Preparation and Characterisation of Polyacrylamide Hydrogels Containing Thalassia Hemprichii

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**Abstract:** Three-dimensional, water-absorbing polymer networks called hydrogels have the ability to hold a large amount of water inside their structure.Since many hydrogels are biocompatible, they can be used in biological and medical applications such contact lenses, bandages for wounds, and drug delivery systems.Specific needs can be met by modifying the physical and chemical characteristics of hydrogels, such as their mechanical strength, capacity for swelling, and responsiveness to environmental conditions.A long-chain polymer made of connected acrylamide monomer units, polyacrylamide is a synthetic polymer. The substance acrylamide, a simple organic compound with the chemical formula CH2=CHCONH2, is repeated throughout its chemical structure.The seagrass species Thalassia hemprichii, also referred to as "turtle grass," is a member of the Hydrocharitaceae family. It is a type of marine angiosperm that can be discovered in tropical and subtropical areas of the Atlantic, Indian, and Pacific oceans. In coastal habitats, it serves a crucial ecological role. Collection of plants preparation of hydrogel material hydrogels using XRD analysis of bio activity using hydrogels samples. **​​**The primary purpose of this investigation was to develop a hydrogel that could be used for various biological purposes. For wound healing, hydrogel formulations of polyacrylamide combined with seagrass extract hydrogel films, were synthesized using this method. The production of a hydrogel film that is both cost-effective and may have potential wound-healing qualities. The hydrogels when combined with seagrass extract has been shown to have the potential for use in pharmacological and biological applications. Further research is needed to confirm these findings and to develop polyacrylamide-based hydrogels for the clinical treatment of inflammatory diseases.

# INTRODUCTION

A class of hydrophilic polymers known as hydrogels are those that have more than 10% water in their structure.[(Aparna et al., 2021; Poornima et al., 2021; Verma & Muthuswamy Pandian, 2021)](https://paperpile.com/c/K6gGYy/jkZqs+tfJ3X+BMZUJ) They are compatible with various use conditions and have a specific structure. Hydrogels are flexible and can be used for a variety of purposes, from industrial to biological, primarily because of their water content. Due to their biocompatibility and inert nature, their use in the medical profession is widely accepted. Hydrogels are used in a variety of ways in the field of dentistry as well.[(Aparna et al., 2021; Poornima et al., 2021; Verma & Muthuswamy Pandian, 2021)](https://paperpile.com/c/K6gGYy/jkZqs+tfJ3X+BMZUJ) These can be used as a more effective replacement for various dental materials .[(Haider & Haider, 2018)](https://paperpile.com/c/K6gGYy/g2vI)There are several generations of hydrogels.Cross-linking makes up the majority of the first generation, materials that can respond to stimuli make up the second generation, and stereo complex material makes up the third generation.[(Aparna et al., 2021; Poornima et al., 2021; Verma & Muthuswamy Pandian, 2021)](https://paperpile.com/c/K6gGYy/jkZqs+tfJ3X+BMZUJ) According to their source, configuration, kind of crosslinking, polymeric content, and physical appearance, hydrogels can be categorized. They can be divided into synthetic and natural hydrogels based on their origins.Natural hydrogels are mainly fibrin, collagen, hyaluronic acid, chitosan, alginate, gelatine, dextran and the synthetic hydrogels are prepared from hydroxyethyl methacrylate, polyethylene glycol acrylate/methacrylate, poly (acrylamide), polyethylene glycol diacrylate/dimethacrylate, poly (vinyl alcohol), vinyl acetate, acryolic acid, methacrylic acid, N-isopropyl acrylamide, N-Vinyl-2-pyrrolidine(3,5)[(Chen, 2019)](https://paperpile.com/c/K6gGYy/SRPx).Combination hydrogels are a third kind of hydrogels that are also offered. Hydrogels are versatile due to their structural and compatibility characteristics.Hydrocolloids are flexible, mostly because of their water content, and can be used for a variety of purposes, from industrial to biological. [(Ahmed & Ali, 2023)](https://paperpile.com/c/K6gGYy/Mglx)

3-Dimensional polymeric networks make up hydrogel. In water, hydrogels do not dissolve.They are utilized in the biomedical disciplines and mimic biotissues. Highly sensitive and hydrophilic in nature, hydrogels.They are sufficiently adaptable [(Xu et al., 2003)](https://paperpile.com/c/K6gGYy/94BT). Because of their physicochemical and biological properties, such as compositional and structural resemblances to the natural ECM, appropriate biocompatibility, high permeability to nutrients and other essential substances, and suitable framework for cells proliferation and survival, hydrogel-based scaffolds have drawn a lot of attention. Polynucleotides, polysaccharides, and polypeptides are examples of natural polymers that can be used to create natural hydrogels.For instance, chitosan is produced from the exoskeletons of shellfish, whereas collagen is sourced from mammals. Depending on how stable they are in a physiological environment, hydrogels can either be biodegradable (like most polyacrylate-based hydrogels) or long-lasting (like polysaccharide-based hydrogels). Significant improvements have been made in the process of creating the special varieties of hydrogels, or "smart hydrogels."[(“Bioactive Hydrogel-Based Scaffolds for the Regeneration of Dental Pulp Tissue,” 2021)](https://paperpile.com/c/K6gGYy/3MkH)

Due to their features that resemble solutions, hydrogels are typically thought of as a type of materials with poor mechanical strength. Traditional hydrogels' weak mechanical qualities have restricted their use. Hydrogels with enhanced mechanical properties have recently been created by researchers, including those with dual cross-linking, double networks, topological hydrogels, nanofiber composite hydrogels, ionic bonds, hydrophobic interactions, hydrogen bonds, and hydrogels with double cross-linking.[(Ho et al., 2022)](https://paperpile.com/c/K6gGYy/YEq4) Controlling the density of cross-links in the gel matrix and the hydrogels' affinity for the aqueous environment in which they are swollen make it simple to adjust their very porous structure. These swelling biomaterials become xerogels, or dried hydrogels, when the water is removed. Depending on the type of functional groups contained in their structure, these gels can be either charged or non-charged. It is known that the charged hydrogels can change shape when exposed to an electric field, and that they often display swelling changes in response to pH changes.[(Sabbagh et al., 2023; *Website*, n.d.)](https://paperpile.com/c/K6gGYy/gwin+cSQM)

In 1959, the synthetic polymer polyacrylamide, which is generated from acrylamide monomer, was first introduced for use as an electrophoresis support matrix.[(Marya et al., 2022)](https://paperpile.com/c/K6gGYy/deN2t) Later, polyacrylamide found numerous uses because to its adaptability and affordability, including microanalysis and macro-fractionation for proteins, nucleic acids, and other biomolecules. [(*Website*, n.d.)](https://paperpile.com/c/K6gGYy/cSQM) If you want to be more precise, the IUPAC terminology for it is poly (prop-2-enamide), and it is a water-soluble polymer created by the polymerization of either acrylamide monomers or N,N′-methylenebis(acrylamide).[(Sreevarun et al., 2023)](https://paperpile.com/c/K6gGYy/Mnfqz) Commercial PAM has a molecular weight (MW) that ranges from 105 to >107 Da. A larger range of applications are possible for high MW PAM (>106 Da) because of its high viscosity, ability to reduce drag, and water retention traits.[(Xiong et al., 2018)](https://paperpile.com/c/K6gGYy/PN5w)

When utilized as a supporting matrix, piezo-resistive polyacrylamide (PAAm) hydrogel has exceptional transparency, softness, flexibility, stretch-ability, and strain sensing capabilities. [(Yi et al., 2021)](https://paperpile.com/c/K6gGYy/BhxR)

T. hemprichii dominates many mixed meadows and is one of the most widely distributed seagrass species in the Indo-Pacific.[(Jiang et al., 2010)](https://paperpile.com/c/K6gGYy/8Taf)

# MATERIALS AND METHOD

## Preparation of extraction

In Tamil Nadu, India, near the Palk Bay coast (9o 44'05.99"N, 79o 01'04.10"E), Thalassia hemprichi was discovered. The numerous seagrass species were hand-collected, and any debris, sand, or epiphytes were removed by washing them in seawater. The sample was then carried to the lab in an icebox filled with slush ice. Once there, it was properly washed with tap water to remove any remaining salt from the surface. After that, the seagrass was spread out on blotting paper to absorb any further moisture. The powdered plant sample (10 g) was extracted using a Soxhlet device with 100 mL of ethanol, and the filtrates were used for further examination.The filtrates were collected using Seagrass thalassia hemprichii meadow filter paper.

## Anti-oxidant activity

### 2,2’-Azino-bis-3- ethylbenzothiazoline-6-sulfonic acid assay

The procedure used by Giao et al. to perform the 2,2'-azino-bis-3-ethylbenzothiazoline-6-sulfonic acid (ABTS) assay was used. The following equation was used to determine both the inhibitory % and the positive control used for ascorbic acid:

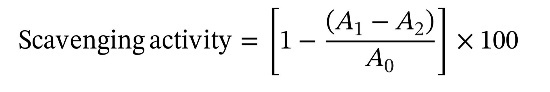
 (1)

I is defined as , where A0 is the absorbance of the control reaction and A1 is the absorbance of the sample.

## Hydroxyl scavenging activity

According to Halliwell et al.19, the hydroxyl radical scavenging assay was described. At a wavelength of 562 nm, the hydroxyl scavenging's absorbance was measured. The percentage of scavenging inhibition was estimated using vitamin C as a positive control as follows:

Where A0 is the absorbance of the control, A1 is the absorbance of the sample, and A2 is the absorbance without sodium salicylate, scavenging activity is equal to

(2)

## Fourier-transformed infrared spectrum

The interaction of the extracts was investigated and recorded using a Nicolet b6700 FTIR Fourier-transformed infrared (FTIR) spectrophotometer from Thermo Scientific. The FTIR spectra with a resolution of 4 cm-' covered the range from 4000 to 400 cm-' by employing hydrogel that contains polyacrylamide.

## x-Ray diffraction analysis

A hydrogel made of chitosan and containing thalassia hemprichii had two large peaks at approximately 30° and 40° (2θ) in its XRD pattern.Polyacrylamide’s semi-crystalline structure is characterized by these peaks. The presence of thalassia hemprichii increased the intensity of these peaks, indicating that it increased the crystallinity of the hydrogel.

## Statistical analysis

Software called Statistical Package for the Social Sciences (SPSS) 14.0 was used for the statistical analysis (SPSS Inc., Chicago, USA). Analysis of variance (ANOVA) was used to assess differences between the samples. At p 0.05, a difference was considered significant**.**

# RESULTS

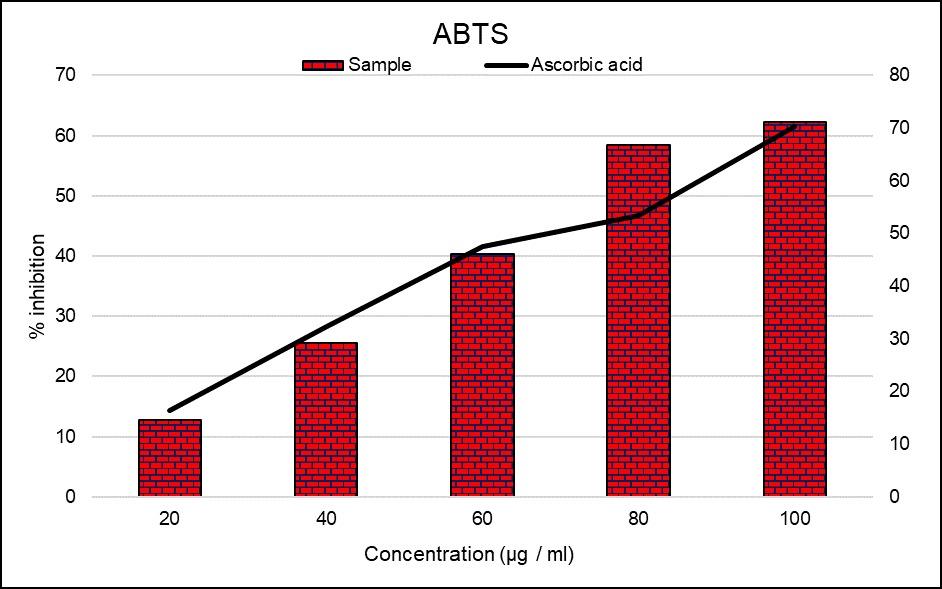


Figure 1: ABTS

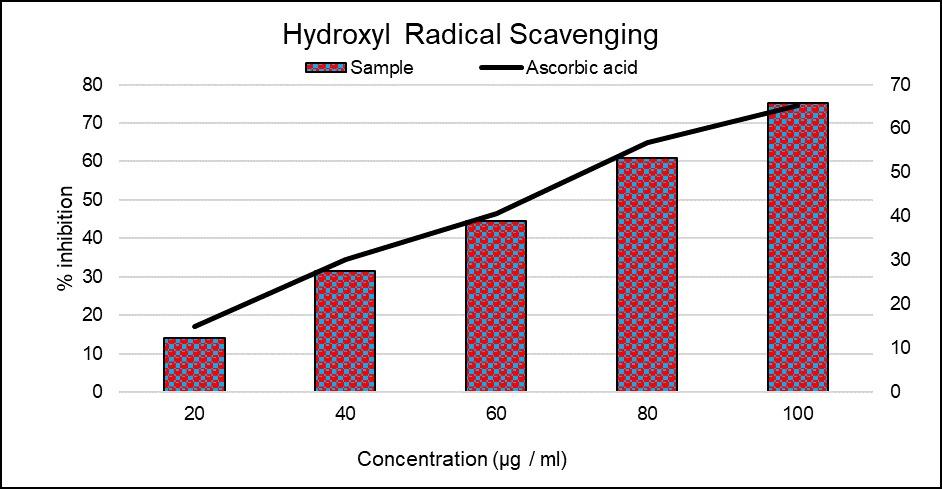


Figure 2: Hydroxyl radical scavenging

## FTIR ANALYSIS

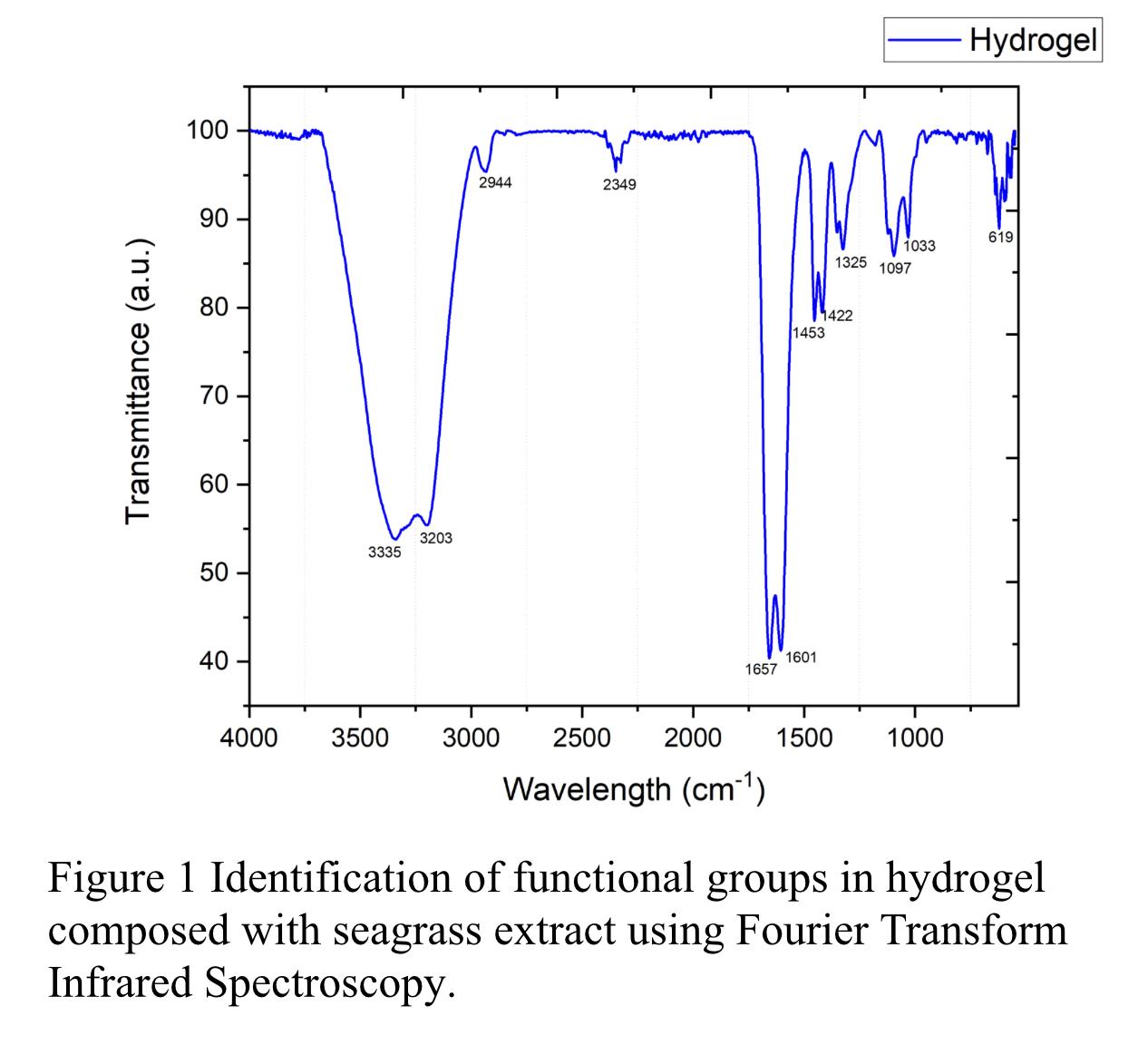


Figure 3: Identification of functional groups

Amide I Band (1650–1700 centimeters-1): The stretching vibration of the C=O bond in the amide functional group is represented by this band in the FTIR spectrum. It denotes the presence of acrylamide units (CH2=CHCONH2) in the context of polyacrylamide hydrogels. The acrylamide monomers, which are important constituents of the hydrogel's polymer matrix, frequently include the C=O bond. Information can be obtained from the Amide I band's intensity and position.

(1500–1560 cm-1) Amide II Band: The bending vibration of N-H bonds and the stretching vibration of C-N bonds in amide linkages are both represented by the Amide II band. It reflects the existence of N-H groups and C-N bonds, which are also present inherently in acrylamide units, in polyacrylamide hydrogels. This band offers details on the hydrogen-bonding interactions and conformation of the amide groups. Variations in the location and intensity of this band may point to modifications in the hydrogel's structural integrity brought on by the addition of chemicals from the Thalassia hemprichii genus.

## XRD ANALYSIS

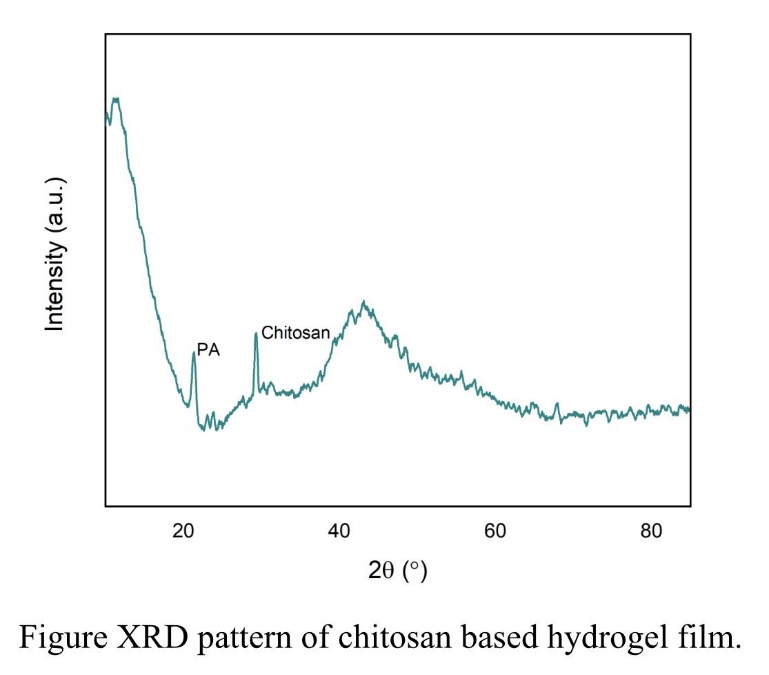


Figure 4: XDR pattern

The XRD pattern of polyacrylamide hydrogels showing broad diffraction peaks or an amorphous pattern is evidence of their non-crystalline nature.Sharp and well-defined diffraction peaks, which are typical characteristics of crystalline materials, are conspicuously absent from the XRD pattern of polyacrylamide hydrogels. Instead, broad, diffuse peaks or a pattern devoid of any features, which are indicative of an amorphous or non-crystalline structure, are seen.

# DISCUSSION

An important accomplishment is the successful inclusion of Thalassia hemprichii chemicals into polyacrylamide hydrogels.[(Subramanian & Harikrishnan, 2023)](https://paperpile.com/c/K6gGYy/Fs1bn) This was confirmed using a variety of analytical methods, such as UV-Vis spectrophotometry. The existence of these substances presents great potential for utilizing Thalassia hemprichii's distinctive bioactive characteristics in a hydrogel matrix. These substances, which are naturally present in large amounts in Thalassia hemprichii, can be used for a variety of purposes in environmental and biomedical research.[(Ganapathy, 2021)](https://paperpile.com/c/K6gGYy/oqIZs). A thorough understanding of the hydrogel's chemical make-up and structural characteristics was provided by FTIR spectroscopy.[(Chokkattu et al., 2023)](https://paperpile.com/c/K6gGYy/FulhK) Specific bands, such Amide I and Amide II, indicated acrylamide unit incorporation and revealed interactions between the hydrogel matrix and chemicals from Thalassia hemprichii(Chehelgerdi et al., 2023). These results pave the way for additional investigation into how the chemical characteristics of the hydrogel might be modified and maximized for certain uses, such as drug delivery or environmental remediation.[(Laghari et al., 2023; Ramakrishnan et al., 2023)](https://paperpile.com/c/K6gGYy/Pm93M+eqRIg).

Thalassia hemprichii-containing polyacrylamide hydrogels' production and characterization provide a window into a world of adaptable materials with enormous potential (Saadh et al., 2024). Thalassia hemprichii chemicals were successfully incorporated into the hydrogel matrix, opening the door for novel biomedical and environmental research applications. The results of the study highlight the versatility of these hydrogels and underline their ability to handle difficult problems, which is advantageous to both human health and the environment.[(Muthuswamy Pandian et al., 2022)](https://paperpile.com/c/K6gGYy/effBu) The quest to fully realize their potential is still underway, with future discoveries and inventions that may completely transform a variety of industries on the horizon.[(Muthuswamy Pandian et al., 2022; Ramakrishnan et al., 2023)](https://paperpile.com/c/K6gGYy/effBu+Pm93M)

# CONCLUSION

In summary, the creation and characterisation of polyacrylamide hydrogels containing Thalassia hemprichii mark an important step toward the creation of novel materials with a variety of possible uses. This study clarified important facets of the physical and chemical properties of Thalassia hemprichii compounds and successfully proved their inclusion into polyacrylamide hydrogels.

The Amide I and Amide II bands observed in the FTIR analysis unmistakably demonstrated the presence of acrylamide units within the hydrogels, and the XRD pattern demonstrated the non-crystalline nature of these hydrogels, which is essential for their exceptional water-absorbing abilities and versatile structural properties.

These results highlight the versatility of polyacrylamide hydrogels containing Thalassia hemprichii. These hydrogels' biocompatibility and pH-responsive qualities make them interesting candidates for use as tissue engineering scaffolds, wound dressings, and drug delivery systems in the field of biomedicine. Additionally, they can be used in the environmental field to discharge environmental cleanup materials under regulated conditions.

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