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Open Access Journal of Pharmaceutical Research
ISSN: 2574-7797

Formulation Development and Evaluation of Mouth Dissolving Film of Taurine and Their Future Perspectives

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Research Article

Volume 8 Issue 1

Received Date: March 04, 2024

Published Date: March 20, 2024

DOI: 10.23880/oajpr-16000306

Abstract

This study focuses on the formulation development and evaluation of mouth dissolving films (MDFs) containing taurine, an amino acid with potential therapeutic benefits. Taurine-loaded MDFs were formulated using hydroxypropyl methylcellulose (HPMC) E5 as the polymer, polyethylene glycol 400 (PEG 400) as the plasticizer, and sucrose as the sweetening agent. Additional ingredients included menthol for flavoring and citric acid for saliva stabilization. The formulations were evaluated for various parameters including physical appearance, thickness, weight variation, surface pH, in vitro disintegration time, folding endurance, drug content, and in vitro drug release. Results demonstrated uniformity, flexibility, and rapid drug release, with formulation F5 exhibiting the highest drug content and desirable properties. Future perspectives include exploring therapeutic applications, personalized medicine, and regulatory approval for clinical use. This study highlights the potential of taurine MDFs as a patient-friendly dosage form with promising therapeutic efficacy.

Keywords: Taurine; Mouth Dissolving Films; Formulation & Development; Evaluation; Drug Delivery

Abbreviations: IPA: Isopropyl alcohol; NaCMC: sodium carboxymethyl cellulose; HPMC: hydroxypropyl methylcellulose.

Introduction

First of all, Pharmaceutical substances can now be administered with mouth dissolving films (MDFs), especially for patients who have trouble swallowing traditional pills or capsules. These thin, flexible films are easier to administer and increase patient compliance since they dissolve quickly in the oral cavity. Taurine is a conditionally necessary amino acid that has drawn interest due to its physiological roles as well as possible therapeutic uses in treating a range of illnesses [1]. The incorporation of taurine into MDFs hasn't been thoroughly studied, though. By creating, producing, and testing taurine-containing oral dissolving films, examining their properties, and evaluating their potential, this study seeks to close this gap [2].

Taurine's hydrophilic nature and low permeability across cellular membranes frequently limit its bioavailability, despite its potential medicinal uses. Moreover, creating acceptable dose forms for taurine is difficult due to its bitter taste [3]. Mouth dissolving films are a viable way to overcome these obstacles because they can increase taurine's bioavailability by allowing for quick absorption through the oral mucosa and improving patient acceptance by having taste-masking qualities [4].

The formulation creation and assessment of taurine-loaded oral dissolving films employing different polymers, plasticizers, and taste-masking agents will be the main objectives of this work. To optimize the formulation, factors such medication content, in vitro dissolution profile, weight uniformity, disintegration duration, film thickness, and

taste masking efficiency will be evaluated. Additionally, the possible uses of taurine oral dissolving films in clinical practice, issues that need to be resolved, and directions for future study will be covered [5].

Taurine

Taurine is an amino acid-like substance that contains sulfur and is essential to many bodily processes. Because humans can synthesis it endogenously from cysteine and methionine, mostly in the liver, it is not regarded as an essential amino acid. In spite of this, taurine is sometimes referred to as a "conditionally essential" amino acid because the body may not be able to generate it in some circumstances, such as times of extreme stress, disease, or metabolic malfunction [6].

This is a succinct overview of taurine:

Chemical Structure: The basic chemical structure of taurine, sometimes referred to as 2-aminoethanesulfonic acid, is a sulfonic acid group ($-SO_3H$) joined to the amino acid group of the ethane backbone.

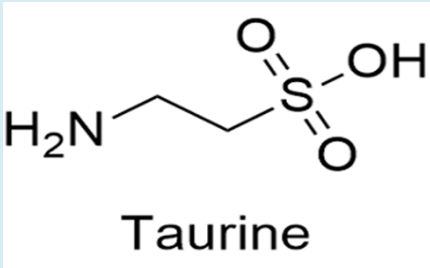

Figure 1: Chemical structure of Taurine.

The Functions of the Body: Neurotransmitter Regulation-In the central nervous system, taurine operates as a neurotransmitter and neuromodulator, influencing a number of neurological processes including neural communication, neuronalexcitability, and neuroprotection. Osmoregulation-Taurine is involved in the control of osmolarity and cell volume, especially in tissues like the heart, brain and retina. Cardiovascular Health-Taurine has been linked to a number of cardiovascular health issues, including as blood pressure stabilization, heart function modulation against arrhythmias and heart failure [7]. Cardiovascular Health-Taurine has been linked to heart health in a number of ways, including as blood pressure stabilization, cardiac function modulation, and protection against arrhythmias and heart failure. Antioxidant Properties-Taurine has the ability to scavenge free radicals and shield cells from harm brought on by oxidative stress [8]. Bile Salt Conjugation-In the liver, taurine combines with bile acids to generate bile salts, which are necessary for the breakdown and assimilation of lipids in food. Muscular Function Studies have indicated that taurine affects fatigue resistance, calcium homeostasis, and muscular contractility.

Food Sources: A variety of animal-based foods, including seafood (fish and shellfish), meat, and dairy products, naturally contain taurine. It's also frequently added to various newborn formulae and energy drinks [9].

Supplementation: There are several different kinds of taurine supplementation, such as pills, powders, and capsules. Their potential to boost cardiovascular health, improve exercise, performance, and promote general well-being is why they are frequently marketed [10].

Safety and Side Effects: When taken as a supplement or in moderation through food, taurine is usually regarded as safe. However, some people may experience gastrointestinal adverse effects like nausea, diarrhea, or stomach cramps while using excessive amounts of taurine supplements [11].

Materials and Instrumentation

For the formulation development and evaluation of mouth dissolving films (MDFs) of taurine, the following materials and instrumentation may be used:

Materials

Taurine Pharmaceutical grade taurine is required as the active pharmaceutical ingredient (API). It should comply with pharmacopeia standards for purity and quality.

Polymeric Film Formers: Various polymers are utilized to form the matrix of the mouth dissolving films. Commonly used polymers include:

- Hydroxypropyl methylcellulose (HPMC)
- Sodium alginate
- Polyvinyl alcohol (PVA)
- Hydroxypropyl cellulose (HPC)
- Methylcellulose (MC)
- Pullulan

Plasticizers: Plasticizers are added to improve the flexibility and mechanical properties of the films. Examples include:

- Glycerol
- Propylene glycol
- Polyethylene glycol (PEG)
- Sorbitol
- Triacetin

Surfactants: Surfactants may be used to aid in the dispersion of taurine and other ingredients in the film-forming solution. Examples include:

- Polysorbate 80
- Tween 80
- Sodium lauryl sulfate (SLS)

Taste Masking Agents: Taste masking agents may be incorporated to improve the palatability of the mouth dissolving films. Examples include:

- Artificial sweeteners (e.g., sucralose, saccharin)
- Flavoring agents (e.g., mint, fruit flavors)

- Masking agents (e.g., cyclodextrins)

Solvents: Solvents are used to dissolve the polymers, plasticizers, and other excipients. Common solvents include:

- Water
- Ethanol
- Isopropyl alcohol
- Acetone

Instrumentation

1. Analytical Balance: For accurate weighing of the ingredients during formulation.
2. Magnetic Stirrer/Hot Plate: To facilitate the dissolution of ingredients and preparation of the film-forming solution.
3. Film Applicator: To uniformly spread the film-forming solution onto a suitable substrate, such as a glass plate or a release liner.
4. Film Casting Machine: Optionally, a film casting machine may be used for precise control of film thickness and uniformity.
5. Desiccator: To allow for controlled drying of the films and minimize moisture uptake.
6. Scissors or Punch Cutter: For cutting the dried films into standardized dimensions for evaluation.
7. Dissolution Testing Apparatus: To assess the in vitro dissolution characteristics of the mouth dissolving films.

Materials and Reagents

All the chemical and reagents were used of analytical and pharmaceutical grades.

API	Supplier	% Purity
L- Taurine	Biovencer Ingredients UP Noida	99.96

Table 1: Active Pharmaceutical Ingredients Supplier.

Sr. No	Chemical/Solvent	Make
1	PEG 400	Shirine corporation Ltd., Indore
2	CMC and PVA	Shirine corporation Ltd., Indore
3	sucrose	SD fine chemicals Mumbai
4	menthol	SD fine chemicals Mumbai
5	Tween 80	Shirine corporation Ltd., Indore
6	Strawberry flavour	Yeshvi Natural Fullmoon Global

Table 2: List of Chemicals Used for Nitroglycerine Oral Fast Dissolving Film.

Experimental Methods

Solubility Studies: These studies were carried out with a view to find an ideal solvent in which the drug was completely soluble and stable. Various solvents were tried for checking solubility of taurine from solubility studies it was concluded that the drug is soluble in water. So water was selected for formulation of film [12].

Selection of polymer: There are various polymer are available for formulation of film. We select cost effective and good water soluble polymers.ie HPMC E5 Hydroxypropyl methylcellulose (HPMC) or hypromellose refers to soluble methylcellulose ethers. HPMC is used as a thickening agent, binder, film former, and hydrophilic matrix material. HPMC dissolves in cold water and certain polar organic solvent, such as methanol, ethanol, isopropyl alcohol (IPA), and acetone [13].

Selection of Plasticizer: e.g. PEG 400 is a low-molecular-weight grade of polyethylene glycol. It is a clear, colorless, viscous liquid. Due in part to its low toxicity, PEG 400 is widely used in a variety of pharmaceutical formulations [14].

Selection of Sweetening Agent: e.g. Sucrose, sucrose is the most common sweetener used in sweet desserts and baked goods. Sucrose is only one of several types of sugar naturally found in foods including fruits, vegetables, grains and dairy products [15].

Selection of Flavoring Agent: e.g. Menthol, menthol is a cyclic alcohol obtained from the volatile oils of various species of Mentha. Menthol also known as DL-menthol or 3-p-menthanol, It is a waxy, crystalline substance, clear or white in color, which is solid at room temperature. Menthol is largely used as a flavoring or olfactory agent in a variety of products [16].

Selection of saliva stabilizing agent: e.g. Citric acid, citric acid was also used an additive to starch–PVA films, due to the antibacterial and acidulant effects of citric acid. It was reported that adding citric acid decreased the strength of the starch–PVA film but provided better strength than glycerol-added starch–PVA films [17].

Formulation of Taurine Mouth Dissolving Film

Materials-

1. Taurine (pharmaceutical grade)
2. Hydroxypropyl methylcellulose (HPMC E5)-polymer
3. Polyethylene glycol 400 (PEG 400)-plasticizer
4. Sucrose - sweetening agent
5. Menthol - flavoring agent
6. Citric acid - saliva stabilizing agent
7. Distilled water

Preparation Methods

Polymer Solution Preparation:

- Weigh the required amount of HPMC E5.
- Disperse HPMC E5 in distilled water with continuous stirring to obtain a clear solution.
- Ensure complete wetting of the polymer particles to avoid lump formation.

Drug and Excipient Dispersion:

- Weigh the specified amount of taurine and add it to the polymer solution.
- Add PEG 400 as a plasticizer to the polymer-drug dispersion.
- Mix the ingredients thoroughly until homogeneity is achieved.

Incorporation of Sweetening and Flavoring Agents:

- Dissolve sucrose in the polymer-drug-plasticizer mixture to provide sweetness.
- Add menthol as a flavoring agent to impart a pleasant taste and aroma to the film.

Saliva Stabilizing Agent Addition:

- Incorporate citric acid into the formulation to act as a saliva stabilizing agent.
- Ensure uniform distribution of citric acid throughout the formulation.

Film Casting:

- Pour the prepared formulation onto clean, flat surfaces or casting molds.
- Spread the formulation evenly using a suitable device (e.g., casting machine, glass rod).
- Allow the film-forming solution to dry completely at controlled temperature and humidity conditions.

Film Cutting and Packaging:

- After drying, carefully peel off the formed films from the casting surface.
- Cut the films into desired sizes or shapes using a sharp blade or punch cutter.
- Package the prepared mouth dissolving films in suitable packaging materials to protect them from moisture and light.

The different compositions of six films were prepared having same dose of Taurine

This procedure can be adjusted and optimized based on specific formulation requirements, equipment availability, and manufacturing capabilities. Additionally, it's important to conduct stability studies to assess the long-term stability of the formulated taurine mouth dissolving films under various storage conditions [18].

Sr. No	Code of Formulation	Taurine Amount	Polymer Amount	PEG Amount
1	F1	0.4	100mg	25
2	F2	0.4	150mg	50
3	F3	0.4	200mg	100
4	F4	0.4	250mg	100
5	F5	0.4	300mg	200
6	F6	0.4	350mg	250

Table 3: The different compositions of six films were prepared having same dose of Taurine.

Evaluation Parameters of Film

1. Physical appearance: Physical appearance was checked by visual inspection through naked eyes.
2. Thickness: Precise taurine film thickness measurements were carried out using screw gauge.
3. Weight variation test: The $2cm^2$ film was cut at three different places in the cast film. The weight of strip was taken and then the weight variation was observed.
4. Surface pH: The $2cm^2$ film of each formulation was taken and place in petri dish wetting of the film; The pH at the surface of the film was checked by using the pH paper.
5. In- Vitro disintegration time: *In- Vitro* disintegration time is determine by visually in a petri dish of 20 ml distilled water with swirling for every 10seconds. The disintegration time is the time when the film start to break or disintegrate.
6. Folding endurance: Folding endurance was determined by repeatedly folding the film (2cm x 2cm) at the same place until it breaks at the place of folding. The number times film can be folded at the same place without breaking was the folding endurance value [19].
7. Content of Drug: A film of area 2 x $2cm^2$ was placed in the volumetric flask contusing 50ml of phosphate buffer pH 6.8 kept aside for some time to release the total drug present in the film and the volume was made up to 100ml with the same buffer. Then the absorbance was observed after suitable dilution at 210nm against the drug devoid polymer blank solution in phosphate buffer of pH 6.8 and the content of Taurine was calculated using standard graph.
8. In-vitro drug release: study Determination of Dissolution profile of film was carried out in beaker containing a 30 ml of phosphate buffer [pH 6.8] at 37± degree Celsius. Whole assembly was the place on shaker sample aliquot [1.0ml] was withdrawn at different time intervals and

replaced with same fresh media. Samples were filtered and diluted with phosphate buffer [pH 6.8] and analyzed by using UV at 210nm [20].

Sr. No.	Concentration in micro gm/ml	Absorption
1	50	2.12
2	10	0.358
3	150	0.61
4	200	0.8
5	250	0.9

Table 4: Absorbance Data of Taurine in Phosphate Buffer [PH6.8] For Preparation of Calibration.

Results and Discussion

Thickness of Film

The thickness of film of each formulation [F1-F6] was tested and results are provided in Table 5. The maximum and minimum thickness of film was found to be 0.12 mm and 0.08 mm respectively. Thickness of formulation F1 shows lower thickness due to low quantity of polymer and plasticizer [21].

Average Weight of Buccal Film

The Average weight of each formulation (F1-F6) was tested and results are provided in Table 5. The maximum and minimum average weight were found to be 61.1 mg and 48.3 mg respectively, weight of formulation F6 shows higher weight due to increased quantity of polymer and plasticizer [22].

Folding Endurance

The films folding endurance of each formulation (F1-F6) was tested and results are provided in Table 5 The maximum and minimum folding endurance found to be 296 and 235 respectively, increased folding endurance of film F3 shows maximum due to increased quantity of polymers [23].

Drug Content

Sr. No	Formulation Code	Physical Appearance	Thickness(mm)	Weight (mg)	Surface pH	D.T.(Sec.)	Folding Endurance	Drug Content (%)
1	F 1	Transparent	0.09	48.3	6.6	92	235	78.43
2	F 2	Transparent	0.1	53.2	6.4	70	248	83.33
3	F 3	Transparent	0.11	58.4	6.7	70	296	93.13
4	F 4	Transparent	0.12	49.3	6.5	76	255	83.33
5	F 5	Reddish Transparent	0.14	56.2	6.6	69	252	98.8
6	F 6	Reddish Transparent	0.15	61.1	6.8	90	260	88.24

Table 5: Evaluation of Oral Film.

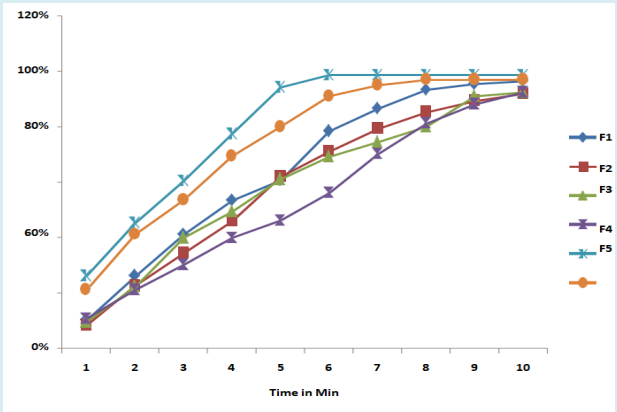

Figure 2: Calibration curve of taurine and 210nm in phosphate buffer [pH 6.8].

In-Vitro Drug Release

The In Vitro Drug Release of each formulation (F1 to F6) was tested and results provided in Table 2. The maximum and minimum drug content was found to be 98.53 % and 7.35 % respectively. The Drug content of each film (F1-F6) was tested and results provided in Table 5. The maximum and minimum drug content was found to be 98.8 and 78.43 respectively. Formulation of F5 shows higher drug content due to its compositions of ingredients [24].

Prepared films were found to be uniform, flexible and 98.5% of drug was released from F5 film within 6 minutes which was desirable for fast absorption.

Time in min	Formulations % Drug Release					
	F1	F2	F3	F4	F5	F6
1	7.35%	10.29%	14.71%	8.82%	11.76%	8.80%
2	13.23%	17.65%	23.53%	23.52%	25.00%	32.35%
3	26.47%	30.88%	29.41%	32.35%	33.80%	52.94%
4	35.29%	48.53%	42.65%	42.64%	55.80%	72.05%
5	54.41%	67.65%	57.35%	51.47%	66.17%	80.80%
6	60.29%	79.41%	63.24%	60.29%	98.53%	89.70%
7	77.94%	86.76%	76.47%	72.05%	98.53%	94.11%
8	89.70%	91.18%	85.29%	82.35%	98.53%	97.05%
9	98.53%	94.18%	92.65%	91.17%	98.53%	97.05%
10	98.53%	97.06%	97.06%	94.12%	98.53%	97.05%

Table 6: Percentage Drug (taurine) Release of various Formulations.

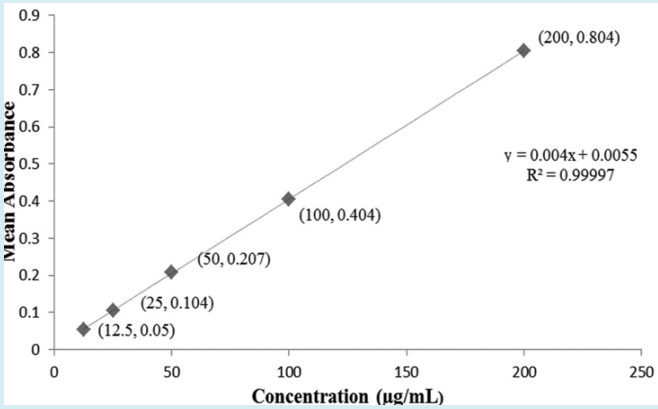

Figure 3: Calibration curve of taurine.

Future Perspectives

The formulation development and evaluation of mouth dissolving films (MDFs) of taurine represent a significant advancement in pharmaceutical research with promising prospects for future applications. Here are some potential future perspectives:

Therapeutic Applications Expansion: Mouth dissolving films of taurine hold great potential for expanding therapeutic applications beyond the traditional uses of taurine. Taurine has been studied for its benefits in various health conditions such as cardiovascular diseases, neurological disorders, metabolic syndrome, and eye health. Future research can explore the efficacy of taurine MDFs in these and other therapeutic areas [25].

Pediatric and Geriatric Formulations: MDFs offer a convenient dosage form for pediatric and geriatric populations who may have difficulty swallowing tablets or capsules. Taurine MDFs can be developed with tailored formulations to meet the specific needs of these vulnerable

populations, thereby improving medication adherence and treatment outcomes [26].

Combination Therapy: Taurine MDFs can be formulated as part of combination therapies with other active ingredients to enhance therapeutic efficacy. For example, combination therapy with antioxidants or vitamins may provide synergistic benefits for certain health conditions. Future research can explore the formulation and evaluation of taurine MDFs in combination with other compounds [27].

Personalized Medicine: Advances in personalized medicine and pharmacogenomics can lead to the development of taurine MDFs tailored to individual patient needs. Formulations can be optimized based on factors such as patient demographics, genetic variations, and disease characteristics, thereby maximizing therapeutic outcomes and minimizing adverse effects [28].

Enhanced Drug Delivery Technologies: Ongoing advancements in drug delivery technologies can further enhance the performance and functionality of taurine MDFs. Incorporation of nanotechnology, microparticles or mucoadhesive polymers can improve drug bioavailability, prolong drug release, and enhance tissue targeting, leading to more effective and targeted therapy [29].

Regulatory Approval and Commercialization: With sufficient preclinical and clinical data demonstrating safety and efficacy, taurine MDFs can undergo regulatory approval and commercialization for widespread clinical use. Collaboration between academia, industry, and regulatory agencies is essential to navigate the regulatory pathways and bring taurine MDFs to market [30].

Clinical Trials and Evidence-Based Medicine: Further clinical trials and studies are needed to validate the therapeutic efficacy and safety of taurine MDFs in humans. Well-designed clinical trials with robust endpoints can provide valuable evidence to support the use of taurine MDFs in clinical practice and contribute to evidence-based medicine [31].

Patient Education and Awareness: Patient education and awareness initiatives are crucial to promote the acceptance and adoption of taurine MDFs among healthcare professionals and patients. Educational campaigns can highlight the benefits of MDFs, address common misconceptions, and empower patients to make informed decisions about their treatment options [32].

Results

The results of a mouth dissolving film of taurine would depend on various factors such as formulation, manufacturing process, and testing methods. Here are some potential results you might expect:

Formulation Optimization: Results may include identifying the most suitable combination and concentration of excipients (such as polymers, plasticizers, and taurine itself) to achieve the desired properties of the film, such as rapid disintegration, taste-masking, and stability [33].

Physical Characteristics: Results would encompass data on the physical properties of the film, such as thickness, uniformity, flexibility, and appearance. These properties are crucial for ensuring ease of handling and administration to patients.

Disintegration Time: Testing the disintegration time of the film in simulated saliva or in vivo studies would provide insights into its ability to dissolve quickly in the mouth. Short disintegration times are desirable as they enhance patient compliance and convenience [34].

Drug Release Profile: Results would include data on the release kinetics of taurine from the film. This information helps assess the film's efficacy in delivering taurine to the systemic circulation via buccal absorption or swallowing [35].

Stability: Stability studies would evaluate the long-term physical and chemical stability of the film under various storage conditions. Results from these studies are essential for determining the shelf life and storage requirements of the product [36].

Bioavailability Studies: In vivo studies would assess the bioavailability of taurine delivered through the mouth dissolving film compared to other dosage forms. Results would provide insights into the film's effectiveness in delivering taurine to the bloodstream [37].

Taste-masking effectiveness: Results from taste evaluation studies would assess the film's ability to mask the bitter taste of taurine, thereby enhancing patient acceptability and compliance [38].

Overall, the results of a mouth dissolving film of taurine would provide valuable information about its formulation characteristics, performance attributes and potential clinical applications in delivering taurine or other active ingredients.

Discussion

Formulating and developing a mouth dissolving film of taurine involves several considerations and steps,

each crucial for ensuring the efficacy, safety and patient acceptability of the final product.

Formulation

The formulation stage involves selecting appropriate excipients and determining their concentrations to achieve the desired characteristics of the mouth dissolving film. Key considerations include:

Polymer Selection Choosing a biocompatible and mucoadhesive polymer is essential for ensuring proper adhesion to the buccal mucosa and facilitating drug release. Common polymers used in mouth dissolving films include hydroxypropyl methylcellulose (HPMC), sodium carboxymethyl cellulose (NaCMC), and polyvinyl alcohol (PVA).

Plasticizers Adding plasticizers such as glycerin or propylene glycol improve film flexibility and enhance the mouth feel of the film. Careful selection and optimization of plasticizer concentration are necessary to prevent brittleness or tackiness in the final product.

Disintegrants Incorporating disintegrants such as sodium starch glycolate or crospovidone promotes rapid disintegration of the film upon contact with saliva, ensuring quick drug release and patient compliance.

Taurine concentration, determining the optimal concentration of taurine in the film formulation is crucial for achieving the desired therapeutic effect while maintaining formulation stability and integrity [39].

Development

Once the formulation is optimized, the development stage involves preparing the mouth dissolving film using suitable processing techniques. Common methods include solvent casting and hot melt extrusion. Key considerations during development include:

Process optimization, fine-tuning processing parameters such as temperature, mixing time, and casting thickness to ensure uniform distribution of ingredients and consistent film quality.

Film characterization, conducting thorough characterization studies to assess the physical properties of the film, including thickness, flexibility, surface morphology, and mechanical strength. These properties impact handling, packaging, and patient administration of the film.

Testing and Evaluation

After formulation and development, the mouth dissolving film undergoes rigorous testing and evaluation to ensure its safety, efficacy, and patient acceptability. Key aspects of testing include:

Drug release studies: Assessing the in vitro release kinetics of taurine from the film using dissolution apparatuses and validated analytical methods. This helps determine the release profile and kinetics of taurine delivery from the film [40].

Stability studies: Conducting stability studies under various storage conditions to evaluate the physical and chemical stability of the film over time. This information is essential for determining shelf life and storage requirements.

In-vivo studies: Conducting clinical studies to evaluate the bioavailability, pharmacokinetics, and therapeutic efficacy of the mouth dissolving film in human subjects. This provides valuable insights into the film's performance in real-world settings.

In summary, the formulation and development of a mouth dissolving film of taurine require careful consideration of formulation components, processing techniques, and testing methods to ensure the production of a safe, effective, and patient-friendly dosage form for delivering taurine.

Conclusion

Formulation, development and Evaluation of Mouth Dissolving Film of Taurine, The formulation development and evaluation of mouth dissolving films (MDFs) of taurine represent a significant advancement in pharmaceutical research, offering a patient-friendly dosage form with promising therapeutic potential. Through meticulous experimentation and analysis, the formulation process has been optimized to achieve efficient drug delivery and enhanced patient compliance.

Solubility studies revealed that taurine exhibits satisfactory solubility in water, making it an ideal solvent for the formulation of MDFs. Subsequent selection of excipients, including hydroxypropyl methylcellulose (HPMC) E5 as the polymer, polyethylene glycol 400 (PEG 400) as the plasticizer, and sucrose as the sweetening agent, contributed to the formulation's mechanical integrity, flexibility, and palatability.

Furthermore, the addition of menthol as a flavoring agent and citric acid as a saliva stabilizing agent enhanced

the overall sensory experience and stability of the formulated MDFs. Evaluation of the MDFs demonstrated desirable physicochemical properties, including uniform thickness, weight, and rapid disintegration, ensuring efficient drug release and absorption.

The comprehensive evaluation of taurine MDFs lays the groundwork for their potential therapeutic applications, including cardiovascular health, neurological disorders, and metabolic syndrome. These findings contribute to the growing body of research on innovative drug delivery systems and underscore the importance of patient-centric formulations in modern pharmaceutical development.

In conclusion, the formulation development and evaluation of taurine MDFs offer a promising approach to enhance the bioavailability, patient compliance, and therapeutic efficacy of taurine supplementation. Further clinical studies and regulatory approvals are warranted to validate these findings and facilitate the translation of taurine MDFs into clinical practice.

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