

Development and Evaluation of Polyherbal Thermosensitive Rectal Gel For Localized Hemorrhoidal Therapy

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Abstract

Hemorrhoids are a common anorectal disorder characterized by inflammation, swelling, pain, bleeding, itching, and irritation of the venous plexus in the anal and rectal region. Conventional treatments primarily provide symptomatic relief but are often associated with recurrence, local irritation, discomfort, and reduced patient compliance during prolonged use. To address these limitations, the present study aimed to formulate and evaluate a polyherbal hemorrhoidal gel for effective local therapy and enhanced patient acceptability. The gel was prepared using Carbopol 934 as the gelling agent owing to its excellent bioadhesive properties, transparency, and stability. Triethanolamine was incorporated to adjust the pH and facilitate gel formation, while methylparaben was added as a preservative to prevent microbial contamination. Glycerin served as a humectant to improve moisture retention and spreadability, and menthol was included to provide a cooling and soothing effect, thereby reducing discomfort and irritation. The formulation was enriched with selected polyherbal extracts, namely Punica granatum peel extract, Boswellia serrata, Centella asiatica, and Mimosa pudica, which are traditionally recognized for their astringent, anti-inflammatory, analgesic, hemostatic, wound-healing, venotonic, and tissue-protective properties. These herbal ingredients were selected to produce synergistic therapeutic effects by reducing inflammation, controlling bleeding, relieving pain, and promoting tissue repair and healing. The formulated gel was evaluated using standard pharmaceutical parameters, including organoleptic characteristics such as color, odor, appearance, texture, and homogeneity, to assess its quality and suitability for topical application. The evaluation results demonstrated satisfactory physical characteristics and formulation stability, indicating that the developed polyherbal gel has significant potential as a safe, stable, and effective topical treatment for hemorrhoids. Thus, the study highlights the promise of polyherbal formulations as an alternative therapeutic approach for the management of hemorrhoidal disorders.

Keyword :- Hemorrhoids, polyherbal gel, topical drug delivery, Carbopol 934, herbal extracts, astringent, anti-inflammatory, wound healing.

Introduction

It has been suggested that the term "haemorrhoidal disease" actually means "disease of the haemorrhoids." This terminology has been used primarily by practitioners of medicine. However, the general public commonly refers to it simply as "haemorrhoids." Therefore, it is important to understand haemorrhoids by their definitions as well as by their symptoms for those that suffer from them. Anal cushions are highly vascularised and serve numerous functions. The primary function of anal cushions is to help support and cushion the anal canal during movement (defecation). They should be symmetrical and positioned in relation to the anal sphincters and perineal tissues. However, due to their highly vascularised nature, anal cushions are also susceptible to dilation and distortion from increasing intra-abdominal pressure. In addition, anal cushions can become distended from inflammatory responses and eventually about to rupture. As a result of this type of stress, anal cushions tend to enlarge and/or displace (downwards) from their respective symmetry lines or base points, leading to abnormal dilation and/or distortion of the vascular channels. These changes in vascular structure may result in haemorrhoidal hyperplasia. Some of the most common symptoms of haemorrhoids include: Painless rectal bleeding (typically a small quantity), Anal itching/pain due to irritation of skin surrounding anus, Tissue bulging around anus. Some people with outside anus have visible or palpable haemorrhoids. Some individuals experience leakage of faeces following a bowel movement, thereby creating difficulty cleaning. [10]

A number of individuals having hemorrhoids may occasionally discover that they have noted bright red blood present in their stool, toilet or hand tissue after attempting to go to the bathroom. Generally speaking, the volume of blood is relatively minor nevertheless, even when there are only minimal traces of blood, this may result in the water also appearing bright red, resulting in a sense of alarmism. Most commonly observed causes of hemorrhoids arise from increased pressure found within the vein structure located within the pelvic region or rectum - this pressure often results from: Excessive amounts of straining produced as a result of chronic constipation; Excessive straining produced as a result of chronic diarrhea; Pregnancy as a result of uterus supporting weight of fetus,

Obesity caused as a result of prolonged periods of sitting like those experienced by commercial drivers or individuals who are otherwise sedentary. External hemorrhoids will typically be easily identified externally to the anus and originate from within lower aspect of the anus - they may become inflamed and the blood within the vein structure has the potential to develop into a clot. This type of clotting will be identified as a thrombosed hemorrhoid. Internally located hemorrhoids are usually not visible externally. The reason that internally located hemorrhoids cannot be seen externally is because they are located further high up within anal canal than are externally located hemorrhoids. Internally located hemorrhoids typically cause bleeding post bowel movement. Large (seriously sized) internally located hemorrhoids have the ability to protrude out through the anus and will typically be visible; this may be significantly painful.

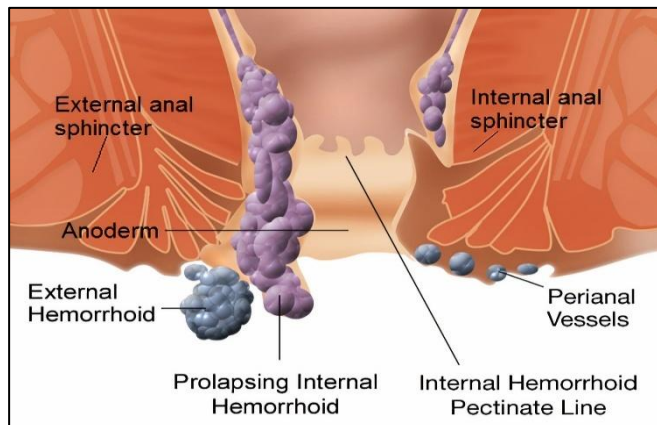


Fig 1:- Hemorrhoid

NEED OF WORK

Hemorrhoids are considered by many to be one of the most common types of anorectal disorders since they are associated with pain, swelling, inflammation, bleeding and irritation; all of which significantly impact on someone's quality of life. Most currently available treatment options are limited to either providing symptom relief or are some type of topical product (e.g. ointments, creams or suppositories) or oral medication, all of which have limitations with respect to symptom relief - either through irritation caused by using a longterm product, or through recurrence of symptoms, greasiness and low-probability of patient compliance (e.g. poor patient management). Therefore, there is an absolute need for an effective, safe and patient-friendly topical formulation that will provide localized delivery, added therapeutic benefits and minimize the adverse effects associated with medicinal plants.

The medical properties of several different types of medicinal plants (i.e. *Punica granatum*, *Mimosa pudica*, *Centella asiatica*, *Boswellia serrata*) have been well documented and exhibiting some degree of properties in respect to astringents, wound healing, anti-inflammatory, venotonic and soothing; making these plants beneficial in managing hemorrhoidal disease. If these polyherbal extracts could be combined with an appropriate gel formulation base, this would result in improved patient acceptability, improved local retention of the active ingredients at the site of application, improved spreading ability of the formulation and a cooling sensation upon application.[09]

When comparing to ointments and creams, gels have many advantages which make them preferable to those products (i.e. non-greasy, ease of application, more rapid drug release and easy to wash off). Notwithstanding these advantages, there has been limited scientific investigation and publication into the formulation and evaluation of a standardized polyherbal gel intended specifically for the treatment of hemorrhoids based on modern pharmaceutical standards.

The purpose of this research was to create, refine, and evaluate the effectiveness of a polyherbal hemorrhoid gel that is stable using various suitable gelling agents and excipients/vehicle combinations as well as measure the physicochemical properties of the products, their safety, stability, and appropriateness for use rectally. This work is intended to combine traditional knowledge about using herbs as medicine with the modern method of creating pharmaceuticals in order to create an alternative way to treat hemorrhoids.[09]

Material and Methods

Table 1: Drug Profile

Sr No.	Plant Name	Family	Used	Picture
1	<i>Pomegranate Peel extract</i>	<i>Lythraceae</i>	• Use as a hemostatic. • Anti microbial agent . • Used for manage high blood pressure & cardiovascular disease . • Also used for extending shelf life of product .[10]	 Fig 2 :- pomegranate peel
2	<i>Boswellia Serrata</i>	<i>Burseraceae.</i>	• It is effective in the treatment of asthma, inflammatory bowel disease, and rheumatoid arthritis . • It is used to manage pain and swelling in RA patients . • Also used for reducing blood lipids and protect the liver. • Helpful for reduce chronic disease such as corhn's disease and ulcerative colitis .[10]	 Fig 3 :- <i>Boswellia Serrata</i>
3	<i>Centella Asiatca</i>	<i>Apiaceae .</i>	• this are used to treat gastric ulcer • wound healing • used in many dermatological condition such as eczema, psoriasis • neuroprotective and cognitive enhancement [10]	 Fig 4 :- <i>Centella Asiatca</i>
4	<i>Mimosa Pudica</i>	<i>Fabaceae</i>	• It is used for controlling blood sugar level and improve metabolic health. • Also helpful in many type of skin infection. • Also used in reproductive disorder. • Used as analgesic.[10]	 Fig 5 :- <i>mimosa pudica</i>

Extraction of Plants

1. Pomegranate peel extract

Method:- Maceration- Peels shade-dried and powdered . Add 50g powder to 500 mL ethanol/water solution (70/30) for 72 hours, with shaking. Filtrate liquid from maceration; macerate marc for 24 hours; combine filtrations. Concentrate extracts to less than 50 °C via evaporation to create thick paste; dry to produce final product.



Fig 6 :- Maceration of *pomegranate peel*

2. *Boswellia serrata*

Method:- Soxhlet Extraction- *Boswellia serrata* resin is extracted using Soxhlet extraction, where the resin is crushed up into a fine powder form for increased surface area to allow for maximum extraction efficiency from the resin. Approximately 20-30 grams of resin powder will be added to the filter paper thimble and inserted into the Soxhlet extractor. To begin extraction, 200-250 ml of petroleum ether 60-80 °C will be added to the round bottom flask and heated using a gentle flame to allow for continuous siphon cycles from the round bottom flask for approximately 4-5 hours. After the defatting process has happened, replace the petroleum ether with ethanol and again siphon the ethanol until the solvent in the siphon tube is nearly colourless, which means that the extraction has been exhaustive, which will take approximately 6-8 hours. The ethanol extract will be concentrated by evaporating the solvent off using a water bath in order to obtain a semi-solid mass. Finally, the extract will be dried, a yield percentage will be calculated for the extract, and the extract will be stored in an air-tight container until ready to use for further gel formulation.



Fig. 7:- Extraction of *boswellia serrata*

3. *Centella Asiatica*

Method:- Maceration- Peels shade-dried and powdered . Add 50g powder to 500 mL ethanol/water solution (70/30) for 72 hours, with shaking. Filtrate liquid from maceration; macerate marc for 24 hours; combine filtrations. Concentrate extracts to less than 50 °C via evaporation to create thick paste; dry to produce final product.



Fig 8:- Maceration of *Centella asiatica*

4. *Mimosa pudica*

Method :- Maceration- Peels shade-dried and powdered. Add 50g powder to 500 mL ethanol/water solution (70/30) for 72 hours, with shaking. Filtrate liquid from maceration; macerate marc for 24 hours; combine filtrations. Concentrate extracts to less than 50 °C via evaporation to create thick paste; dry to produce final product. [8 & 9]



Fig 9 :- maceration of *Mimosa pudica*

Formulation Table

Table 2: Formulation Table

Sr.no	Ingradient	Batches			Role
		Batch 1	Batch 2	Batch 3	
1	Pomegranate peel extract	1.5 gm	1.5 gm	1.5 gm	Heamostatic
2	Boswellia serrata	1.5 gm	1.5 gm	1.5 gm	Anti-Inflammatory
3	Centella Asiatica	1.5gm	1.5 gm	1.5gm	Wound Healing
4	Mimosa pudica	1 gm	1 gm	1 gm	Antiheamorrhoidal
5	Methyl paraben	0.8gm	1 gm	1 gm	Preservative
6	Carbopol 934	1.3 gm	1.5 gm	2 gm	Primary Gelling Agent
7	Triethanolamine	1 gm	1 gm	1.5 gm	Neutrilizar
8	Glycerine	2 gm	3 gm	3 gm	Humactant
9	Menthol	0.3 gm	0.3 gm	0.3 gm	Cooling Agent
10	Purified water	q.s	q.s	q.s	Vehicle

Formulations and Observations

Batch 1 – Gel Not Formed Properly

Disperse Carbopol 934 in warm distilled water while mixing.

Add solution of methyl paraben and glycerin, then add solution of menthol in glycerin. With constant stirring add mixed herbal extracts.

Add a small amount of triethanolamine for neutralization.

Bring total volume to last amount of the water.

Observation

Gel formation was incomplete. The prepared gel showed thin and non-uniform consistency due to inadequate hydration and neutralization of Carbopol 934.

Batch 2 – pH not Stable

Mix Carbopol in distilled water and let it expand properly before adding an aqueous solution of Methyl Paraben and Glycerin to it. Mix the Menthol and Glycerin Solution in the Carbopol base. Add Herbal Extract to the mixture while stirring continuously. The gel was made with triethanolamine to adjust pH. The water added to bring the total final product volume to the desired amount. The product appears to have been prepared in accordance with standard practices, however, there is some indication of instability due to a change in pH upon standing.

Observation

The gel showed improved consistency compared to Batch 1; however, pH instability was observed during storage, indicating inadequate formulation stability.

Batch 3 – Gel that is optimized and remains stable.

The first step is to disperse Carbopol 934 into warm sterile water and let it hydrate completely. Next, add the solution of methyl paraben and the glycerin while stirring continuously. Thirdly, dissolve the menthol into the glycerin, then add it to the gel base. Combine the standardized herbal extracts gradually, ensuring even incorporation throughout the entire gel. Continue to incorporate triethanolamine until the clear stable gel is achieved (pH level between 6 and 7.0). Finally adjust the final mass of the gel using distilled water until an even gel is produced. Outcome of batch 3 – Smooth, stable, and even gel will provide adequate pH, viscosity and ability for even spreading to provide data on the effectiveness.

Observation

The optimized batch produced a smooth, stable, and uniform gel with satisfactory pH, viscosity, spreadability, and stability characteristics, making it suitable for further evaluation of effectiveness.

Why Batch 3 Was Selected as the Optimized Batch?

Batch 3 was considered the optimized batch because it showed better physical and stability characteristics compared to Batch 1 and Batch 2. The increased concentration of Carbopol 934 and proper neutralization with triethanolamine resulted in complete gel formation with smooth and uniform consistency. The formulation also maintained a stable pH between 6.0 and 7.0 during storage, unlike Batch 2 which showed pH variation. Additionally, Batch 3 exhibited satisfactory viscosity, homogeneity, spreadability, and overall stability, making it suitable for further evaluation and therapeutic application.



Fig 10 : Hemorrhoid gel

EVALUATION PARAMETER

1. Physical Appearance Evaluation

Table 3: Physical appearance

Sr.no	Test	Method	Observation
1	Colour	Visual Inspection	Dark Yellowish
2	Odour	Visual Inspection	Mild Herbal With Menthol Smell
3	Appearance	Visual Inspection	Smooth
4	Texture	Visual Inspection	Non Gritty, Soft

5	Consistency	Visual Inspection	Semi-solid
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2. pH Test

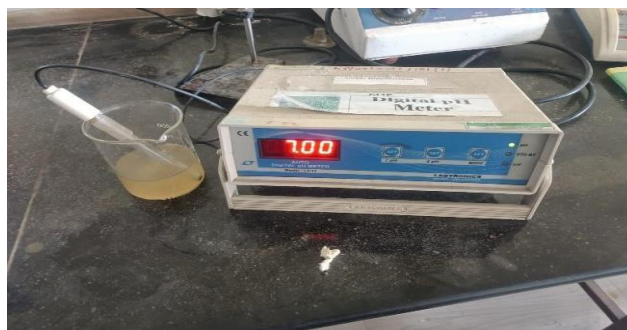


Fig 11:- pH meter

Prepare 1% dispersion, 1 gram gel + 100 ml distilled water. Stir 30 minute. Dip electrode with stable reading, note pH. Take three reading.

3. Viscosity



Fig 12 :- Brookfield Viscometer

Instrument: Brookfield Viscometer Fill beaker with gel (no air bubbles). Select suitable spindle (e.g., Spindle 64).Set speed to 10 rpm. Immerse spindle in gel up to mark. Start instrument; wait for stable reading. Note viscosity in cP. Take 3 readings and average.

4. Spreadability



Fig 15 :- Spreadability test

Place ~1 g gel at the center of a glass slide. Put another glass slide on top. Place a 500 g weight over it for 5 min to form a thin film. Tie a 20 g weight to the upper slide. Measure the time (T) it takes for the upper slide to move 7.5 cm.

Where,

M = Weight tied to upper slide (20 g)

L = Distance (7.5 cm)

T = Time in seconds.

Good hemorrhoid gel should spread easily with $S \approx 20\text{--}25 \text{ g}\cdot\text{cm/s}$.

5. Extrudability test



Fig 16 :- Extrudability test

Fill gel into a collapsible aluminum tube and seal. Weigh the filled tube. Press the tube by hand with uniform force. Collect the gel ribbon extruded in 10 seconds. Weigh the extruded gel.

6. Homogeneity



Fig 17 :- Homogeneity

Take 0.5 gram gel into clean, dry glass slide. Place a second slide over it and press gently to spread into thin film. Observe film visually against light by touch. Check for lumps, coarse particles, grittiness or phase separation. Result.

Gel must be uniform, smooth and free from any types of separation. [12]

Result and Discussion

The performance of the polyherbal hemorrhoid gel was evaluated by various physicochemical, mechanical and safety assessment methods to establish whether it was suitable as a topical treatment for rectal use. The formulation with added extract of *Punica granatum*, *Boswellia serrata*, *Centella asiatica*, and *Mimosa pudica* in Carbopol 934 gel base, neutralised with triethanolamine had satisfactory results for all evaluations.

The organoleptic properties of the gel showed it had a smooth texture, uniform consistency, dark yellowish colour and mild herbal odour and menthol sensation indicating that the ingredients had been successfully mixed without

any phase separation. The gel was also visually free from any grittiness or lumps confirming that it had good homogeneity.

Phytochemical Analysis

Table 4: Phytochemical Testing

Sr. no	Constituents	<i>Pomegranate peel extract</i>	<i>Boswellia serrata</i>	<i>Centella asiatica</i>	<i>Mimosa pudica</i>
1	Flavonoids	+	-	-	+
2	Tannis	+	-	-	+
3	Triterpenoids	-	+	+	-
4	Essential oil	-	+	+	-
5	Resins	-	+	-	-
6	Glycosides	-	-	-	+
7	Saponins	-	-	+	-

Table 5:- Summary of Evaluation Parameter

Sr.no	Test	Method	Observation
1	PH	Digital PH Meter	6.5 to 7
2	Viscosity	Brookfield viscometer	40,000 to 50,000 cp (centipoise)
3	Skin Irritation	Manual Test	No Irritation
4	Spredability	Apparatus or Manual Test	18.75 g.cm/s Hemorrhoid gel should easily spread
5	Washability	Glass plate / Water	Wash easily without any residue
6	Extrudability	Collapsible tube	4-5 ribbon can observe in 10 second gel as smooth continios ribbon and uniform force
7	Homogenecity	Visual and Microscopic	Homogenous

The pH was found to be between 6.5 - 7.0 which is within the acceptable physiological range for rectal preparations. This demonstrates that the formulation will not cause irritation to sensitive anorectal tissue and is safe for prolonged topical application.

Viscosity was determined by using a Brookfield viscometer and was found to be in the range of 40,000 - 50,000 cps which indicates that the gel is of optimal thickness. The viscosity will allow the gel to remain at the applied site without leakage and will still allow for ease of spreadability.

The spreadability values (18.75 g·cm/s) indicated that the gel has many properties that make it very easy to spread with a little force. This is critical to ensure that patients are comfortable when applying the gel over hemorrhoids that are often swollen due to inflammation.

The extrudability test showed that the gel extruded smooth ribbons of about 4-5 in 10 seconds from the collapsible tube, indicating an ease of packaging and dispensing the gel.

The washability test demonstrated that the gel could easily be removed with water and would not leave any residues behind, making it more acceptable to patients versus oily creams or ointments.

The gel strength study indicated that the gel was firm enough, as the weight penetration time showed that the gel sank slowly after being applied, thereby allowing the gel to hold its structure after it is applied.

There were no signs of skin irritation on human skin after 1 hour of application according to the skin irritation test, supporting that the formulation is nonirritant and safe.

Collectively, these results support that the polyherbal extracts combined with the Carbopol gel base produced a stable, patient-friendly and pharmaceutically acceptable formulation for treating hemorrhoids. The action of the herbals provides many important benefits (anti-inflammatory, astringent, woundhealing, venotonic and soothing), all of which are critical for patients dealing with hemorrhoids.

Conclusion

A polyherbal hemorrhoid gel was successfully developed and tested using traditional herbal extracts within a modern Carbopol base. The gel met the necessary pharmaceutical standard for rectal administration based on evaluation parameters, which included pH, viscosity, spreadability, extrudability, washability, gel strength, homogeneity, and skin irritation. The inclusion of *Punica granatum*, *Boswellia serrata*, *Centella asiatica* and *Mimosa pudica* provided multiple therapeutic effects, including antiinflammatory, bleeding control, wound healing, anti-itch, and strengthening of the venous tissue via synergistic action. Further, the gel formulation demonstrated favorable patient compliance properties, such as non-greasy, easy to apply, easy to remove, and nonirritating; therefore, it was superior to traditional creams or ointments. Stability-oriented formulations with appropriate excipients (i.e., Carbopol 934, triethanolamine, glycerin, menthol, and methyl paraben) produced the desired physicochemical properties and shelf life. Based on the foregoing, the polyherbal hemorrhoid gel has demonstrated promise as an effective alternative topical therapy for managing hemorrhoids and warrants further evaluation in clinical trials and commercialization activities.[25]

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