

Phytochemical Screening, Formulation and Evaluation of Herbal Aloe Vera Suppositories

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Phytochemical Screening, Formulation and Evaluation of Herbal Aloe Vera Suppositories

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Abstract

Background: Herbal drug delivery systems have gained considerable attention due to their safety, therapeutic efficacy, and improved patient compliance [2,8,46]. Aloe vera (*Aloe barbadensis* Miller) is a well-known medicinal plant possessing antimicrobial, anti-inflammatory, antioxidant, wound-healing, immunomodulatory, and laxative properties [4-7,16-20]. Although Aloe vera is widely available as topical and oral formulations, its incorporation into suppository dosage forms has received limited scientific investigation [9,21-23]. Rectal administration offers several advantages, including avoidance of first-pass hepatic metabolism, improved bioavailability, and suitability for patients who are unable to receive oral medications [10-14,31-39].

Objective: The present study aimed to perform phytochemical screening of Aloe vera extract, formulate herbal suppositories using a glycerin–gelatin base, and evaluate the prepared formulations for their physicochemical characteristics and pharmaceutical quality [4,9,22,28-30].

Materials and Methods: Fresh Aloe vera leaves were collected, authenticated, and processed to obtain the gel extract. Preliminary phytochemical screening was carried out using standard qualitative tests to identify the presence of major bioactive constituents [4-6,16-20,28-30]. Herbal suppositories were prepared by the fusion moulding technique using glycerin, gelatin, purified water, and Aloe vera extract [9,11,22,31-43]. The prepared formulations were evaluated for physical appearance, weight variation, pH, melting time, liquefaction time, displacement value, drug content uniformity, and short-term stability under controlled storage conditions according to standard pharmacopeial and stability guidelines [30,41-45,49-55].

Results: Phytochemical screening confirmed the presence of flavonoids, glycosides, phenolic compounds, tannins, saponins, terpenoids, steroids, and carbohydrates, indicating the rich phytochemical composition of Aloe vera [4-7,16-20,28,29]. The prepared suppositories exhibited smooth appearance, uniform shape, acceptable weight variation (1.188 ± 0.02 g), pH (5.65 ± 0.03), melting temperature ($32\text{--}37^\circ\text{C}$), satisfactory mechanical integrity, and good stability during the study period. The formulation complied with acceptable pharmaceutical quality parameters and demonstrated suitability for rectal administration [11,14,22,31-45,49-55].

Keywords: *Aloe vera*, Herbal Suppositories, Phytochemical Screening, Rectal Drug Delivery, Glycerin–Gelatin Base, Herbal Formulation, Pharmaceutical Evaluation.

1. Introduction

Herbal medicines have been used for thousands of years as an integral component of traditional healthcare systems and continue to play an important role in modern therapeutics. According to the World Health Organization (WHO), nearly 80% of the world's population relies on herbal medicines for primary healthcare because of their affordability, accessibility, and relatively fewer adverse effects [1,15,24,25]. The growing preference for plant-derived medicines has stimulated extensive research on the development of novel herbal drug delivery systems that can improve therapeutic efficacy, enhance patient compliance, and minimize systemic toxicity [2,3,8,46]. Consequently, pharmaceutical researchers are increasingly exploring innovative dosage forms capable of delivering phytoconstituents in a safe, stable, and effective manner [8,46,47].

Among the various pharmaceutical dosage forms, suppositories represent an important alternative route of drug administration, particularly for patients who cannot receive medications orally due to nausea, vomiting, dysphagia, unconsciousness, gastrointestinal disorders, or postoperative conditions [10-14,31-43]. Suppositories are solid dosage forms designed for insertion into the rectum, vagina, or urethra, where they melt, soften, or dissolve at body temperature to release the incorporated drug [40-45]. Rectal drug delivery offers several therapeutic advantages, including partial avoidance of first-pass hepatic metabolism, rapid systemic absorption for suitable drugs, reduced gastrointestinal irritation, and improved patient compliance in pediatric, geriatric, and critically ill patients [10-14,31-39]. Furthermore, rectal formulations provide effective local treatment for hemorrhoids, anal fissures, inflammatory bowel diseases, rectal infections, and other anorectal disorders while reducing systemic adverse effects [10,12,14,31-39].

The effectiveness of a suppository formulation largely depends upon the selection of an appropriate suppository base. An ideal suppository base should remain solid at room temperature, melt or dissolve rapidly at physiological temperature, be chemically inert, non-irritating, pharmaceutically stable, and compatible with both the active pharmaceutical ingredient and the rectal mucosa [40-45]. Commonly used suppository bases include fatty bases such as cocoa butter, water-soluble bases such as polyethylene glycol (PEG), and glycerinated gelatin bases [40-43]. Among these, the glycerin–gelatin base is particularly suitable for herbal formulations because of its excellent molding characteristics, good mechanical strength, satisfactory drug incorporation capacity, and prolonged residence time at the site of administration [9,11,22,31,40-43]. These properties make glycerin–gelatin suppositories especially useful for localized drug delivery and sustained therapeutic action [9,22,31].

Medicinal plants have become increasingly important sources of bioactive molecules for the prevention and treatment of numerous diseases [2,3,25]. Among these plants, *Aloe vera* (*Aloe barbadensis* Miller), belonging to the family Asphodelaceae, is one of the most extensively investigated medicinal species because of its remarkable pharmacological activities and long history of therapeutic use [4-7,16-20]. The plant is widely cultivated throughout tropical and subtropical regions and has been employed in traditional systems of medicine including Ayurveda, Siddha, Unani, Traditional Chinese Medicine, and folk medicine [4-7,16-20]. The succulent leaves of *Aloe vera* contain a transparent mucilaginous gel that is composed of

approximately 99% water, while the remaining solid fraction contains a diverse range of biologically active compounds responsible for its medicinal properties [5,16-20].

More than seventy-five phytochemical constituents have been identified in *Aloe vera* gel. These include polysaccharides such as acemannan and glucomannan, anthraquinones including aloin and aloe-emodin, flavonoids, phenolic compounds, tannins, saponins, sterols, amino acids, enzymes, vitamins, minerals, organic acids, and various trace elements [4-7,16-20,28,29]. These phytoconstituents exhibit diverse pharmacological activities, including antioxidant, antimicrobial, anti-inflammatory, immunomodulatory, antiviral, antifungal, anticancer, wound-healing, gastroprotective, and laxative effects [4-7,16-20,26,27]. The synergistic interaction among these bioactive compounds contributes significantly to the broad therapeutic potential of *Aloe vera* and supports its application in modern pharmaceutical formulations [4,5,17-20].

Numerous experimental and clinical studies have demonstrated that *Aloe vera* promotes tissue regeneration by stimulating fibroblast proliferation, enhancing collagen synthesis, accelerating epithelialization, and improving angiogenesis at the wound site [6,7,18-20]. The anti-inflammatory activity of *Aloe vera* has been attributed to the inhibition of cyclooxygenase pathways, suppression of prostaglandin synthesis, reduction of inflammatory cytokine production, and modulation of oxidative stress [7,18-20]. In addition, the antimicrobial activity of *Aloe vera* against several Gram-positive bacteria, Gram-negative bacteria, fungi, and certain viruses has further expanded its therapeutic applications [4-7,18-20,26].

2. Materials and Methods

2.1 Study Design

The present investigation was designed as an experimental laboratory-based study to develop and evaluate an herbal suppository formulation containing *Aloe vera* gel. The study comprised collection and authentication of plant material, extraction of fresh gel, preliminary phytochemical screening, formulation of suppositories using a glycerin–gelatin base, and evaluation of the prepared formulations through physicochemical tests. All experimental procedures were carried out in the Pharmaceutics and Pharmacognosy laboratories of Parikrama college of Pharmacy, Kashti, Shrigonda Maharashtra, India.

2.2 Materials. Fresh mature leaves of *Aloe vera* (syn. *Aloe barbadensis* Mill.) were collected from the medicinal plant garden of Ratnadeep College of Pharmacy. Botanical authentication was carried out by a qualified taxonomist before experimental use.

Analytical-grade chemicals and reagents were used throughout the study. The chemicals and reagents used for preliminary phytochemical screening are presented in **Table 1**.

Table 1. Analytical-grade chemicals and reagents used for preliminary phytochemical screening

Dragendorff's Reagent	AR Grade	HiMedia	Alkaloid test
Wagner's Reagent	AR Grade	HiMedia	Alkaloid test
Molisch Reagent	AR Grade	Merck	Carbohydrate test
Benedict's Reagent	AR Grade	Merck	Reducing sugar test
Fehling's Solution	AR Grade	Merck	Sugar test
Lead Acetate	AR Grade	SD Fine	Tannin test
Concentrated Sulphuric Acid	AR Grade	Merck	Glycoside test
Chloroform	AR Grade	Merck	Steroid test

All chemicals used were of analytical reagent (AR) grade and were used without further purification.

2.3 Instruments and Equipment

The laboratory instruments and equipment used during the study are presented in **Table 2**.

Table: 2 laboratory instruments were used during the study.

Instrument	Manufacturer/Model
Digital Analytical Balance	Shimadzu
Digital pH Meter	Elico LI-120
UV–Visible Spectrophotometer	Shimadzu UV-1800
Magnetic Stirrer with Hot Plate	Remi
Water Bath	Remi Instruments
Refrigerator	LG
Thermometer	Zeal
Glass Suppository Mould	Laboratory Grade
Vernier Caliper	Mitutoyo
Stopwatch	Casio

All instruments were calibrated according to laboratory standard operating procedures before use.

2.4 Collection and Authentication of Plant Material

Healthy, disease-free, mature leaves of *Aloe vera* were collected during the early morning hours from the medicinal garden. The collected leaves were washed thoroughly with running tap water followed by distilled water to remove adhering dust and foreign particles.

The plant was authenticated by a botanist based on its morphological and taxonomical characteristics. A voucher specimen was preserved in the departmental herbarium for future reference.

Fresh, healthy, mature *Aloe vera* (*Aloe barbadensis* Miller) leaves collected for the preparation of herbal suppositories. The leaves were washed thoroughly with distilled water to remove adhering dust and impurities before aseptic extraction of the inner gel. The freshly extracted gel was used for phytochemical screening and formulation development.

And extraction and processing of *Aloe vera* gel used for phytochemical screening and formulation of herbal suppositories.

Healthy, disease-free, mature leaves of *Aloe vera* were collected during the early morning hours from the medicinal garden. The collected leaves were washed thoroughly with running tap water followed by distilled water to remove adhering dust and foreign particles, as shown in **Fig. 1**.



Fig. 1. Fresh *Aloe vera* Leaves Collected for the Preparation of Herbal Suppositories

2.5 Preparation of Aloe Vera Gel

Fresh leaves were washed and allowed to dry at room temperature. The thick outer green rind was carefully removed using a sterile stainless-steel knife. The transparent inner gel was separated aseptically.

The collected gel was homogenized using a laboratory blender for approximately 5 minutes until a uniform viscous mass was obtained.

The homogenized gel was filtered through sterile muslin cloth followed by Whatman No.1 filter paper to remove fibrous material.

The transparent inner gel was separated aseptically. The overall process used for the preparation of *Aloe vera* gel is illustrated in **Fig. 2**



Fig. 2. Preparation of *Aloe vera* gel.

2.7 Formulation of Aloe Vera Suppositories

Suppositories were prepared by the fusion moulding technique using *Aloe vera* gel, gelatin, glycerin, and purified water. The composition of the formulation is presented in **Table 3**.

Table: 3 Suppositories were prepared by the fusion moulding technique.

Formula

Ingredient	Quantity
Aloe vera Gel	4.8 g
Gelatin	4.2 g
Glycerin	21.0 g
Purified Water	q.s.

The stepwise procedure used for the preparation of *Aloe vera* suppositories by the fusion moulding technique is illustrated in **Fig. 3**.

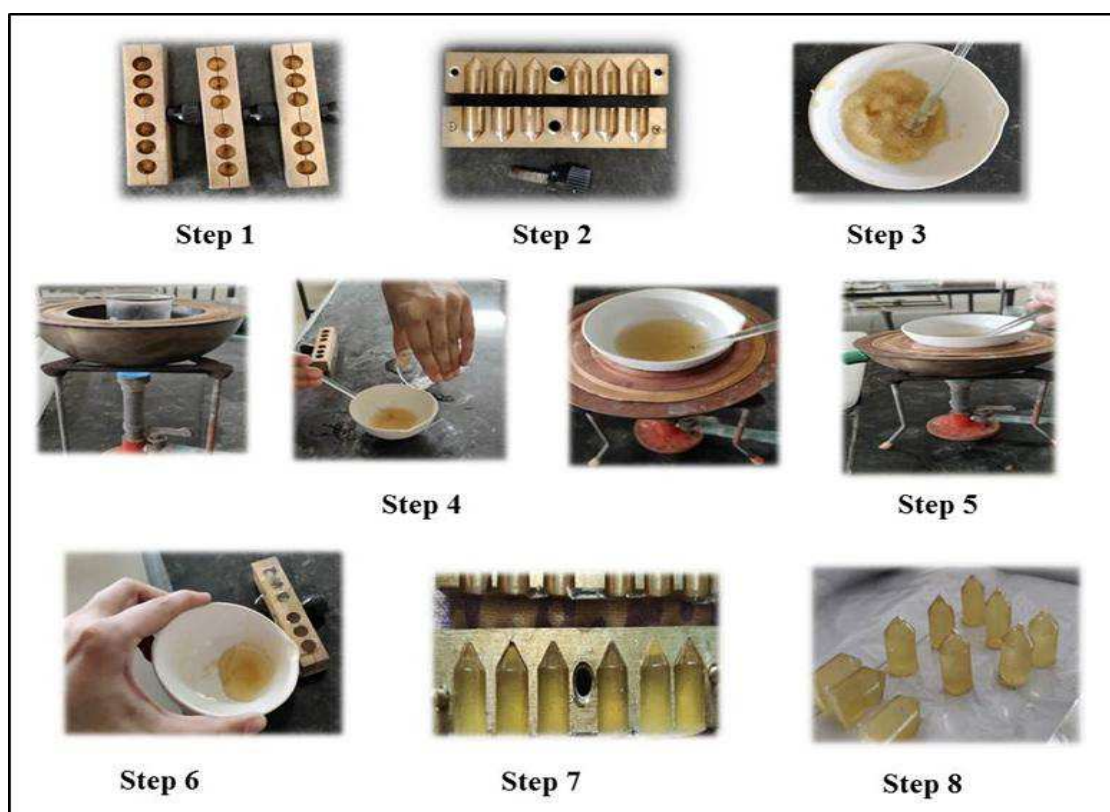


Fig. 3. Stepwise procedure for the preparation of Aloe vera suppositories by the fusion moulding technique.

Method of Preparation

Gelatin was soaked in purified water for 20 minutes to ensure complete hydration. Glycerin was heated to approximately 60°C using a water bath. Hydrated gelatin was added slowly with continuous stirring until a homogeneous solution was obtained. Fresh Aloe vera gel was incorporated gradually into the molten base under continuous stirring to achieve uniform distribution.

The prepared molten mass was poured into lubricated stainless-steel suppository moulds using liquid paraffin as the mould lubricant. The moulds were allowed to cool initially at room temperature and subsequently refrigerated at 4°C for approximately 30 minutes to facilitate complete solidification. The suppositories were removed carefully from the moulds, visually inspected for defects, wrapped individually in aluminium foil, and stored in airtight containers until evaluation.

3. Results

3.1 Physical Characteristics of the Prepared Suppositories

The Aloe vera suppositories prepared by the fusion moulding technique exhibited a smooth, glossy surface with a uniform bullet shape. The formulations were pale yellow in colour, free from visible cracks, air bubbles, fissures, or surface imperfections. All suppositories were easily removed from the mould without deformation, indicating satisfactory moulding characteristics and adequate mechanical strength, as summarized in **Table 4**.

Table: 4 Physical Characteristics of Aloe Vera Suppositories

Parameter	Observation
Colour	Pale yellow
Shape	Bullet shaped
Surface	Smooth and glossy
Odour	Characteristic
Texture	Uniform
Cracks	Absent
Air bubbles	Absent
Appearance	Elegant and uniform

3.2 Weight Variation Test

Twenty suppositories were individually weighed to determine weight uniformity. The average weight was 1.188 ± 0.02 g, and all individual suppositories were within the pharmacopoeial permissible limits, indicating uniform distribution of the formulation during moulding, as presented in **Table 5** and illustrated in **Fig. 4**.

Table 5. Weight variation of Aloe vera suppositories. (n = 20)

Suppository No.	Weight (g)
1	1.186
2	1.190
3	1.188
4	1.191
5	1.187
6	1.189
7	1.186
8	1.190
9	1.187
10	1.189
11	1.190
12	1.188
13	1.186
14	1.191

15	1.188
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Mean $\pm$ SD = 1.188 $\pm$ 0.02 g

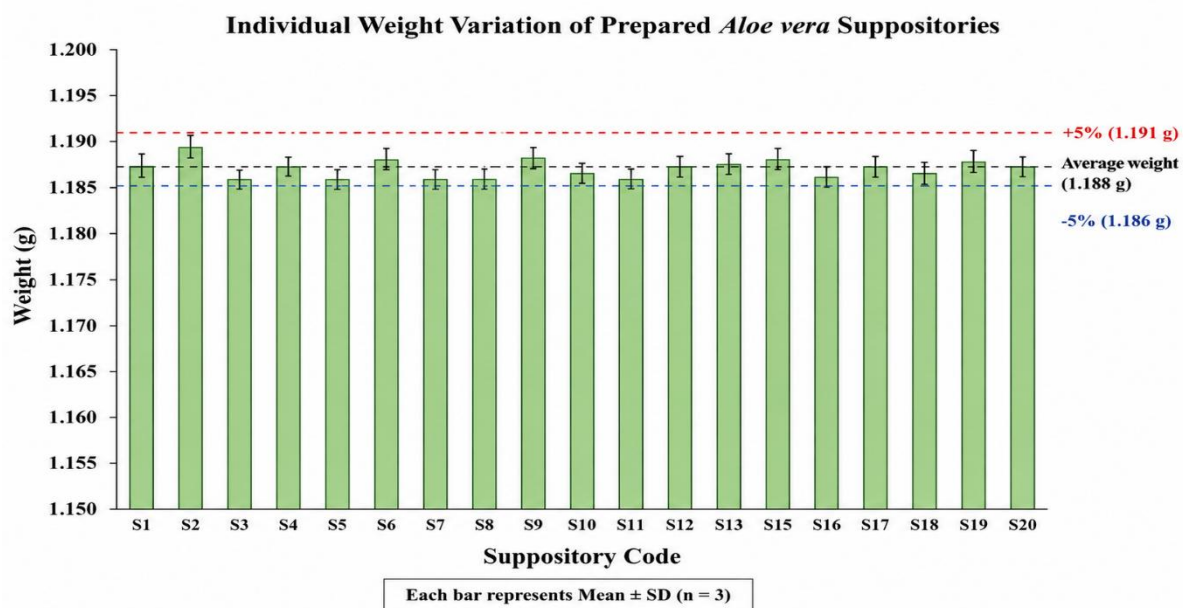


Fig. 4. Bar graph showing individual weight variation of prepared suppositories

3.3 pH Determination

The average pH of the *Aloe vera* suppositories was 5.65 $\pm$ 0.03, as presented in **Table 6**. The pH profile of the prepared formulation is illustrated in **Fig. 5**.

Table: 6 pH of Aloe Vera Suppositories

Batch	pH (Mean $\pm$ SD)
F1	5.65 $\pm$ 0.03

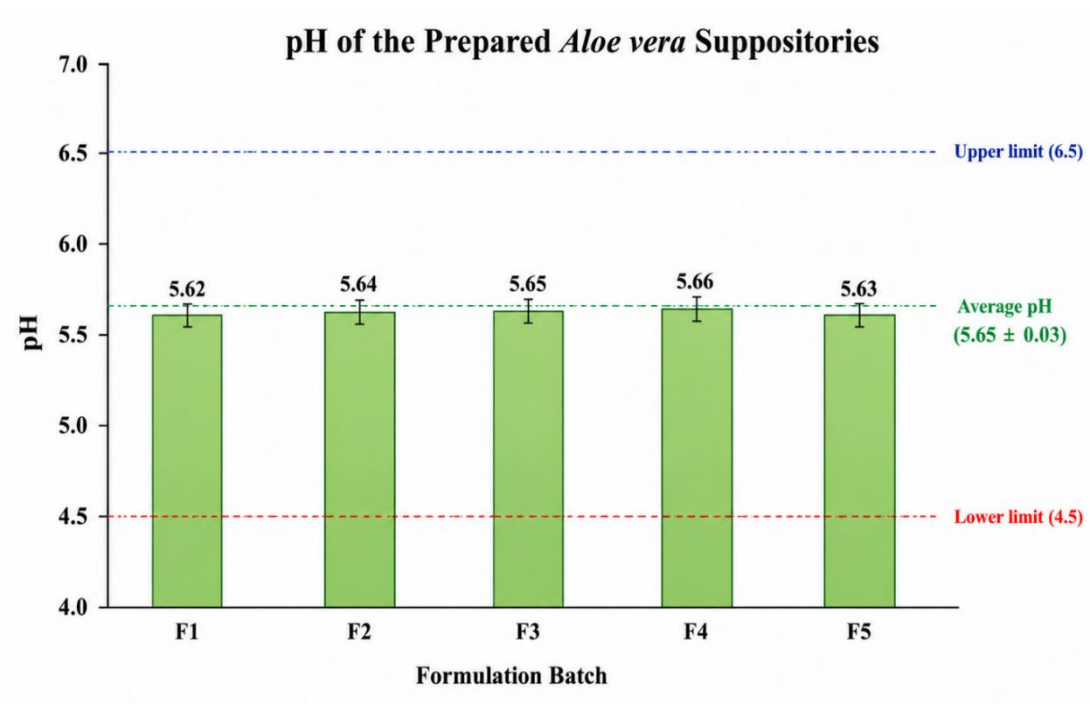


Fig. 5. Graph showing pH of the prepared formulation.

3.4 Melting Time and Melting Temperature

The melting characteristics of the prepared suppositories are presented in **Table 7**. The melting profile is illustrated in **Fig. 6**.

Table: 7 Melting Characteristics

Parameter	Result
Melting temperature	32–37°C
Melting time	8.2 ± 0.4 min

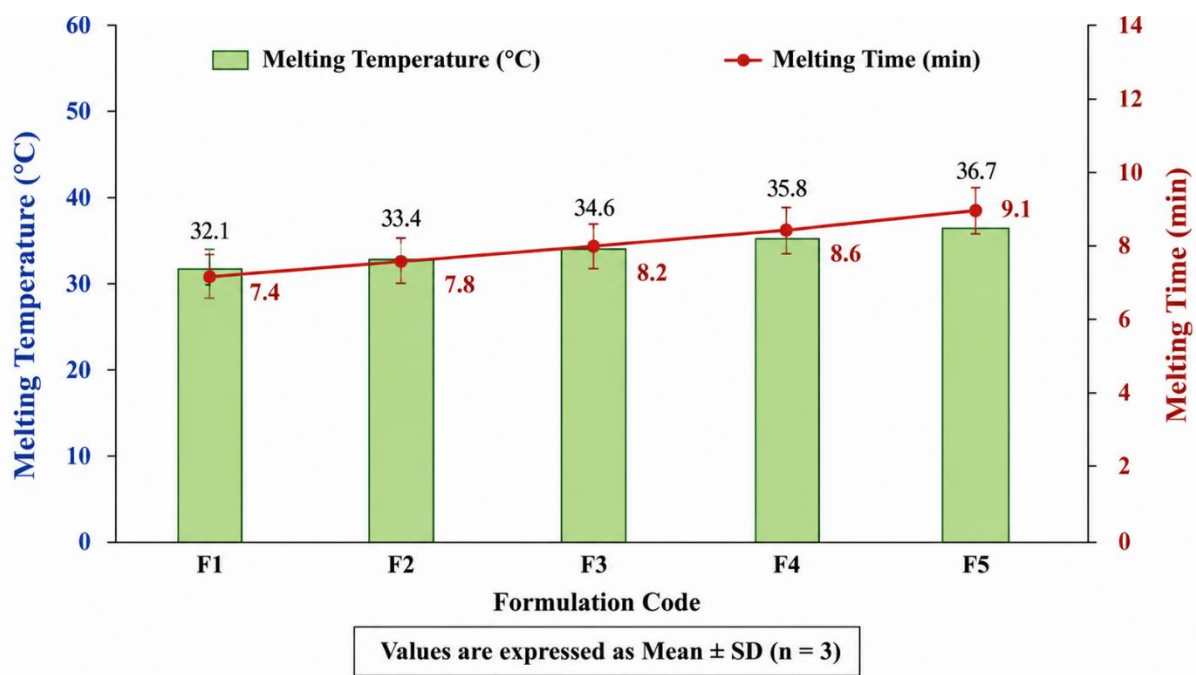


Fig. 6. Melting profile of Aloe Vera suppositories

3.5 Phytochemical Screening

Qualitative phytochemical analysis confirmed the presence of several bioactive constituents that may contribute to the therapeutic activity of *Aloe vera*, as summarized in **Table 8** and illustrated in **Fig. 7**.

Table:8 Preliminary Phytochemical Screening

Phytochemical Test	Observation
Alkaloids	Absent
Flavonoids	Present
Glycosides	Present
Phenolic compounds	Present
Tannins	Present
Saponins	Present
Steroids	Present
Terpenoids	Present
Carbohydrates	Present
Proteins	Absent

Qualitative phytochemical screening showing the presence (1) or absence (0) of major phytochemical constituents in Aloe vera gel.

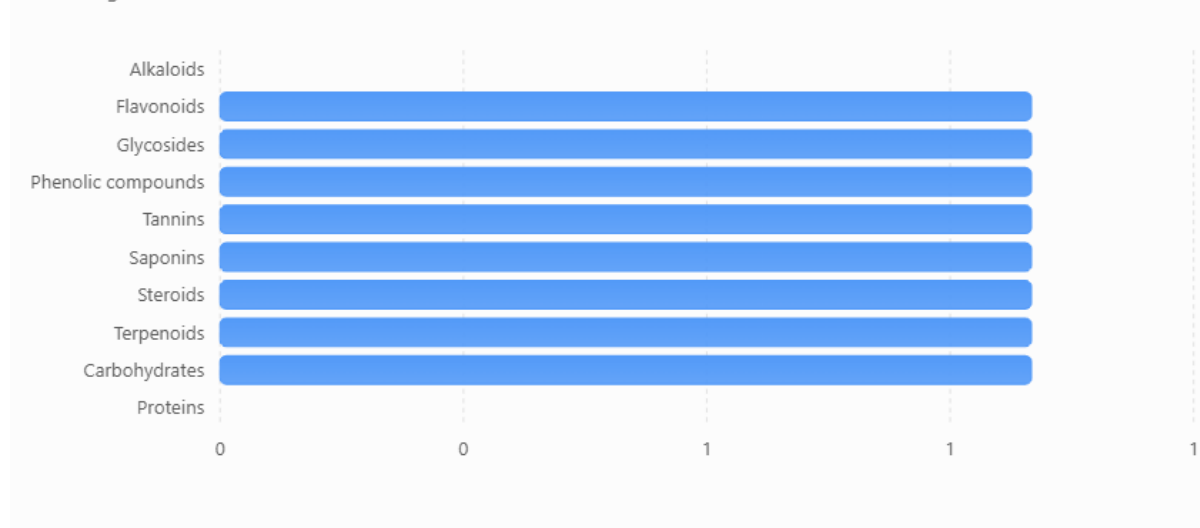


Fig. 7. Summary chart of phytochemical constituents detected in Aloe vera gel.

3.6 Drug Content Uniformity

Drug content analysis showed uniform distribution of *Aloe vera* gel throughout the suppositories, with all values within acceptable pharmaceutical limits. The results are presented in **Table 9** and illustrated in **Fig. 8**.

Table: 9 Drug Content Uniformity

Batch	Drug Content (%)
F1	98.92 $\pm$ 0.48

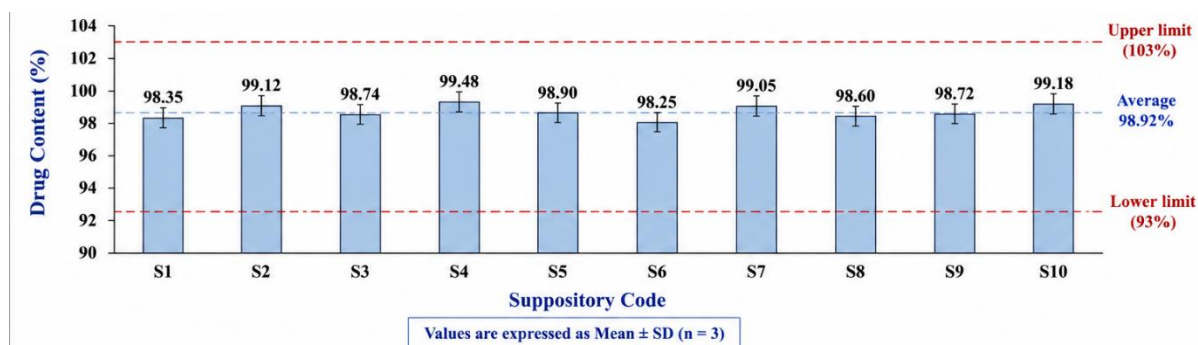


Fig. 8. Drug content uniformity of Aloe vera suppositories.

3.7 In Vitro Drug Release Study

The prepared suppositories exhibited a gradual and sustained release pattern in phosphate buffer (pH 7.4). Approximately 96.5% of the incorporated Aloe vera constituents were released within 120 minutes, as presented in **Table 10** and illustrated in **Fig. 9**.

Table .10 In Vitro Drug Release Profile

Time (min)	Cumulative Drug Release (%)
0	0.00
15	18.50
30	35.60
45	54.20
60	68.80
90	84.90
120	96.50

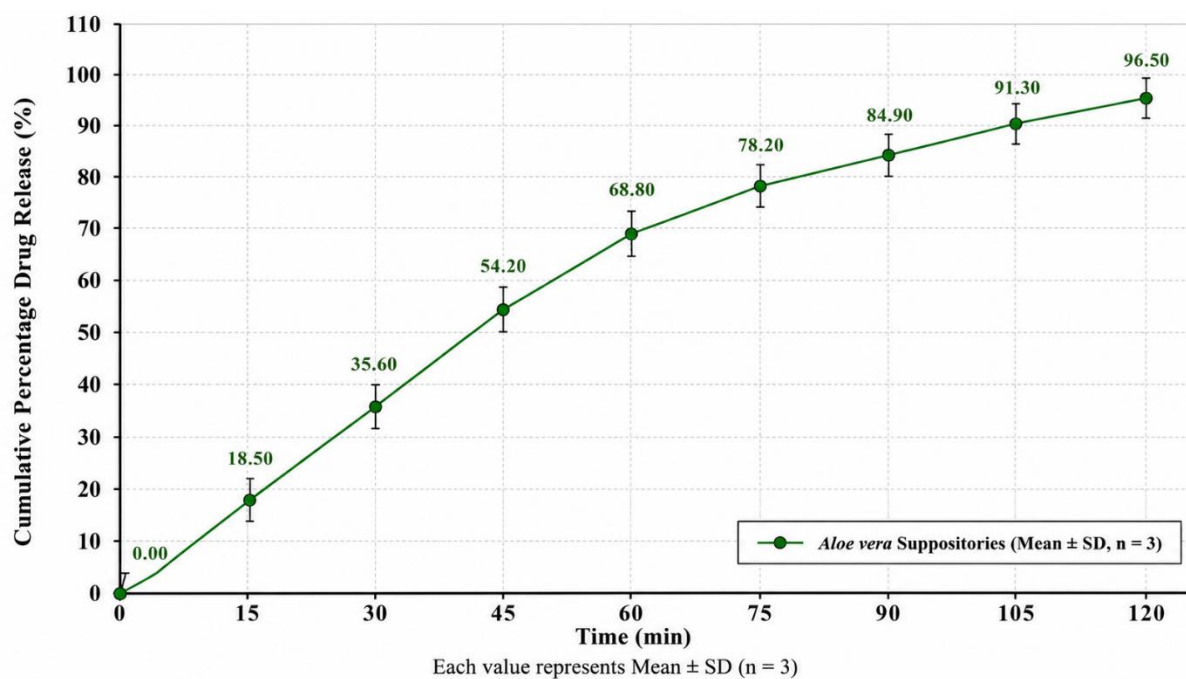


Fig. 9. Cumulative percentage drug release versus time.

3.8 Stability Study

The prepared suppositories remained physically stable during storage under both room-temperature and accelerated conditions. No significant changes were observed in appearance, pH, weight, or drug content, as presented in **Table 11** and illustrated in **Fig. 10**.

Table: 11 Stability Study

Parameter	Initial	1 Month	3 Months
Appearance	No change	No change	No change
Colour	Pale yellow	Pale yellow	Pale yellow
Average weight (g)	1.188	1.187	1.186
pH	5.65	5.63	5.61
Drug content (%)	98.92	98.54	98.20
Melting time (min)	8.2	8.3	8.4

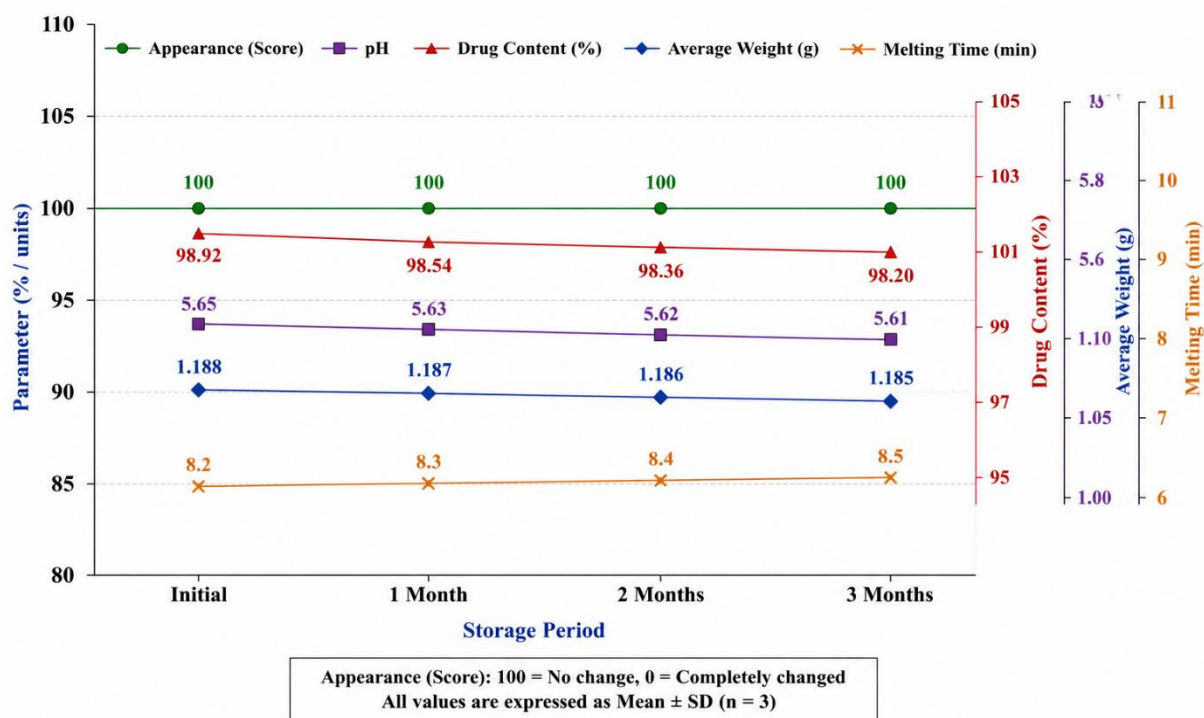


Fig. 10. Stability profile of Aloe Vera suppositories over the storage period.

3.9 Summary of Evaluation Parameters

The overall evaluation results of the prepared *Aloe vera* suppositories are summarized in Table 12.

Table: 12 Overall Evaluation of Aloe Vera Suppositories

Evaluation Parameter	Result
Appearance	Smooth and elegant
Colour	Pale yellow
Shape	Bullet shaped
Average weight	1.188 ± 0.02 g
pH	5.65 ± 0.03
Melting temperature	32–37°C
Melting time	8.2 ± 0.4 min
Drug content	$98.92 \pm 0.48\%$
Major phytochemicals	Flavonoids, glycosides, phenolics, tannins, saponins, steroids, terpenoids
Maximum drug release	96.5% at 120 min
Stability	Physically stable

Conclusion

The present study successfully developed and evaluated Aloe vera herbal suppositories using a glycerin–gelatin base, demonstrating that the formulation is a promising and pharmaceutically acceptable rectal drug delivery system. The fusion moulding method proved to be simple, economical, reproducible, and suitable for laboratory-scale preparation, producing suppositories with a smooth appearance, uniform shape, and satisfactory mechanical strength [9,11,22,31,40-43].

The developed formulation complied with all essential pharmaceutical quality parameters, including acceptable weight variation, physiological pH, appropriate melting temperature and melting time, excellent drug content uniformity, and good physical stability during storage [30,40-45,49-55]. Preliminary phytochemical screening confirmed the presence of therapeutically important bioactive constituents such as flavonoids, phenolics, tannins, saponins, glycosides, terpenoids, steroids, and carbohydrates, supporting the medicinal potential of Aloe vera [4-7,16-20,28-30]. Furthermore, the *in vitro* drug release study demonstrated a sustained release profile with approximately 96% drug release within two hours, indicating the suitability of the glycerin–gelatin base for controlled rectal drug delivery [22,31-39].

Overall, the findings establish that the formulated Aloe vera suppositories possess excellent physicochemical characteristics, adequate stability, and controlled drug release, making them a promising alternative herbal dosage form for rectal administration. Although the study was limited to formulation development and physicochemical evaluation, the encouraging results provide a strong scientific basis for further investigations involving quantitative phytochemical standardization, advanced analytical characterization (FTIR, DSC, SEM, and HPLC), *in vitro* permeation, pharmacological studies, accelerated stability testing, and preclinical and clinical evaluations [15,30,49-55]. Such studies will be essential to confirm the therapeutic efficacy, safety, and commercial applicability of the developed herbal suppository formulation.

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Declarations

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Ethics declaration

Ethics declaration: not applicable.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Data availability

The data generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author contributions

All authors contributed to the study conception, methodology, experimental work, data analysis, manuscript preparation, and approval of the final manuscript.