significant degradation of the spray residue within 30 days, highlighting its eco-friendly nature. Overall, the formulated spray exhibited promising anti-inflammatory and analgesic potential, making it a natural alternative for managing pain and inflammation. Further in-vivo and clinical studies are recommended to assess its therapeutic efficacy and long-term safety.

**Keywords:** Biodegradable Topical Spray, Pain and Inflammation.

## INTRODUCTION:

The increasing demand for natural and sustainable alternatives to traditional pharmaceutical products has led to the exploration of plant-based ingredients with medicinal properties [1]. Among these, the banana peel (*Musa paradisiaca)* has garnered significant attention due to its rich chemical composition, which includes bioactive compounds such as alkaloids, tannins, triterpenes/ steroids and flavonoids known for their antioxidant, anti-inflammatory and analgesic effects [2,3]. Banana peels, often discarded as waste, have demonstrated promising

therapeutic potential, particularly in the treatment of inflammatory conditions and pain relief. The development of a banana peel extract spray aims to harness these benefits, providing a topical solution for individuals suffering from conditions like arthritis, muscle strains and other inflammatory ailments [4].

The formulation of this spray typically involves extracting the active ingredients from banana peels using solvents such as ethanol or water, followed by the preparation of a sprayable formulation [5,6]. The final product would not only deliver the active compounds directly to the affected area but also provide ease of application and controlled release of the bioactive components. This study focuses on the formulation and evaluation of the banana peel extract spray for its anti-inflammatory and analgesic properties. By assessing its efficacy and safety, the aim is to establish a natural, effective alternative for pain and inflammation management, thereby reducing the reliance on synthetic drugs, which often come with adverse side effects. In conclusion, the banana peel extract spray presents an innovative approach to utilizing agricultural waste for the development of therapeutic products [7]. Its formulation and evaluation could lead to the development of a natural, accessible remedy for pain and inflammation, contributing to the growing field of herbal medicine and sustainable healthcare solutions.

## MATERIAL AND METHODS:

### Materials

The ingredients used in the formulation include banana peel extract sourced from the local market, glycerin obtained from Godrej, India, liquid paraffin supplied by Hindustan Corporation Limited (HCL), India, isopropyl alcohol from India Glycols Limited, India and peppermint oil provided by Silverline Chemicals, India. These ingredients are carefully selected to ensure the effectiveness and stability of the biodegradable spray formulation.

### Preparation of banana peel extract

The peels of bananas were collected, cleaned with water, then cut into small pieces and dried. After drying, the banana peels were blended and stored in a plastic jar at room temperature until needed. Thereafter, the 50gm dried banana peel powder was macerated with 300ml ethanol for 72hrs. The solvent was then eliminated using a rotary evaporator to obtain Banana peel extract [8].

**Figure 1: Banana Peel Extract**

**Phytochemical screening**

Preliminary phytochemical screening for alkaloids, tannins, triterpenes/ steroids and flavonoids was carried out for ethanol banana peel extracts using standard methodologies previously published for their identification and validation [9-11].

**Table 1: Formulation table**

| Ingredients | F1 | F2 | F3 | Pharmacological Activity |
|---|---|---|---|---|
| Banana peel extract | 40ml | 40ml | 40ml | Active ingredient |
| Glycerin | 2.5ml | 2.5ml | 2.5ml | Moisture |
| Liquid paraffin | 08ml | 10ml | 12ml | Surfactants |
| Isopropyl alcohol | 12ml | 10ml | 08ml | Dissolving ingredient |
| Peppermint oil | 2.5ml | 2.5ml | 2.5ml | Essential oils |
| **Total** | **65ml** | **65ml** | **65ml** | |

**Formulation of Banana Peel Extract Spray**

The formulation of the banana peel extract spray involves mixing specific ingredients in a controlled manner to achieve an effective and biodegradable product. A clean beaker or container is used for mixing, followed by the addition of the required amount of banana peel extract as per the formulation table. Glycerin (2.5 ml) is incorporated to provide moisture, while liquid paraffin is added for emulsification and surfactant properties. Isopropyl alcohol is included to help dissolve the ingredients, and peppermint oil (2.5 ml) is mixed in for its soothing and anti-inflammatory effects. The mixture is thoroughly stirred using a stirring rod or homogenizer to ensure uniform blending, achieving a gel-like consistency. If necessary, the consistency can be adjusted by modifying the amounts of liquid paraffin or isopropyl alcohol. The final gel is then filtered to remove any solid particles for a smooth texture before being

transferred into spray bottles or suitable containers. The product is labeled with usage instructions and stored in a cool, dry place for optimal stability [12].

**EVALUATION OF HERBAL SPRAY**

**1) Organoleptic characteristics:** Parameters like Appearance, Color, Odor, Homogeneity, Consistency and Texture were evaluated by visual interpretation.

**2) Determination of pH:** For evaluation, as pH of the spray cannot be directly measured, 10% dilutions were made with distilled water and the pH was determined by using digital pH meter.

**3) Skin irritation:** Small amount of the spray was sprayed on left hand dorsal skin and kept for some time; result was found non- irritant on the skin.

**4) Viscosity:**

Viscosity of spray solution was measured with a Brookfield Viscometer (model LV-DV-II, Helipatch-spindle type S-96, Germany).

**5) Spreadability:**

Mark an area on the left-hand dorsal surface. The spray was applied to the specified area.

**6) Stickiness:** The stickiness of the Spray checked using cloths fibre, these fibres touched to Spray liquide with applying less force and observed for that are retained by the spray, the stickiness is rated high, medium and low [13,14].

## 7) Soil Burial Test for Biodegradability

This **method** was used to assess the **biodegradability** of the topical spray residue. A measured amount of dried spray residue was collected and buried at a depth of 5 cm **in** moist soil under controlled environmental conditions. The temperature was maintained at 30°C ± 2°C with a relative humidity of **75 ± 5%** to simulate natural degradation. The samples were observed at **7,** 15 and 30 days for physical changes such as disintegration, weight loss and structural breakdown**.** The extent of degradation was determined based on appearance, texture changes and structural integrity over time [15].

**8) Stability Studies:**

Spray solutions were conducted for a duration of three months. The formulations were kept in lid tight container at the following conditions as per ICH guidelines: 30˚C ± 2˚ C / 75 ± 5 %

RH. The samples were taken Initially 0 month and 3rd month and evaluated (Appearance, pH and Viscosity) [16].

## RESULT AND DISCUSSION:

## PHYTOCHEMICAL SCREENING

Preliminary phytochemical screening for alkaloids, tannins, triterpenes/ steroids and flavonoids was carried out for ethanol banana peel extracts using standard methodologies for their identification and validation.

**Table 2: Preliminary Phytochemical Screening** [17-19]

| Phytochemical Class | Test Name | Procedure | Positive Observation | Inference |
|---|---|---|---|---|
| **Alkaloids** | **Mayer's Test** | Add **Mayer's reagent** (Potassium mercuric iodide) to 2 mL of the extract. | **Cream-colored precipitate** | Positive |
| | **Dragendorff's Test** | Add **Dragendorff's reagent** (Potassium bismuth iodide) to 2 mL of the extract. | **Reddish-brown precipitate** | Positive |
| **Flavonoids** | **Shinoda Test** | Add **magnesium turnings** and **conc. HCl** to 2 mL of the extract. | **Pink or red coloration** | Positive |
| | **Alkaline Reagent Test** | Add **sodium hydroxide solution** to the extract. | **Yellow color disappears with acid** | Positive |
| **Polyphenols & Tannins** | **Ferric Chloride Test** | Add **$FeCl_3$ solution** to 2 mL of the extract. | **Greenish-black or blue-black coloration** | Positive |
| | **Lead Acetate Test** | Add **lead acetate solution** to the extract. | **White precipitate** | Positive |
| **Steroids & Triterpenoids** | **Salkowski Test** | Add **chloroform and conc. $H_2SO_4$** to 2 mL of the extract. | **Reddish-brown ring at the interface** | Positive |
| | **Liebermann-Burchard Test** | Add **acetic anhydride and conc. $H_2SO_4$** to the extract. | **Green or blue coloration** | Positive |

## EVALUATION OF HERBAL SPRAY

**Table 3: Evaluation of Herbal Spray**

| No. | Parameters | F1 | F2 | F3 |
|---|---|---|---|---|
| 1 | Appearance | Uniform | Uniform | Uniform |
| 2 | Color | Pale yellow colour | Pale yellow colour | Pale yellow colour |
| 3 | Odor | Pleasant | Pleasant | Pleasant |
| 4 | Homogeneity | Uniform and homogeneous | Uniform and homogeneous | Uniform and homogeneous |
| 5 | pH | 6.1 | 6.2 | 5.8 |
| 6 | Skin Irritation | No | No | No |
| 7 | Washability | Good | Good | Good |
| 8 | Viscocity (cP) | 28 | 25 | 27 |

**Appearance, Color, and Odor:**

All formulations exhibited a uniform appearance, which is desirable for easy application and quick absorption. The Pale-yellow colour was attributed to the presence of polyphenols and flavonoids. The Pleasant odor was mild and pleasant, making it suitable for consumer acceptance.

**pH Analysis:**

The pH of the formulations ranged between 5.8 to 6.2 which is within the ideal pH range for skincare products (4.5-7.0)**.** This ensures skin compatibility and prevents irritation**.** Among all, F2 (pH 6.2) was closest to the natural skin pH, making it the most dermatologically suitable formulation**.**

**Homogeneity:**

By visual examination of the appearance and presence of any lumps, flocculates, or aggregates, the formulations were checked for homogeneity. The homogeneity of prepared all formulations liquid toner has been shown to be **uniform and homogeneous consistency**, ensuring proper distribution of active ingredients.

**Irritation Test:**

No irritation was observed for any formulation, indicating the **dermal safety** of the toner.

**Washability:**

All formulations demonstrated **good washability**, making them convenient for daily use without leaving residue on the skin.

**Viscosity:**

Among the three formulated batches, **F2** demonstrated the most optimized viscosity value of **25 cP**, ensuring a balance between ease of spraying and adequate skin adherence. The viscosity of this batch was found to be within the acceptable range for topical sprays, preventing nozzle clogging while allowing uniform dispersion over the application area.

The slightly lower viscosity of F2, compared to F1 and F3 (28 cP and 27 cP, respectively), indicates improved fluidity, which may contribute to enhanced spreadability and absorption. This optimization ensures that the spray forms a fine mist without excessive dripping or residue formation.

**Spreadability:**

The spreadability of the topical spray was evaluated to determine its ability to distribute evenly over the skin surface. Among the three batches, **F2** exhibited the highest spreadability (6.8 $cm^2$), indicating better coverage and ease of application compared to F1 (5.2 $cm^2$) and F3 (5.6 $cm^2$).

The optimized spreadability of F2 can be attributed to its balanced viscosity (**25 cP**), which ensures smooth flow and uniform dispersion upon spraying. Higher spreadability enhances the therapeutic effectiveness by allowing a more even distribution of the banana peel extract, potentially improving its anti-inflammatory and analgesic action.

**Stickiness:**

Among the formulations, **F2 exhibited an optimal stickiness level**, ensuring **good adherence** without excessive residue**. F1 showed higher stickiness**, which may lead to an uncomfortable feel, while **F3 had the lowest stickiness**, suggesting quicker drying but potentially reduced adhesion. The results indicate that **F2 provides the best balance** between adherence and user comfort, making it the **most suitable formulation** for topical application.

## Table 4: Stickiness Test

| Formulation | Stickiness Rating | Observation |
|---|---|---|
| **F1** | High | Retained a large number of fibers, indicating a higher tacky residue. |
| **F2** | Medium | Retained a moderate number of fibers, ensuring balanced adherence. |

| | | |
|---|---|---|
| **F3** | Low | Retained very few fibers, indicating minimal stickiness and quick drying. |

## Soil Burial Test for Biodegradability

The biodegradability assessment showed progressive degradation of the topical spray residue over 30 days. By day 7**,** the residue exhibited slight softening and color change. By day 15**,** partial disintegration of the residue was observed. By day 30, the residue showed significant degradation with reduced mass indicating early signs of biodegradation. These results confirm that the spray residue is biodegradable within 30 days**,** reinforcing its eco-friendly nature**.** Overall, the findings support the formulation's environmental safety and biodegradability**,** making it a promising candidate for sustainable pharmaceutical applications**.**

**Table 5: Biodegradability assessment**

| Time Interval | Observation |
|---|---|
| **Day 7** | Slight softening and colour change |
| **Day 15** | Partial disintegration observed |
| **Day 30** | Significant degradation, reduced mass |

**Stability Studies:**

The stability of the formulated topical spray containing banana peel extract was evaluated over a period of **three months** under **ICH guidelines** at **30˚C ± 2˚C / 75 ± 5% RH**. The formulations were stored in **lid-tight containers**, and samples were analyzed at **0 months (initial) and 3 months** for **appearance, pH and viscosity** to assess any physicochemical changes.

**Table 6: Stability Study Results**

| Parameters | F2 (0 Month) | F2 (3 Month) | Results |
|---|---|---|---|
| **Appearance** | Pale yellow colour | Pale yellow colour | Stable |
| **pH** | 6.2 ± 0.1 | 6.1 ± 0.2 | Slightly decreased, within acceptable limits |

| | | | |
|---|---|---|---|
| **Viscosity (cP)** | 25 ± 1 | 24 ± 1 | Minor decrease, remains suitable for spraying |

The formulation retained its clarity and yellowish color over three months, indicating no significant degradation or precipitation. A slight decrease in pH from 6.2 to 6.1 was observed, which remains within the acceptable range for topical formulations and does not affect stability. Similarly, a minimal reduction in viscosity **(**25 cP to 24 cP) was noted, but it remained within the optimal range for a topical spray, ensuring ease of application. These results confirm that F2 remains stable under accelerated conditions for three months, with no major physical or chemical instability.

## CONCLUSION:

The formulated topical spray containing banana peel extract demonstrated promising anti-inflammatory and analgesic properties, supported by its optimized physicochemical characteristics, stability, and eco-friendliness. The optimized formulation (F2) exhibited ideal viscosity, rapid drying time, and moderate stickiness, ensuring effective skin adherence without discomfort. Stability studies confirmed minimal changes over three months, maintaining its integrity under ICH-recommended conditions. The biodegradability assessment further reinforced its sustainability, with significant degradation observed within 30 days. These findings suggest that this herbal-based topical formulation could serve as a natural and effective alternative for managing inflammation and pain. Further in-vivo and clinical studies are recommended to evaluate its therapeutic efficacy, safety profile, and long-term skin compatibility, ensuring its potential for commercial and pharmaceutical applications.

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