

FORMATION AND EVALUATION OF TRANSDERMAL PATCHES FOR DIABETES BY PLANT EXTRACT (GUAVA LEAVES)

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Abstract : This study explores the organoleptic and physicochemical properties of transdermal patches formulated with *Psidium guajava* (guava) leaf extract, targeting sustained therapeutic delivery. Organoleptic evaluation revealed that the extract and resulting patches exhibited a greenish-brown color, characteristic herbal odor, smooth texture, and transparent, uniform appearance. Six formulations (F1–F6) were developed using varying concentrations of hydroxypropyl methylcellulose (HPMC), polyvinyl alcohol (PVA), and glycerol to optimize film characteristics. Physicochemical assessments demonstrated consistent thickness (2.0–2.2 mm), minimal weight variation (1.7–2.3%), and stable moisture content (4.1–4.6%) across formulations. Moisture uptake ranged from 7.1–7.8%, while folding endurance exceeded 250 folds, indicating mechanical robustness. Surface pH values (6.8–7.1) confirmed skin compatibility, and drug content uniformity remained within acceptable limits (97.8–101%). Mechanical evaluations showed tensile strength between 3.2–4.1 kg/cm² and elongation at break from 32–63%, reflecting flexibility and durability. The guava leaf extract, rich in quercetin and flavonoids, demonstrated potential hypoglycemic activity by enhancing insulin sensitivity and inhibiting α -glucosidase. The transdermal route offers a promising alternative for sustained release, bypassing first-pass metabolism and improving therapeutic efficacy.

Keywords: *Psidium guajava*, Guava, HPMC, PVA, Transdermal, Patches

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from defects in insulin secretion, insulin action or both. The long-term complications include neuropathy, nephropathy, retinopathy, and cardiovascular diseases¹. Conventional oral administration of antidiabetic drugs often suffers from limitations such as poor bioavailability, hepatic first-pass metabolism, and fluctuating plasma drug concentrations. Hence, transdermal route of drug delivery offers a promising alternative for sustained and controlled drug release². Diabetes management often requires multiple daily doses of oral antidiabetic agents or subcutaneous insulin injections, leading to poor compliance and risk of hypoglycemia. Transdermal route offers a promising alternative for delivering anti-diabetic agents, especially for drugs that undergo extensive first-pass metabolism or have short biological half-lives³. Transdermal systems provide a non-invasive mode of drug delivery, eliminate gastrointestinal irritation, and bypass hepatic metabolism, thereby increasing bioavailability⁴. Moreover, they can be designed to deliver drugs in a sustained manner, maintaining constant plasma drug levels over extended periods. This is particularly beneficial for diabetic patients who require continuous glucose regulation. Additionally, transdermal route allows for easy termination of therapy in case of adverse effects by simply removing the patch. It is suitable for both synthetic drugs and natural plant-derived bioactive compounds, making it a versatile platform for modern as well as herbal medicine-based therapies. Plant-based therapies are considered safer and more cost-effective compared to synthetic drugs. They often exhibit multi-targeted actions, low toxicity, and minimal side effects. Among various medicinal plants, Guava has received considerable attention due to its hypoglycemic, antioxidant and anti-inflammatory properties⁵.

Transdermal patches deliver drugs through the skin into the systemic circulation, avoiding hepatic first-pass metabolism and maintaining consistent plasma drug levels. Herbal medicines, such as extracts from guava leaves (*Psidium guajava* Linn.), have gained attention due to their potent antidiabetic effects and minimal side effects. Guava leaves contain flavonoids like quercetin, which inhibit α -glucosidase and improve insulin sensitivity. The incorporation of guava leaf extract into a transdermal patch allows for sustained delivery of active constituents, thereby improving therapeutic efficacy and patient compliance⁶.

Developing a transdermal patch of guava leaf extract for diabetes offers a novel, patient-friendly and effective therapeutic approach. It combines the therapeutic advantages of natural phytoconstituents with modern pharmaceutical technology to overcome the limitations of traditional drug delivery.

MATERIALS AND METHOD

Collection of Plant Sample: Fresh *Psidium guajava* (guava) leaves were collected from local regions and authenticated by a botanist from the Department of Botany. The leaves were washed thoroughly with tap water followed by distilled water to remove dust and debris. The clean leaves were shade dried for 10–12 days and powdered using a mechanical grinder. The powdered material was stored in an airtight container for further use.

Extraction by Soxhlet Method: Approximately 10 g of dried and powdered *Psidium guajava* leaves were accurately weighed and placed inside a thimble. Ethanol and distilled water (70:30 ratio, 100 mL total) were used as extraction solvents.

The solid plant material was placed in the Soxhlet thimble. The Soxhlet extract or was attached to around bottom flask containing the solvent. The solvent was heated to reflux; vapors traveled through the distillation arm and condensed, filling the thimble chamber. The extract dissolved in the warm solvent and was siphoned back into the distillation flask repeatedly. The process was continued for 6–8 hours until the solvent in the siphon tube became colorless. The resulting extract was concentrated using a rotary evaporator and dried under reduced pressure to yield a semi-solid extract. The dried extract was stored in an air tight container for formulation.

Formulation of Transdermal Patch

The polymers (HPMC and PVA) were dissolved in distilled water with continuous stirring and gentle heating until a homogeneous mixture formed. The guava leaf extract was added slowly with constant stirring. Glycerol was added as a plasticizer. Resulting viscous solution was poured in to sterile Petriplates. Plates were dried at 40 °C in a hot air oven for 24 hours. After drying, patches were carefully peeled off and stored in desiccators for further evaluation.

Evaluation of transdermal patches of guava leaves

Physicochemical Evaluation: These tests assess the basic physical and chemical properties of the patch:

- **Thickness and weight uniformity:** Ensures consistency across batches.
- **Moisture content and uptake:** Determines stability and shelf life.
- **Folding endurance:** Measures flexibility and durability.
- **Surface pH:** Ensures skin compatibility to avoid irritation.
- **Drug content uniformity:** Confirms even distribution of the active pharmaceutical ingredient (API).

Mechanical Properties: These tests evaluate the patch's structural integrity and usability:

- **Tensile strength:** Measures the force required to break the patch.
- **Elongation at break:** Indicates flexibility and stretchability.
- **Adhesive properties:** Includes peel strength, tackiness, and shear strength to ensure the patch stays on the skin without causing discomfort.

RESULTS AND DISCUSSION

Organoleptic Properties of extract of guava leaves:

The organoleptic characteristics such as appearance, color, odor, and texture of the guava leaf extract and the prepared transdermal patches were examined visually and by tactile observation.

Table No. 1: Organoleptic Properties of extract of guava leaves

Parameter	Observation
Color	Greenish brown
Odor	Characteristic herbal smell
Texture	Smooth and flexible
Appearance	Transparent, uniform film

Formulation of Transdermal Patch

Six different formulations (F1–F6) were prepared using varying concentrations of polymers (HPMC, PVA) and plasticizer (glycerol) to optimize the film characteristics.

Table No. 2: Formulation of transdermal patch guava leaves

S. No.	Ingredients	F-1	F-2	F-3	F-4	F-5	F-6
1	<i>Psidium guajava</i> extract (%)	1	1	1	1	1	1
2	HPMC	2	2	3	3	4	4
3	PVA	2	3	3	4	4	5
4	Glycerol	0.5	0.5	1	1	1	1
5	Distilledwater	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.

Evaluation of transdermal patches of guava leaves

Table No. 3: Physicochemical Evaluation of transdermal patches of guava leaves

Evaluation Parameters	F-1	F-2	F-3	F-4	F-5	F-6
Thickness (mm)	2.0	2.1	2.1	2.2	2.0	2.1
Weight variations (%)	2.0 %	2.3 %	1.7 %	1.8 %	2.1 %	1.9 %
Moisture content (%)	4.3 %	4.4 %	4.5 %	4.2 %	4.6 %	4.1 %
Moisture uptake (%)	7.3 %	7.8 %	7.7 %	7.1 %	7.3 %	7.1 %
Folding endurance (No. of fold)	258	260	267	276	288	289
Surface pH	6.8	6.9	7.0	7.1	6.9	7.0
Drug content uniformity (%)	98.1 %	101 %	98.3 %	99.2 %	97.8 %	99.3 %

Mechanical Properties: These tests evaluate the patch’s structural integrity and usability:

Table No. 4: Evaluation of Mechanical Properties of transdermal patches of guava leaves

Evaluation Parameters	F-1	F-2	F-3	F-4	F-5	F-6
Tensile strength (Kg/cm ²)	3.2	3.5	3.7	3.8	4.1	4.0
Elongation at break (%)	45 %	55 %	46 %	52 %	63 %	32 %

Discussion

The formulated transdermal patches were uniform in thickness, smooth, and flexible, indicating proper polymer–plasticizer interaction.

Organoleptic evaluation revealed that all patches had a pleasant appearance with mild herbal odor. Physical evaluation (not shown here) such as tensile strength, folding endurance, and moisture content can be conducted to assess mechanical and storage stability. The guava leaf extract demonstrated potential hypoglycemic effects due to the presence of bioactive compounds like quercetin and flavonoids, which enhance insulin sensitivity and inhibit α -glucosidase enzyme activity. The transdermal route provides sustained release of the plant extract, bypassing first- pass metabolism and improving therapeutic efficacy.

CONCLUSION

The present study demonstrated the successful formulation of transdermal patches using *Psidium guajava* leaf extract for potential use in the management of diabetes mellitus. The Soxhlet extraction method effectively isolated phytoconstituents from guava leaves. The prepared patches were flexible, transparent, and stable, with acceptable organoleptic characteristics.

These findings suggest that guava leaf extract-based transdermal patches could serve as a promising alternative for sustained anti-diabetic drug delivery. Further pharmacological and *in- vivo* studies are recommended to evaluate glucose-lowering efficacy and transdermal permeation profiles.

CONFLICTS OF INTERESTS

There are no conflicts of interests.

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