International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Formulation and Evaluation of Pomegranate Peel Powder Based Medicated Sprinkle for Wound Healing in Diabetic Ulcer

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Abstract:
Interest in herbal medicines continues to grow despite availability of modern treatments, as medicinal plants offer rich bioactive compounds for traditional and modern applications. This project formulates and evaluates a medicated topical sprinkle using Punica granatum (pomegranate) peel powder, valued for its antimicrobial polyphenols like punicalagin and ellagic acid. The powder is prepared by drying, then granulated with mannitol, microcrystalline cellulose (MCC), talc, sodium benzoate, and water to form a damp mass. Post-formulation, it was assessed for physicochemical parameters including color, odor, pH across temperatures, showing no significant changes. This sprinkle offers an innovative topical delivery for diabetic wound healing, leveraging pomegranate peel's antioxidant and antibacterial properties effectively.

Keywords: Medicated topical sprinkles, Punica granatum peel, diabetic wounds, antimicrobial, wound healing.

Introduction:

Medicated sprinkle dosage forms are finely divided solid particles designed for direct application to the skin, wounds, or mucous membranes, providing localized drug delivery without the need for reconstitution. These forms excel in absorbing moisture, protecting irritated areas and delivering actives like antimicrobials or anti-inflammatories for conditions such as diaper rash, burns, or surgical sites. As part of topical solid dosage forms, powders offer simplicity and stability, complementing gels by enabling dry, non-occlusive therapy.

Properties of medicated sprinkle: [13][23][24][25]

Medicated sprinkles exhibit key physical traits suited for breathable, non-occlusive therapy.

1. Composed of solid particles with air as the dispersion medium.
2. Free-flowing, dry, and finely divided.

3. Provides a protective, absorbent layer on skin or wounds.
4. Most powders offer cooling sensation and aeration.
5. Organic-based powders (e.g., starch) are hygroscopic and reversible with drying.
6. Inorganic powders (e.g., talc) are stable but may cake irreversibly in moisture.
7. Capacity to absorb liquids and form pastes on wetting.
8. Caking occurs on standing in humid conditions due to particle adhesion.
9. Ageing via particle aggregation or settling.
10. Inter-particle friction creates bulk density; glidants improve flow.
11. Gliding powders show pseudo-plastic behaviour when dispersed.

Components of Medicated sprinkle:

1. Vehicle (diluent base)
2. Active drug substance
3. Excipients
4. Absorbents
5. Glidants/lubricants Components of medicated sprinkle

The development of a medicated topical sprinkle powder derived from pomegranate peel offers a novel and practical approach to treating these recalcitrant wounds. Unlike conventional semi-solid formulations such as gels or creams, a sprinkle powder provides unique advantages in the context of highly exudative diabetic ulcers. It can effectively absorb excess wound fluid while delivering a concentrated dose of polyphenols and tannins directly to the site of infection. This formulation strategy aligns with the increasing global demand for natural, safe, and sustainable therapeutic interventions that can reduce the reliance on synthetic antibiotics, which are increasingly losing efficacy against resistant strains like Methicillin-resistant Staphylococcus aureus (MRSA).[19][6]

The therapeutic potential of Punica granatum extends beyond simple antimicrobial action; it involves a multi-targeted approach that addresses oxidative stress and chronic inflammation-two primary drivers of delayed healing in diabetes. The peel of the pomegranate is exceptionally rich in punicalagins, ellagic acid, and various flavonoids that exhibit higher radical scavenging activity than the juice or seeds.[8][9]

Introduction Of Drug:

Plant Profile

Punica Granatum Peel:[19]

Scientific Name **:** Punica grantum (L)

Synonyms **:** Pomegranate, Dadima, Anar, Granada

Scientific Classification: **-**

Table 1.1: Scientific classification of Punica granatum

Kingdom	Plantae
Order	Myrtales
Family	Lythraceae
Genus	Punica
Species	Granatum

Binomial name	Punica garanatum(L)

Parts Used: Peel,(rind/pericarp), seeds, flowers, leaves, bark, roots.

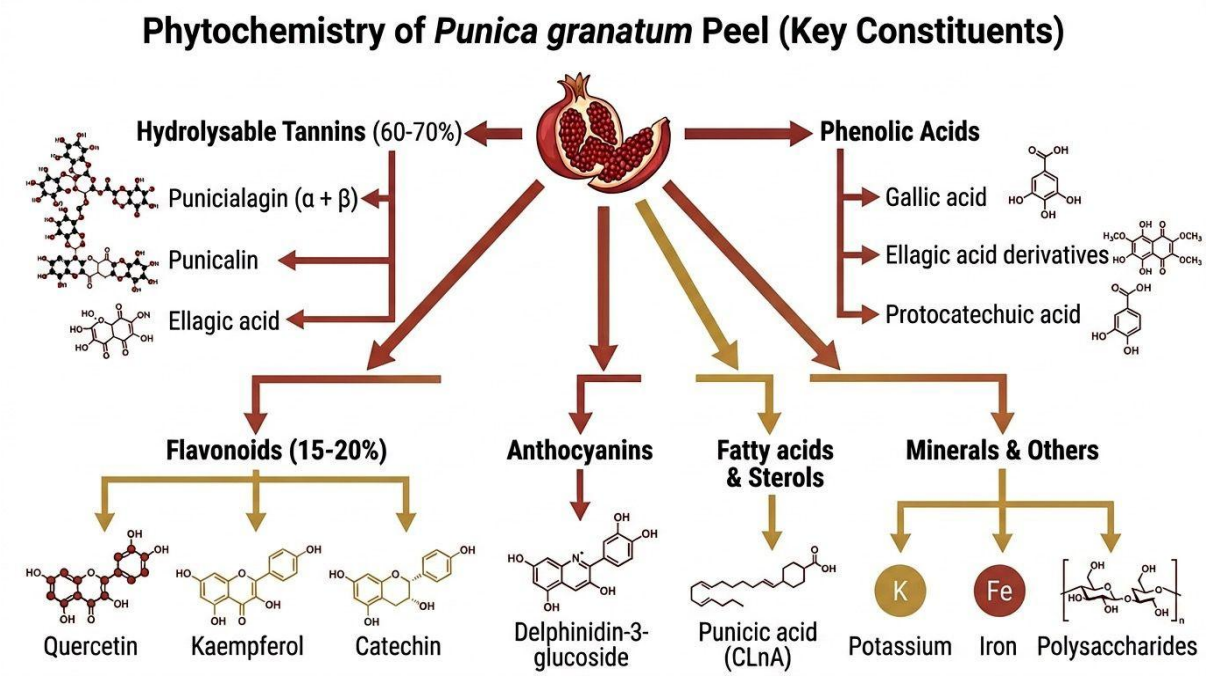

Figure 1.1 Phytochemistry of Punica granatum

Wound Healing Potential:[14]

Restoration of diseased or damaged tissues is a complicated process that involves a series of well-structured biochemical and cellular activities. Homeostasis, inflammation, proliferation, and remodelling are the four meticulous and programmed phases. Pomegranate peel contains significant levels of polyphenols, including gallic acid, ellagic tannins, and ellagic acid. Due to the presence of polyphenols and flavonoids, pomegranate peel possesses wound healing properties.

Phenolic compounds (e.g., punicalagin and ellagic acid) from Punica granatum peel exhibit potent antimicrobial, antioxidant, and wound contraction effects, as evidenced in studies on diabetic ulcer models.

Powder-based system for direct topical application, ensuring intimate wound contact.

Provides sustained release of actives in a dry, stable form suitable for chronic ulcers.

Facilitates moist wound environment upon hydration, promotes debridement, and reduces dressing changes.

Minimizes infection risk by delivering antimicrobials precisely, alleviating pain and inflammation in diabetic wounds.

Experimental Work

Role of Ingredient

Table1.2 : Role of ingredient

Sr No.	Ingredient	Role of ingredient
1	Punica granatum peel powder	Antioxidant activity to reduce oxidative stress and inflammation at the wound site
2	Corn starch	Used as diluent and binding agent
3	Mannitol	Used as solubilizer
4	Microcrystalline cellulose	Used as granulating agent
5	Talc	Used as glidant and lubricant
6	Sodium benzoate	Used as preservative
7	Distilled water	Used as vehicle

Formulation for preparation of medicated sprinkle

Table1.3: Formulation for preparation of medicated sprinkle

Sr no.	Ingredient	Quantity required for 100 gm (%w/w)		
		F1	**F2**	**F3**
1	Punica granatum peel powder	**20 gm**	20 gm	20 gm
2	Corn starch	**25 gm**	25 gm	25 gm
3	Mannitol	**30 gm**	35 gm	25 gm
4	Microcrystalline cellulose	**22.5 gm**	17.5 gm	27.5 gm
5	Talc	**2 gm**	2 gm	2 gm
6	Sodium benzoate	**0.5 gm**	0.5 gm	0.5 gm
7	Distilled water	**9.5 gm**	9.5 gm	9.5 gm

***F1 batch is our optimize batch.**

Method of Preparation of Medicated Sprinkle

Preparation[18]

1. Weight all the ingredients accurately on a well calibrated weighing balance.
2. Mix all the ingredients in a mortar and pestle.
3. Add binding solution as per requirement until a damp mass is formed which is not too wet or too dry.
4. Mix the mixture properly.
5. After forming proper mass, pass it through sieve size 18/20.
6. The granules formed are dried in hot air oven at 120 ° Celsius for 60 minutes.
7. After drying granules are weighed properly.
8. Then filled in a well labelled sachet for deliver

Evaluation Parameter Of Medicated Sprinkle[18]

A. Density: -

There are two types of density to be measured.

A. Bulk density

B. True or tapped density

B. Bulk Density

$\rho b = M/V_b$

Where,

ρb is a bulk density of granules.

M is mass of sprinkles in gm.

V_b is volume of sprinkles in measuring cylinder in ml.

If more compressible bed of particulate – less flowable powder or sprinkles.

If less dense or compressible – more flowable powder or sprinkles.

C. Tapped Density

$\rho b = M/V_b$

Where,

ρb is a bulk density of sprinkles.

M is a mass of sprinkles in gm.

V_b is a volume of sprinkles in measuring cylinder after tapping in ml.

D. Flow Properties

Flow Property of material results from many forces:

A. Frictional force

B. Surface tension force

C. Mechanical force caused by interlocking of irregular shape particles

D. Electrostatic forces

E. Cohesive/ Vander Waals forces

Forces also affect granule property such as particle size and shape, particle size distribution, surface texture, roughness & surface area.

If particle size of powder is </= 150 micrometres the magnitude of frictional and Vander Waals force predominates.

When particle size increases mechanical and physical properties become more important with packing properties.

Flow properties of granules are determined by measuring Three parameters: -

A. Angle of repose

B. Percentage compressibility index

C. Hausner's ratio

A. Angle of repose

$\tan \theta = h/r$

Where,

θ is Angle of repose,

h is height of pile,

r is radius of pile.

Table 1.4: Measurement of angle of repose

Sr No.	Angle of Repose	Type of Flow
1	<25	Excellent
2	25-30	Good
3	30-40	Passable
4	>40	Poor

B. Percentage compressibility index

It is directly related to the relative flow rate cohesiveness and particle size. It is simple, fast and popular method of presiding powder flow characters

It can be obtained from bulk density measurements

% Compressibility index = Tapped Density – bulk Density / tapped density * 10

Table 1.5: Compressibility Index

Sr. No.	% Compressibility Index	Type of flow
1	5-15	Excellent
2	12-16	Incredibly good
3	18-21	Good
4	23-25	Passable
5	33-37	Poor
6	>40	Extremely poor

C. Hausner's ratio

It is related to interpaticulate friction and as such could be used to predict powder flow characteristics.

It showed that powder with low particulate friction such as coarse sphere had ratio of approximately 1.2, whereas more is Cohesiveness – less free flowing powders such as flakes have Hauser's ration greater than 1.6.

Hausner's Ratio = Tapped density / Bulk density

Moisture content

The amount of moisture present in the sprinkles is called moisture content.

Sprinkles contain 2% moisture. It is required for the binding of the powder or sprinkles during compression in die cavity.

Percentage of moisture is calculated by using moisture balance or IR balance. The small amount of sample taken from oven to measure moisture content and place in the moisture balance.

Initial reading should be note down after that we are initiating the IR bulb. As IR bulb is initiated the moisture is removed from the sprinkles via heating after that note down the reading.

% Moisture content = Initial weight – Final weight / Initial weight

Table 1.6: Result of evaluation parameter

Evaluation parameter	Result
Physical evaluation	Color: brown Odour: odourless pH: 5.8
Bulk density	0.40 gm/ml
Tapped density	0.507 gm/ml
Angle of repose	26.6°
% compressibility ratio	21.1%
Hausner ratio	1.27
Moisture content	4.0%

Result and Discussion of Evaluation Parameter

1. **Physical Evaluation:** The formulation showed a brownish yellow color and smooth consistency, indicating uniform blending and a visually appealing product likely acceptable for user handling and application.
2. **Measurement of pH :-** The pH of 5.8 falls within 4.5–6.0, compatible with skin pH. This suggests the formulation is non-irritating and suitable for topical application.
3. **Flowability:** Angle of repose was 26.6° (<30° indicates excellent/very good flow), Carr's index was 21.1% (15–25% indicates good flow), and Hausner ratio was 1.27 (1.25–1.35 indicates fair to good flow). These values confirm the powder/sprinkles exhibit good to very good flowability, suitable for capsule filling and sprinkling without major caking issues.
4. **Compressibility/Packing Behavior** : Bulk density was 0.40 g/mL and tapped density was 0.507 g/mL. These indicate relatively low density and loose packing, typical of porous granules or pellets, with tapped density ~27% higher than bulk (consistent with Carr's index of 21.1%). This suggests fair to good compressibility, acceptable for medicated sprinkles provided dose uniformity and capsule filling weights are maintained, with no excessive particle fragility.
5. **Moisture Content:** Moisture content was 4%, indicating well-controlled drying and processing. This minimizes risks of caking, agglomeration, and hygroscopicity during storage, while supporting good handling and sprinkling for topical use—neither too dry (dusty) nor too moist (clumping).
6. **Stability study :** Table 1.7 : Stability Study of Medicated Sprinkle Formulation Storage Condition: 40°C ± 2°C / 75% RH ± 5%

Parameters	Initial	15 Days	30 Days
Color	Brown	No change	No change
Odour	Odourless	Odourless	Odourless
pH	5.8	5.7	5.6
Bulk Density (g/mL)	0.40	0.41	0.42
Tapped Density (g/mL)	0.507	0.510	0.514
Angle of Repose (°)	26.6°	27.1°	27.8°
Compressibility Index (%)	21.1%	21.8%	22.4%
Hausner Ratio	1.27	1.28	1.29
Moisture Content (%)	4.0%	4.3%	4.6%

Conclusion

The development of a Punica granatum peel medicated sprinkle powder represents a significant advancement in the search for effective, natural, and sustainable treatments for chronic diabetic ulcers. The pomegranate pericarp is a uniquely rich source of bioactive polyphenols, tannins, and flavonoids that address the multi-faceted challenges of diabetic wound healing through antioxidant, antimicrobial, and tissue-remodeling actions. The extract's ability to simultaneously combat oxidative stress, inhibit broad-spectrum pathogens (including multidrug-resistant organisms), and support tissue regeneration makes it a superior, multi-target alternative to many single-action synthetic agents.

Formulating these constituents into a topical medicated sprinkle powder offers distinct clinical advantages, especially for highly exudative diabetic ulcers, by absorbing excess wound fluid and delivering a stable, high-concentration dose of phytochemicals at the site of action. This sprinkle-based system is technically feasible and maintains potency, consistency, and good skin compatibility over long-term use. Given its favorable safety profile and reliance on plant-derived actives, Punica granatum peel medicated sprinkle powder emerges as a scientifically sound and clinically promising intervention that harnesses traditional phytomedicine to meet the modern challenges of diabetic wound care.

Acknowledgement

The authors would like to thank Shree Swaminarayan Sanskar Pharmacy College, Zundal, Gandhinagar, Gujarat, India, for providing the necessary facilities to carry out the research work.

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