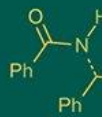


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Formulation and evaluation of herbal hydrogel containing methanolic extract *Zingiber zerumbet*

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Abstract

Purpose: This study aimed to formulate and evaluate a topical herbal hydrogel incorporating a methanolic extract of *Zingiber zerumbet* seeds.

Methods: The plant material was extracted via maceration using methanol and screened for phytochemicals. The hydrogel was prepared using Carbopol 940 as the gelling agent, neutralized with triethanolamine (TEA). The formulation was evaluated for physical appearance, pH, spreadability, stability, and swelling index.

Results: Phytochemical screening confirmed the presence of alkaloids and saponins, while tannins and flavonoids were absent. The formulated hydrogel was smooth, homogeneous, and physically stable. It exhibited a pH of 6.04, which is compatible with human skin, and a high spreadability value of 750 g.cm/sec. The swelling index was calculated at 34%, indicating effective water absorption capacity.

Conclusion: The results suggest that the *Zingiber zerumbet* hydrogel is a stable, skin-friendly topical delivery system with favorable physicochemical properties, making it a viable candidate for further pharmacological exploration of its anti-inflammatory and antioxidant potential.

Keywords: *Zingiber zerumbet*, hydrogel, Carbopol 940, phytochemical screening, topical delivery, maceration

1. Introduction

Zingiber zerumbet, often known as bitter ginger, is a species with a variety of pharmacological properties that belongs to the Zingiberaceae family, which contains about 53 genera, 1200 species, and even more in different parts of South Asia. Research has revealed that *Zingiber zerumbet* exhibits a mixture of terpenes and sesquiterpenes. In Brazil, the National Institute of Amazonian Research conducted a partnership and developed a product using *Z. zerumbet*, such as yogurt, which improves the function of the gastrointestinal tract. The rhizome part has been further investigated because of its medicinal properties during the extraction process through maceration, and the rhizome part exhibits good therapeutic effect against inflammation and GIT-related problems [1]. *Z. zerumbet*, which exhibits the existence of pulvinus between the petiole and ligule. The ligule is thin and broad, measuring between 1.5 and 2.5 cm in length, while the petiole is 6 mm long. Because of the mucilaginous material that is present in the inflorescence, which the Hawaiians utilize as natural hair conditioners, it is known as "shampoo ginger" and is thought to glow and produce throughout the months of August and September [2]. The plant's characteristics include the ability to grow up to two meters with petiolate leaves, green inflorescence that turns red as it ages, and Z rhizome. Zerumbet has been used as a herbal cure in Asian, Chinese, and Indian cultures. It is found in Bangladesh, Malaysia, and Nepal in India. While *Z. zerumbet* has a variety of phytochemicals that have been examined, the main ones include alkaloids, polyphenols, and terpenes [3]. Osteoarthritis (OA) has been applied to arthritis. The anti-inflammatory action of *Z. zerumbet* has been studied and reported for dried ethanol extract [4].

2. Materials and Methods

2.1 Materials

Various materials and chemicals were used during the research work, including *Zingiber zerumbet* seeds, methanol, carbopol 940, triethanolamine, and different reagents required for phytochemical screening and hydrogel preparation. Methanol was mainly used for extraction

of the plant constituents, while carbopol 940 was used for preparing the hydrogel base. Reagents such as Wagner's reagent, ferric chloride, ethanol, and sodium hydroxide were used to identify the presence of different phytochemicals in

the extract. All the chemicals and materials used in the study were of analytical grade and handled under suitable laboratory conditions ^[5-10].

Table 1: Materials used in research

S. No.	Materials	Purpose
1	<i>Zingiber zerumbet</i> seeds	Plant material used for extraction
2	Methanol	Solvent used for extraction
3	Carbopol 940	Gelling agents used for hydrogel preparation
4	Triethanolamine (TEA)	Neutralizing agent for gel formation
5	Distilled water	Used for preparation of hydrogel
6	Wagner's reagent	Test reagent for alkaloids
7	Ethanol	Used in saponin test
8	Ferric chloride solution	Test reagent for tannins
9	Sodium hydroxide solution	Test reagent for flavonoids
10	Whatman filter paper	Used for filtration of extract
11	Aluminium foil	Used to cover extraction flask
12	Glass slides	Used in Spreadability study
13	Mortar and pestle	Used for grinding seed material
14	Conical flask	Used for extraction process
15	Water bath	Used for evaporation of solvent
16	pH meter	Used for determination of pH
17	Air-tight containers	Storage of powders and extract
18	Refrigerator	Storage of prepared extract
19	Analytical balance	Accurate weighing of materials
20	Magnetic stirrer/glass rod	Stirring during gel preparation

2.2 Preparation of Plant Material

The seeds of *Zingiber zerumbet* were collected and cleaned properly to remove dirt and unwanted materials. The cleaned seeds were shade dried at room temperature for

adequate drying. After complete drying, the seeds were crushed into a fine powder using a mortar and pestle. The powdered sample was stored in an air-tight container until further experimental work was carried out.



Fig 1: *Zingiber zerumbet* seed powder

2.3 Extraction Procedure

The methanolic extract of the powdered seed material was prepared using the maceration method. About 0.54g of the powdered sample was taken in a 25ml conical flask was covered with aluminum foil and kept undisturbed at room temperature for 48-72 hours with occasional shaking to ensure proper extraction of phytoconstituents.

After the extraction process was completed, the mixture was filtered using whatman filter paper. The filtrate obtained was then concentrated on a water bath maintained at 50°C until a semi-solid extract was formed. The prepared extract was stored in an air-tight container under refrigerated conditions for further studies.



Fig 2: Extraction Method

2.4 Preliminary Phytochemical Screening

Preliminary phytochemical screening of the methanolic extract was carried out to identify the presence of important secondary metabolites such as alkaloids, saponins, tannins, and flavonoids.

1. **Test for Alkaloids:** A small quantity of the extract was treated with Wagner's reagent. Formation of a reddish-brown precipitate indicated the presence of alkaloids in the extract.
2. **Test for Saponins:** Approximately 5mg of the extract was mixed with ethanol and shaken vigorously for a

few minutes. The appearance of stable froth or a soapy layer confirmed the presence of saponins.

3. **Test for Tannins:** The extract was treated with ferric chloride solution and observed for color change. Formation of a dark blue or greenish-black color indicates the presence of tannins. However, no significant color change was observed in the extract.
4. **Test for Flavonoids:** The extract was treated with sodium hydroxide solution and observed for the development of yellow coloration. Since no yellow color appeared, flavonoids were considered absent in the extract.

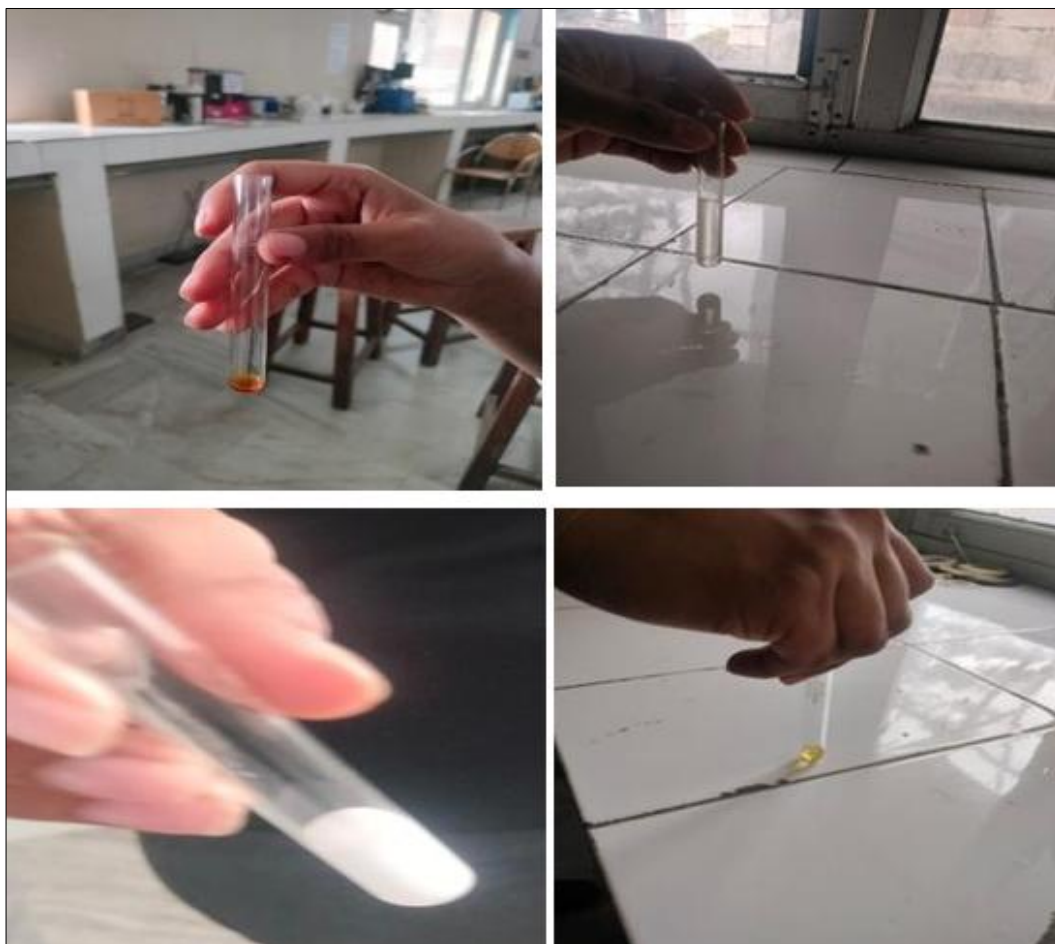


Fig 3: Preliminary Phytochemical Screening

2.5 Preparation of Hydrogel formulation

The hydrogel formulation was prepared using Carbopol 940 as the gelling agent. Initially, Carbopol 940 was dispersed slowly in distilled water with continuous stirring until a smooth and uniform mixture was formed. The dispersion was allowed to stand for some time to ensure complete hydration of the polymer.

After proper hydration, the plant extract was added gradually with continuous stirring to obtain a homogeneous mixture. Triethanolamine (TEA) was then added dropwise while stirring gently, resulting in the formation of a clear hydrogel. The prepared formulation was stored in a tightly closed container and kept undisturbed for 24 hours before further evaluation.



Fig 4: Formulation of Hydrogel

2.6 Evaluation of Hydrogel Formulation

- Physical Appearance:** The prepared hydrogel was visually examined for its color, clarity, consistency, and homogeneity. The formulation appeared smooth, uniform, and free from any visible particles or phase separation.
- Determination of pH:** The pH of the prepared hydrogel was measured and found to be 6.04. This pH range is considered suitable and safe for topical application on the skin.
- Spreadability Study:** The spreadability of the hydrogel was evaluated using the standard procedure.

Formula: $S = M \cdot L / T$

Where,

S = Spreadability

M = Weight applied

L = Length moved by the glass slide

T = Time taken (sec)

The spreadability value of the formulation was found to be 750 g.cm/sec, indicating good spreading ability of the hydrogel.

- Stability Study:** The prepared hydrogel formulation was subjected to stability studies under specified storage conditions. During the study period, no noticeable changes in color, appearance, suggesting that the formulation remained stable.
- Swelling Index:** The swelling behavior of the hydrogel was determined by immersing the dried hydrogel sample in water at room temperature for a fixed period of time. After complete swelling, the sample was removed carefully, excess surface water was wiped off, and the swollen hydrogel was weighted.

The swelling index was calculated using the following formula:

Swelling index = $W_s - W_d / W_d$

Where,

W_s = Weight of swollen hydrogel

W_d = Weight of dry hydrogel

The swelling index of the formulation was found to be 34%, indicating good water absorption capacity.

Table 2: Evaluation Parameter Table [11-12]

S. No.	Parameter	Result	Observation
1	Physical Appearance	No change	Uniform gel
2	pH	6.04	Skin-friendly
3	Spreadability	750g.cm/sec	Good spreadability
4	Stability Study	No change	Stable formulations
5	Swelling Index	34%	Good water absorption

3. Results & Discussion

3.1 Preliminary Phytochemical Screening

Preliminary phytochemical screening of the methanolic extract of *Zingiber zerumbet* showed the presence of important secondary metabolites such as alkaloids, flavonoids, and saponins, while tannins were found to be absent. The presence of these phytoconstituents indicates that the extract possesses potential biological activity and may contribute to antioxidant and anti-inflammatory effects. Among these compounds, flavonoids and saponins are well known for their role in reducing oxidative stress and inflammation.

3.2 Evaluation of Hydrogel Formulation

Physical appearance, pH, spreadability, stability, and swelling index were among the physicochemical parameters that were assessed for the manufactured herbal hydrogel containing *Zingiber zerumbet* extract. The formulation's smooth, uniform, and lump-free appearance suggested that the polymer and extract had been properly dispersed throughout the gel basis. Throughout the experimental period, neither phase separation nor grittiness were noticed. The produced hydrogel was found to have a pH of 6.04, which is similar to the pH of normal skin and so deemed appropriate for topical application. To prevent irritation and increase patient acceptability, a pH that is compatible with skin is crucial. Similar results were found in earlier hydrogel investigations, where formulations based on carbopol showed pH levels suitable for cutaneous application. The formulation's spreadability value was determined to be good, suggesting that the gel may be applied to the skin's surface with minimal resistance. Because it guarantees consistent application and improved contact with the affected area, good spreadability is regarded as a crucial quality for topical medicines. The appropriate concentration of Carbopol 940 utilized in the formulation may have contributed to the outcome.

Good formulation stability was shown by the stability research, which revealed no appreciable changes in the hydrogel's color, consistency, or appearance under storage settings. This implies that during the observation time, the produced hydrogel remained stable and retained its physical integrity. The formulation's swelling index of 34% shows that the hydrogel network has a good capacity to absorb water.

4. Conclusion

The present study successfully demonstrated the preparation and evaluation of a herbal hydrogel containing methanolic extract of *Zingiber zerumbet*. The phytochemical screening confirmed the presence of important bioactive constituents, particularly alkaloids, flavonoids, and saponins, which may contribute to the therapeutic activity of the formulation.

These findings support earlier reports describing the phytochemical richness and medicinal importance of the plant. The hydrogel prepared using Carbopol 940 showed satisfactory physicochemical characteristics including good homogeneity, acceptable pH, good spreadability, and stability. The pH of the formulation was found suitable for topical use, suggesting that the formulation may be safe and non-irritating to the skin. The spreadability and swelling behavior further indicated that the prepared hydrogel may provide efficient topical application and good moisture retention.

The formulation remained physically stable throughout the study period without showing any visible change in appearance or consistency. The swelling index result also suggested effective hydration capacity of the polymeric network, which is considered beneficial for topical drug delivery systems. Overall, the obtained results suggest that the prepared herbal hydrogel may serve as a promising topical formulation for further pharmaceutical and therapeutic applications.

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