

## Design and Evaluation of Resveratrol-Loaded Hydrogel from *Arachis Hypogaea* Linn

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Date of Submission: 05-02-2025

Date of Acceptance: 15-02-2025

### ABSTRACT:

Resveratrol, a naturally occurring polyphenol with potent antioxidant and anti-inflammatory properties, has gained significant attention in pharmaceutical and cosmetic formulations. However, its poor water solubility and stability limit its therapeutic potential. This study focuses on the formulation and evaluation of a hydrogel-based delivery system for resveratrol to enhance its solubility, stability, and bioavailability. Hydrogels were prepared using biocompatible polymers such as starch and Carbopol ensuring an optimal gel structure for sustained release. The formulated hydrogels were characterized for physicochemical properties, including pH, viscosity, spreadability, drug content, and in vitro release. were conducted to assess the formulation's integrity over time. The results demonstrated that the hydrogel effectively encapsulated resveratrol, providing controlled release and improved stability. These findings suggest that hydrogel-based formulations could serve as an effective vehicle for resveratrol delivery in pharmaceutical and cosmetic applications.

**Key words:** Resveratrol, Hydrogel, Drug Delivery, Controlled Release, Biocompatible Polymers, Polyphenols.

### I. INTRODUCTION:

Hydrogels are three-dimensional cross-linked polymer network that are smart enough to respond the fluctuations of environmental stimuli (ionic strength, pH, temp, presence of enzyme, electric field etc.) and swell or shrink accordingly. In the swollen state, they are soft and rubbery, resembling the living tissue exhibiting excellent biocompatibility. Hydrogels have attracted considerable attention as excellent candidates for Bio adhesive devices, controlled release devices and targetable devices of therapeutic agents. Hydrogel-based delivery devices can be used for

oral, rectal, ocular, epidermal and subcutaneous application. Various sites that is available for the application of hydrogels for drug delivery.

Hydrogels are biodegradable in nature by utilization of this property we can form biodegradable implantable hydrogels. Used in subcutaneous delivery of anticancer drugs is being prepared viz. cross linked PHEMA which is applied to cytarabine. Drug is incorporated into hydrogels and delivers to oral cavity for local treatment of diseases of the mouth, such as stomatitis, fungal diseases, periodontal disease, viral infections, and oral cavity cancers.

Hydrogels have attracted considerable attention as excellent candidates for Bio adhesive devices, controlled release devices and targetable devices of therapeutic agents. Hydrogel-based delivery devices can be used for oral, rectal, ocular, epidermal and subcutaneous application. Various sites that is available for the application of hydrogels for drug delivery. Hydrogels can hold water and drug in them due to their cross-linked structure. Due to their water holding ability they can hold and retain wound exudates. Gelatin and sodium alginate-based hydrogels when applied have the ability to cover and protect the wound from bacterial infection.



Fig: 1 Hydro Gel

## II. PLANT PROFILE:

**Synonyms:** earthnut, goober, goober pea, monkey nut, peanut.

**Family:** Leguminaceae

**Sub family:** Fabaceae/Papilionaceae

**Biological source:** The dried seed of plant *Arachis hypogaea*.

**Geographical source:** A native of Brazil it became widely distributed throughout south America at an early date & in the sixteenth century Portuguese brought it to west Africa. Later it was introduced to China, Japan, India, Malaysia & Malagasy republic.

### 1.1 VERNACULAR NAMES:

- **Common Name:** Peanut, Monkey Nut, Earth Nut, Brazilnut.
- **Tamil:** நிலக்கடலை [Nilakkatalai]
- **Malayalam:** നിലക്കടല [Nilakkadala]
- **Telugu:** పేరుసనగ [Verusanaga]
- **Kannada:** ನೆಲಗಡಲೆ [Nelagadale]
- **Hindi:** मूंगफली [Moongaphalee]
- **Gujarati:** મગફળી [Magaphali]
- **Korean:** 땅콩 [Ttangkong]

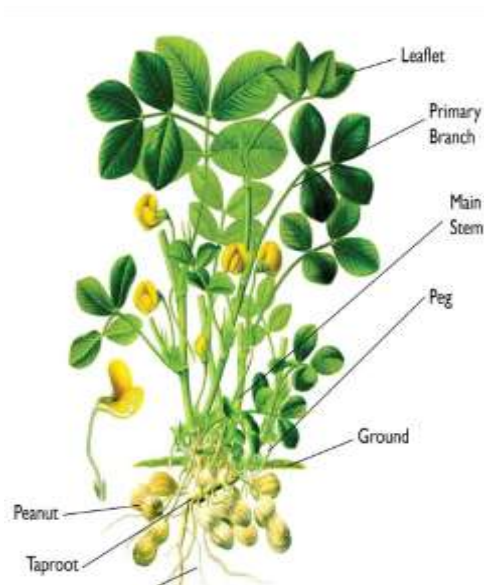


Fig: 2 *Arachis hypogaea* Plant

### 2.2 DESCRIPTION OF TRANS-RESVERATROL:

- **Drug Name:** Trans-resveratrol
- **Chemical Formula:**  $C_{14}H_{12}O_3$
- **Drug Class:** Polyphenol, Stilbene, Antioxidant
- **Source:** Naturally found in red grapes, berries, peanuts, and red wine.

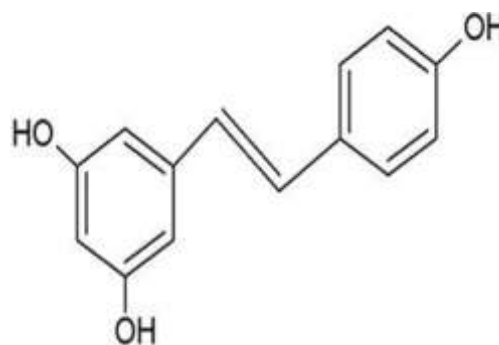


Fig: 3 Chemical Structure Of Trans-Resveratrol

### 2.3 CHEMICAL & PROPERTIES:

- **Chemical Formula:**  $C_{14}H_{12}O_3$
- **Molecular Weight:** 228.24 g/mol
- **Appearance:** colorless to pale yellow
- **Odour:** characteristic odour
- **Melting point:** 253-267 °C
- **Boiling point:** 449.1±14.0°C

### 2.4 USES:

- **Cardiovascular Protection:** May help lower blood pressure, reduce LDL oxidation, and improve endothelial function.

- **Neuroprotection:** Shows potential in preventing neurodegenerative diseases (e.g., Alzheimer's, Parkinson's).
- **Cancer Prevention:** Demonstrates anti-proliferative effects in certain cancers (breast, prostate, colorectal).
- **Anti-Aging & Longevity:** Activates sirtuins, which are linked to lifespan extension in animal models.

- **Diabetes & Metabolic Health:** May improve insulin sensitivity and reduce inflammation in metabolic disorders.

### III. MATERIALS AND METHODS: 1.2 DRUG AND EXCIPIENTS:

The main ingredients selected for the preparation of anti-cancer herbal hydrogel in the present study were as Resveratrol from *Arachis hypogaea* Linn. And Other materials like Starch, Carbopol, Borax, Glycerol, Water.

### 3.2 METHODS:

#### Separation And Purification Of Resveratrol From The Herbal Extract:

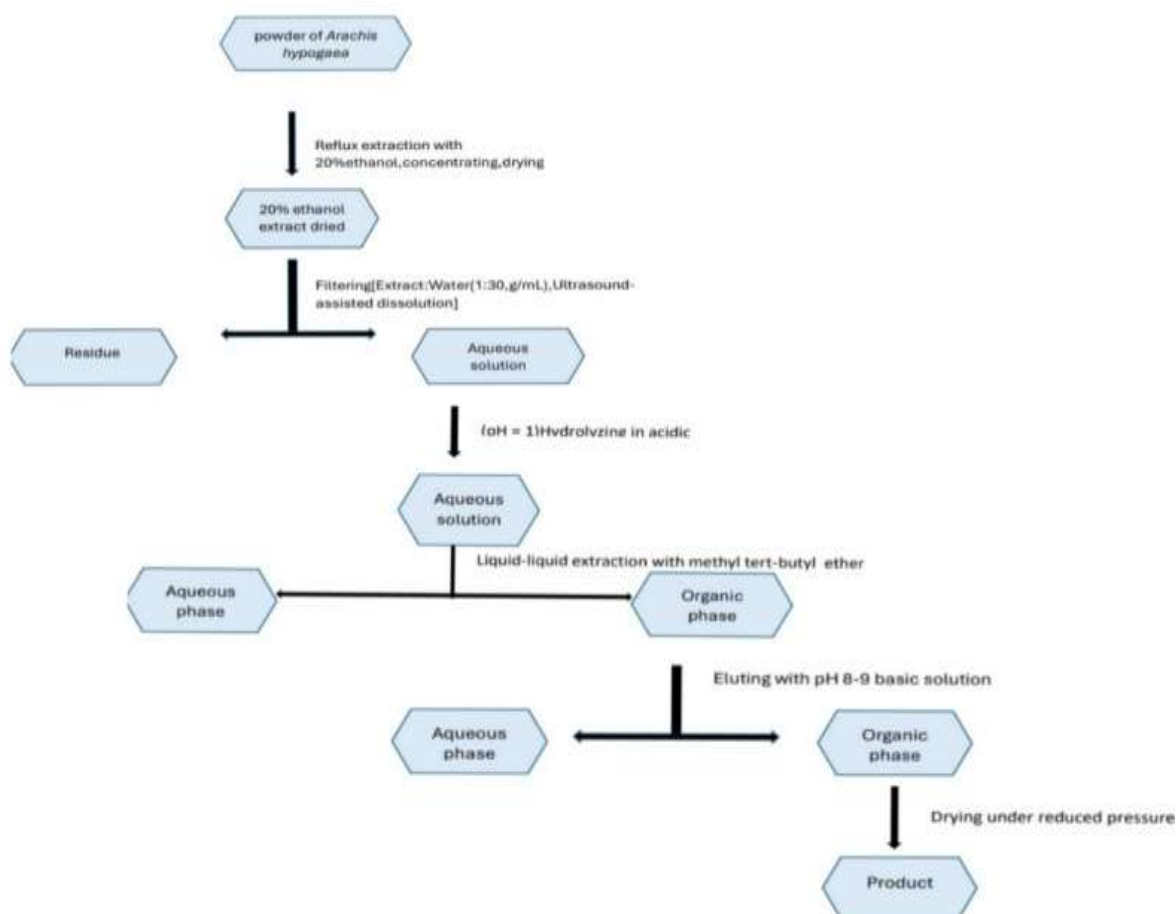


Fig: 4 Methodology

**Preparation Of Starch Solution:** Disperse 5 g of starch in 100 mL of deionized water. Heat the mixture to 70-90°C while stirring continuously until the starch is fully gelatinized and forms a clear gel.

**Incorporation Of Glycerol:** Add 1 g of glycerol to the hot starch solution. Stir thoroughly to ensure even distribution.

**Addition Of Borax:** Dissolve 0.5 g of calcium chloride in a small amount of water. Slowly add the borax solution to the starch-glycerol mixture while stirring. Continue stirring for 10-15 minutes to ensure uniform distribution.

**Incorporation Of Active Pharmaceutical Ingredient (API – Resveratrol):** Add 100mg of

API to the hydrogel mixture, stirring continuously to ensure even distribution.

**Gelation:** Pour the hydrogel mixture into moulds to create patches. Allow the mixture to polymerize

and gel at room temperature, or gently heat if needed to initiate the polymerization process fully.

**Formation Of Hydrogel Patches:** After the gel has formed, allow it to cool and solidify. Cut the gel into patches of desired size and shape.

S.NO	INGREDIENTS	RHG 1	RHG 2	RHG 3	RHG 4	RHG 5
1	Resveratrol	100 mg	100 mg	100 mg	100 mg	100 mg
2	Starch	5 g	4 g	3 g	2 g	3 g
3	Glycerol	2 ml	5 ml	7 ml	1 ml	3 ml
4	Borax	1 g	0.5 g	0.5 g	0.5 g	1 g
5	Methyl Paraben	0.1 g	0.1 g	0.1 g	0.1 g	0.1 g
6	Distilled Water	80 ml	90 ml	80 ml	50 ml	90 ml

**Table: 1 Composition Of Hydrogel**



**Fig: 5 Hydrogel Patches**

### 3.3 EVALUATION OF HYDROGEL:

Evaluating hydrogels involves assessing their properties, performance, and suitability for specific applications. This evaluation typically includes various physical, chemical, and mechanical tests. Below is an overview of the key aspects considered when evaluating hydrogels:

**3.3.1 Appearance:** The formulations' physical appearance was analyzed visually. The Hydro gel was Soft, flexible with a smooth surface. Moderately firm, as the borax concentration provides some cross-linking but not excessive stiffness. Elastic and slightly sticky, due to unreacted starch molecules retaining water.

**3.3.2 Color:** The color of the formulation was checked out against white & black backgrounds. The Hydro gel was white or translucent in color.

**3.3.3 Odor:** The odor of the hydrogel was checked by taking smell of little amount of hydrogel. The Hydro gel was mild or odorless.

**3.3.4 Determination of PH:** To determine the PH of the product, dilute the product in distilled water (1:10) then measure the PH of the dilution. The PH

of the Hydro gel was 7.0-7.4. Citric acid is used to adjust the PH of the product.

**3.3.5 Rheology:** Viscosity of hydrogels is evaluated by using Cone plate type viscometer under constant temperature at 4°C. This viscometer is highly specific for the evaluation of viscosity. The viscosity is determined by the simple equation of the angle of repose through that height and length is determined.

**3.3.6 Spreadability study:** The apparatus was made of wooden block with scale and two glass slides having a pan mounted on a pulley. Excess formulation was placed between two glass slides and 100 gm weight was placed on upper glass slide for 5 minutes to compare the formulation to achieve uniform thickness. Weight can be added and the time to separate the two slides was taken as spreadability time.

$$S = (m \times l) / t$$

Where,

- S is spreadability,
- m is weight tied on upper slide,
- l is length of glass slide and
- t is time taken in seconds

**3.3.7 Swelling Ratio:** The swelling ratio is determined by immersing the hydrogel in water or another solvent and measuring its weight before and after swelling. The ratio indicates the hydrogel's ability to absorb and retain water, which is crucial for applications like drug delivery and wound care.

**3.3.8 Tensile Strength and Elongation:** Tensile testing is used to measure the hydrogel's ability to withstand stretching forces. The tensile strength (maximum stress) and elongation at

**3.3.9 Viscoelastic Properties:** Rheological tests are conducted to measure the hydrogel's viscoelastic behavior, which includes both its elastic (solid-like) and viscous (liquid-like) responses.

**3.3.10 Gel Fraction:**

The gel fraction represents the proportion of the hydrogel that is cross-linked and does not dissolve in water. It is measured by extracting the soluble components from the hydrogel and weighing the remaining material.

$$GF (\%) = Wg / Wo \times 100$$

- Wg = weight of the dried gel after extraction (i.e., after removing soluble fractions)
- W0 = initial dry weight of the polymer before extraction

**3.3.11 Chemical Composition and Cross-Linking:** Spectroscopic techniques like Fourier-transform infrared (FTIR) spectroscopy are used to analyze the chemical structure and cross-linking density of the hydrogel.

**3.3.12 Scanning Electron Microscopy (SEM):** SEM can be used to provide information about the sample's composition, surface topography, and other properties such as electrical conductivity.

**3.3.13 In -Vitro Drug Release Study:** Since hydrogels are the swollen polymeric networks, interior of which is occupied by drug molecules, therefore, release studies are carried out to understand the mechanism of release over a period of application. The parameters are matched with the standard plot so that the equivalence between the drug solutions is carried out.

**Principle:** Resveratrol absorbs light at specific wavelengths in the UV region, mainly around **306 nm**. This allows its quantification using a UV-Visible spectrophotometer.

**Procedure:**

1. **Preparation of Standard Curve:** Prepare standard solutions of resveratrol at known concentrations (e.g., 0, 10, 20, 30, 40 µg/mL) in a suitable solvent (e.g., ethanol, methanol).
2. **Measure Absorbance:** Measure the absorbance of each standard solution at 306 nm using a UV-Vis spectrophotometer.
3. **Hydrogel Sample Preparation:** Dissolve a known amount of the resveratrol-loaded hydrogel in an appropriate solvent (e.g., methanol) and measure the absorbance at 306 nm.
4. **Quantification:** Use the standard curve to determine the concentration of resveratrol in the sample.

**IV. RESULT AND DISCUSSION:**

**1.3 PHYSICAL PROPERTIES OF HYDROGEL:**

PARAMETERS	RHG 1	RHG 2	RHG 3	RHG 4	RHG 5
<b>COLOR</b>	White Or Translucent Color	Or In Translucent In Color	White Or Translucent In Color	Translucent In Color	Translucent In Color
<b>ODOUR</b>	Odorless	Odorless	Odorless	Mild Or Odorless	Odorless
<b>pH</b>	7.1	7.3	7.2	7.1	7.4
<b>VISCOSITY</b>	6328 cP	5913cP	5631cP	4956cP	5432cP
<b>SPREADIBILITY</b>	4 Cm	2 Cm	3 Cm	5 Cm	3 Cm
<b>VISCOELASTIC</b>	Higher Elasticity Gel-Like Behavior	Liquid-Like Or Semi-Solid Behavior	Solid - Like Behavior	Higher Elasticity Gel-Like Behavior	More Gel-Like Behavior
<b>GEL FRACTION</b>	65%	31%	83%	70%	55%

**Table: 2 Physical Properties Of Hydrogel**



**Fig: 6 Prepared Hydrogel**

**4.2 SWELLING INDEX:**

To determine the swelling index weigh 1g of hydrogel and put that hydrogel into 10ml distilled

water containing Nessler's cylinder. Then weigh the hydrogel for every 1hr. The swelling index of the Hydrogel is given below:

TIME (Hr)	WEIGHT OF HYDROGEL (g)	SWELLING CALCULATION	SWELLING INDEX
0	1.000	-	0.00
1	1.350	(1.350-1.000)/1.000	0.350
2	1.500	(1.500-1.000)/1.000	0.500
3	1.520	(1.520-1.000)/1.000	0.520
4	1.530	(1.530-1.000)/1.000	0.530

**Table: 3 Swelling Index**

**4.3 MECHANICAL & ADHESION PROPERTIES:**

( **Tensile Strength** ) Tensile strength refers to the maximum stress a material can withstand while being stretched before it breaks. It is important to assess its mechanical properties of the hydrogel. The Tensile Strength of the RHG 4 hydrogel is given below:

- Width: 10 mm
- Thickness: 2 mm
- Length: 50 mm
- The maximum force measured during the tensile test is 50 N.

$$\text{Area} = \text{width} \times \text{Thickness}$$

$$= 10 \times 2 = 20 \text{ mm}^2$$

$$\text{Tensile strength} = \text{maximum force/area}$$

$$= 50\text{N}/20\text{mm}^2$$

$$= 2.5\text{N}/\text{mm}^2$$

$$= 2.5\text{MPa}$$



**Fig: 7 Tensile Strength**

**4.4 THERMAL STABILITY:**

Thermal stability (20,30- and 40-degree Celsius) of the prepared formulations was determined according to Indian standard guideline.

FORMULATION	THERMAL STABILITY
RHG 1	Stable
RHG 2	Unstable
RHG 3	Unstable
RHG 4	Stable
RHG 5	Unstable

Table: 4 Thermal Stability

4.5 SEM ANALYSIS:

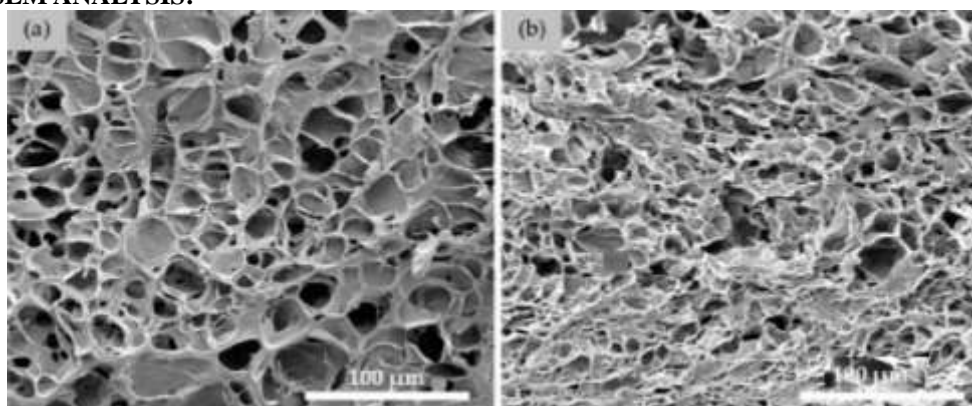


Fig: 8 SEM Analysis Of RHG 4

4.6 FT-IR SPECTRUM:

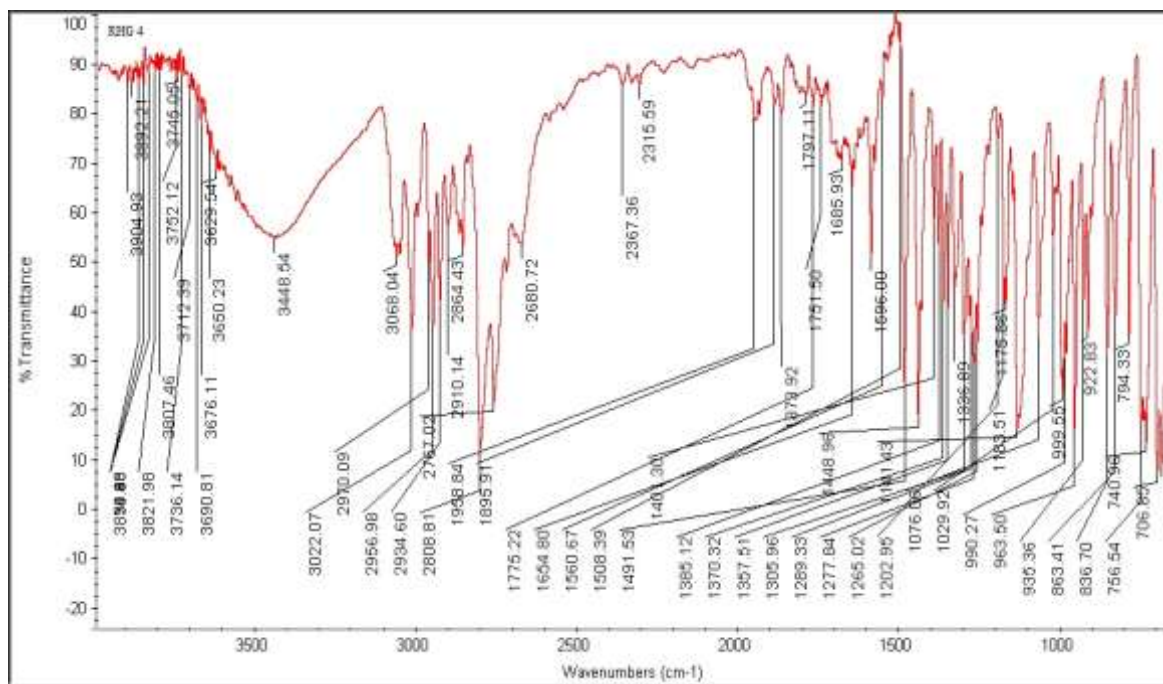


Fig: 9 FT-IR Spectrum Of RHG 4

4.7 UV-STUDIES:

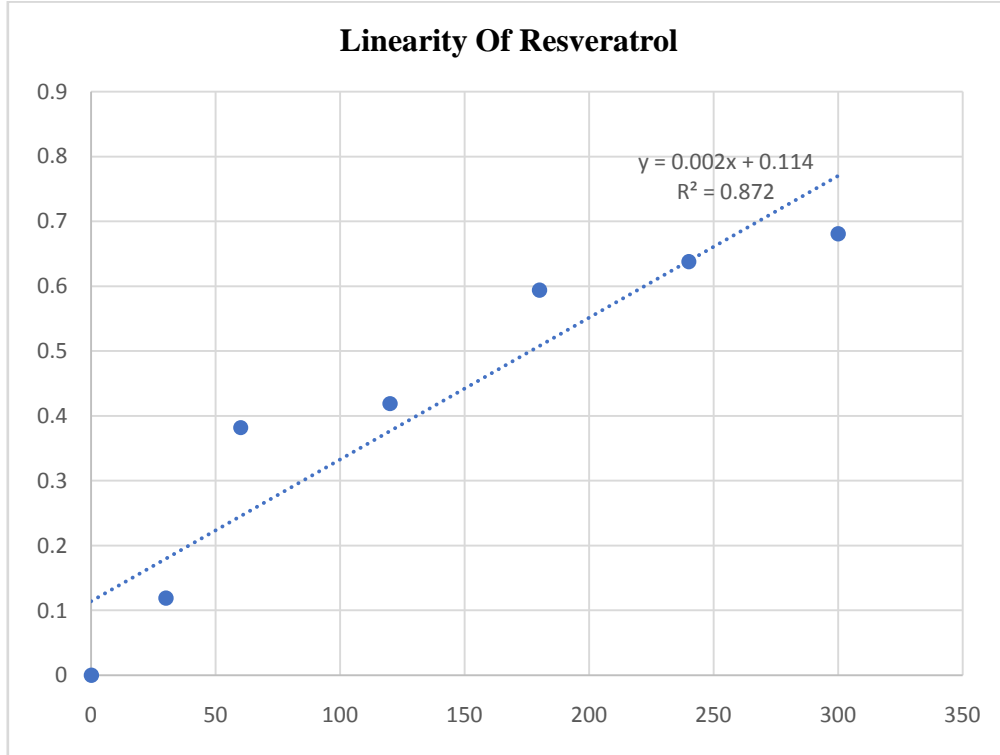


Fig: 10 Linearity Of Resveratrol

4.8 DRUG RELEASE STUDIES:

TIME (min)	ABSORBANCES	Mcg/MI	Mg/MI	PERCENTAGE OF DRUG RELEASE
0	0.00	0.00	0.00	0.00
30	0.119	1.04386	3.131579	3.131579
60	0.382	3.350877	10.05263	11.09649
120	0.419	3.675439	11.02632	15.42105
180	0.594	5.210526	15.63158	23.70175
240	0.638	5.596491	16.78947	30.07018
300	0.681	5.973684	17.92105	36.79825

Table: 5 Drug Release Studies

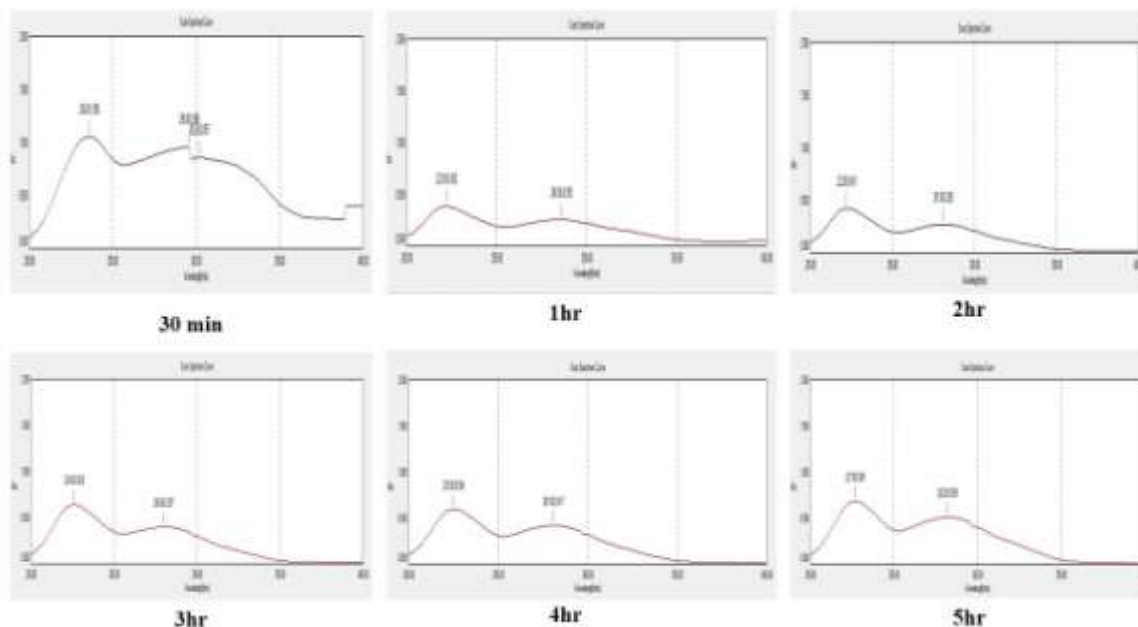


Fig: 11 Drug Absorbance

## V. CONCLUSION:

The physical properties and performance characteristics of the five hydrogel formulations (RHG 1 to RHG 5) were systematically evaluated and compared. The **viscosity** of the hydrogels varied, with RHG 1 exhibiting the highest viscosity (6328 cP) and RHG 4 the lowest (4956 cP), which influenced their spreadability, ranging from 2 cm to 5 cm. The **gel fraction** was found to be highest in RHG 3 (83%), indicating a more robust network structure, while RHG 2 had the lowest gel fraction (31%). In terms of **swelling index**, all formulations showed increased swelling over time, with RHG 4 demonstrating the highest increase by hour 4.

Mechanical properties, including **tensile strength**, were strongest in RHG 4 (2.5 MPa), showing good mechanical integrity. The **thermal stability** test revealed that RHG 1 and RHG 4 were stable across temperature variations, while RHG 2, RHG 3, and RHG 5 exhibited instability, suggesting variability in their response to temperature changes.

Further, **SEM analysis** and **FT-IR spectroscopy** confirmed the structural integrity and functional groups present in the hydrogels, supporting their suitability for drug delivery applications. The **Drug Release Studies** demonstrated a progressive and controlled release of resveratrol, with up to 36.8% drug

release after 300 minutes, indicating the potential of these hydrogels for sustained drug delivery.

Overall, the results suggest that RHG 4 exhibits the most promising characteristics in terms of viscosity, gel fraction, tensile strength, and stability, making it a potential candidate for resveratrol-based cancer treatment formulations. Further optimization of the formulations, particularly with regard to thermal stability and gel fraction, could enhance the performance of these hydrogels in clinical applications.

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