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Taste Masking of a Certain Bitter Drugs

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ABSTRACT

The bitterness of pharmaceutical drugs poses a significant challenge in patient compliance, particularly in pediatric and geriatric populations. Taste masking techniques have been widely explored to enhance the palatability of bitter drugs without compromising their therapeutic efficacy. This review provides a comprehensive analysis of various taste masking strategies, including physical barriers, chemical modifications, and advanced formulation approaches. Encapsulation, ion-exchange resins, and microencapsulation techniques are extensively studied for their effectiveness in masking bitterness. Additionally, the role of polymer coatings, sweeteners, and drug-excipient interactions in improving patient acceptability is discussed. Recent advancements in nanotechnology and solid dispersion systems have introduced novel approaches for effective taste masking. This review also evaluates the impact of taste masking on drug release profiles and bioavailability. By analyzing recent studies and innovations, this paper highlights the most efficient methods for achieving optimal taste masking while ensuring drug stability and efficacy.

INTRODUCTION

The palatability of pharmaceutical formulations plays a vital role in ensuring patient compliance, particularly in pediatric and geriatric populations. Many active pharmaceutical ingredients (APIs) possess an inherently bitter taste, which often leads to patient reluctance, incomplete medication intake, and treatment failure [1]. Taste masking has therefore emerged as a crucial strategy in drug formulation, aiming to reduce or eliminate the perception of bitterness without compromising drug efficacy and bioavailability [2]. The sensation of bitterness is primarily mediated by taste receptors known as TAS2Rs (taste receptor type 2 family), which are located on the tongue [3]. These receptors detect bitter compounds, triggering an aversive response that is thought to be an evolutionary mechanism to prevent ingestion of toxic substances [2,4]. However, in the case of pharmaceutical drugs, bitterness is often a side

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effect of their chemical structure rather than an indication of toxicity. Many widely used medications, including antibiotics (e.g., azithromycin, ciprofloxacin), antihistamines (e.g., cetirizine, loratadine), and nonsteroidal anti-inflammatory drugs (NSAIDs), are reported to have undesirable taste profiles, significantly affecting patient adherence [5]. The World Health Organization (WHO) and various regulatory bodies, including the U.S. Food and Drug Administration (FDA) and the European Medicines Agency (EMA), have emphasized the importance of palatable formulations, particularly for pediatric and geriatric populations [6, 7,13]. As a result, extensive research has been conducted to develop taste-masking technologies that improve drug acceptability while maintaining therapeutic efficacy. The primary challenge in taste masking is achieving an optimal balance between effective bitterness suppression and maintaining drug stability, solubility, and bioavailability [8].

Mechanism of Taste Sensation and Bitter Taste Perception

Taste sensation is an organoleptic property that arises from the chemical stimulation of receptor cells located on taste buds. Functionally, these receptor cells are classified into two types. The first type consists of ion channel receptors, which are responsible for detecting salty and sour tastes. These receptors allow ions to enter the taste cells, generating chemical signals that are transmitted to the brain. When tastants interact with these receptors, they alter the net negative charge of the taste cells, leading to an increase in positive ion concentration. This depolarization process triggers the release of neurotransmitters, facilitating taste perception.[1,2,3,4] The second type of receptor cells consists of surface protein receptors, which detect sweet, bitter, and umami flavors through a taste transduction process. Bitter taste perception, in particular, involves the interaction of bitter compounds (tastants) with G-protein-coupled receptors (GPCRs). This interaction activates a G protein called gustducin, which subsequently stimulates the effector enzyme phosphodiesterase 1A (PDE1A).[1,4] Once activated, these effector enzymes modify intracellular levels of second messengers such as cyclic adenosine monophosphate (cAMP). This leads to the release of calcium ions from the endoplasmic reticulum and the activation of sodium, potassium, and calcium channels in the extracellular membrane. As a result, ionization occurs, depolarizing the taste cell and prompting the release of neurotransmitters. This neurotransmitter release generates a nerve impulse that travels via the ninth cranial nerve to the brain, where the taste signal is processed.[1]

The Most Important Materials Used for Taste Masking

Taste masking is an essential aspect of pharmaceutical formulation, particularly for bitter drugs, to enhance patient compliance and drug acceptability. Various materials are used to achieve taste masking, including polymers, lipids, complexing agents, sweeteners, and nanocarriers. The following are the most important materials used in taste masking:

1. Polymers for Taste Masking

Polymers are widely utilized in pharmaceutical formulations to create barrier coatings that prevent the bitter taste of active pharmaceutical ingredients (APIs) from being perceived by taste receptors [4]. Eudragit® (methacrylate copolymers) are commonly used due to their ability to form controlled-release coatings that enhance taste masking[5]. Hydroxypropyl methylcellulose (HPMC) is another widely used polymer for taste masking in orally disintegrating tablets (ODTs) and films [2]. Similarly, ethyl cellulose, a water-insoluble polymer, has been reported to provide an effective taste-masking effect by creating a physical barrier around drug particles [4].

2. Lipid-Based Taste Masking

Lipid-based carriers are effective in encapsulating bitter APIs within lipid matrices, preventing direct interaction with taste receptors and improving palatability [8]. Solid lipid nanoparticles (SLNs) have gained significant attention for their ability to sustain drug release while masking bitter taste [16]. Lipid-based microparticles have also been used to mask the taste of bitter drugs in oral suspensions and chewable tablets [17].

3. Complexing Agents

Complexation is an effective method of reducing bitterness by forming inclusion complexes between the drug and a taste-masking agent (Gupta et al., 2022) [4]. Cyclodextrins, particularly β-cyclodextrin and hydroxypropyl-β-cyclodextrin (HP-β-CD), are widely used to encapsulate bitter drugs and reduce their taste perception [4]. Additionally, ion-exchange resins (IERs) are used in taste masking as they can bind bitter drugs and prevent their release in saliva, only allowing drug release in the stomach [9].

4. Sweeteners and Flavoring Agents

Sweeteners and flavors are commonly added to pharmaceutical formulations to counteract bitterness and improve taste perception [13]. Artificial sweeteners such as aspartame, sucralose, and saccharin are widely used in chewable tablets, liquid formulations, and orally disintegrating films (ODFs) to suppress bitterness [5]. Natural sweeteners like stevia and thaumatin have gained popularity due to their natural origin and better taste profile [13]. Additionally, flavoring agents such as menthol and vanilla extract are commonly included in formulations to modify taste perception and improve patient acceptability [15].

5. Nanotechnology-Based Taste Masking

Nanotechnology has emerged as a promising approach to enhance taste masking while ensuring effective drug delivery [4,14]. Nanocrystals have been utilized to reduce drug solubility in saliva, thereby minimizing the perception of bitterness while improving drug bioavailability [14]. Liposomes are another nanotechnology-based carrier that encapsulates bitter drugs, preventing them from interacting with taste receptors [11].

Table 1 :summarizing the most important materials used for taste masking in pharmaceuticals:[1,2,3,4,5,16,23,42,43,49,52]

Category	Materials	Mechanism of Action	Examples of Applications
Polymeric Coatings	Eudragit, Cellulose derivatives (HPMC, Ethylcellulose)	Forms a barrier around the drug to prevent taste perception	Coated tablets, microparticles
Ion Exchange Resins	Amberlite, Indion	Binds to the drug and releases it gradually in the stomach	Suspensions, lozenges
Complexation Agents	Cyclodextrins (β-cyclodextrin)	Encapsulates the drug molecule, reducing taste exposure	Oral liquids, powders
Lipids and Waxes	Beeswax, Stearic acid, Lecithin	Creates a hydrophobic barrier that limits drug dissolution in saliva	Chewable tablets, granules

Sweeteners and Flavoring Agents	Aspartame, Sucralose, Menthol, Vanillin	Masks bitterness by modifying taste perception	Syrups, chewable tablets, liquid formulations
Prodrug Approach	Ester derivatives of bitter drugs	Alters drug structure to remove bitterness until metabolism	Prodrug formulations (e.g., Chloramphenicol palmitate)
Microencapsulation	Gelatin, Alginate, Chitosan	Encapsulates the drug to prevent interaction with taste buds	Microcapsules in suspensions and tablets
pH Modifiers	Citric acid, Sodium bicarbonate	Alters drug solubility and ionization in the oral cavity	Effervescent tablets, oral dispersible films
Surfactants	Poloxamers, Sodium lauryl sulfate	Reduces drug solubility in saliva, limiting taste exposure	Oral liquids, emulsions

Strategies for Taste Masking

Several techniques have been explored for taste masking in pharmaceutical formulations, each with unique advantages and limitations:

1. **Physical Barrier Methods:** This involves coating the drug particles with polymeric films, lipid layers, or microencapsulation techniques to prevent direct interaction with taste receptors [9]. Enteric coatings and spray-drying techniques have been widely used for this purpose.

2. **Complexation Techniques:** The use of ion-exchange resins, cyclodextrins, and molecular complexes helps in altering the drug's interaction with taste receptors, thereby reducing bitterness perception [10,13].

3. **Microencapsulation**: Drug particles are enclosed within microspheres, liposomes, or biodegradable polymeric carriers to minimize their interaction with taste buds, enhancing patient acceptability [11].

4. **Prodrug Approach:** Chemical modification of the API to form a tasteless or less bitter precursor, which converts into the active form after administration, is another effective strategy [12].

5. **Addition of Sweeteners and Flavor Modifiers:** Artificial sweeteners, flavoring agents, and bitterness suppressors are commonly used to improve taste perception in liquid formulations [13,16,17].

Each of these approaches has been optimized with advancements in nanotechnology, solid dispersion systems, and artificial intelligence (AI)-driven formulation design [14]. The development of electronic tongues (E-tongues), which simulate human taste perception, has further enhanced the evaluation of taste-masking effectiveness, providing a more scientific approach to formulation design [15].

Recent Developments and Future Perspectives

Recent studies have explored nanoparticle-based taste-masking systems, lipid nanoparticles, and biopolymer coatings for enhanced effectiveness [16]. Solid dispersions using hydrophilic carriers such as polyethylene glycol (PEG) and polyvinylpyrrolidone (PVP) have shown promising results in improving solubility and palatability [17,20,21]. Additionally, machine learning and AI-driven modeling have been integrated into taste-masking studies to predict bitterness and optimize formulation parameters [18]. As pharmaceutical research advances, the focus will continue to be on developing sustainable, patient-friendly, and regulatory-compliant taste-masking technologies. With the increasing use of personalized medicine, future formulations may be customized based on individual patient preferences and genetic predispositions to taste sensitivity [19].

Objective of the Study on Taste Masking

The primary objective of this study is to develop and evaluate effective taste-masking strategies for a certain bitter drug to enhance patient compliance, drug acceptability, and therapeutic efficacy. Since bitterness is a significant barrier to medication adherence, particularly among pediatric, geriatric, and special-needs patients, this study aims to explore novel pharmaceutical techniques that effectively suppress bitterness while ensuring drug stability and bioavailability [1,32,33].

The key objectives include:

1. To investigate the mechanisms of bitterness perception and its impact on patient adherence to bitter drug formulations [30].
2. To explore and compare various taste-masking techniques, including microencapsulation, nanotechnology-based carriers, complexation, and polymer coatings, to determine the most efficient approach for bitterness suppression [31].
3. To evaluate the physicochemical properties, dissolution behavior, and bioavailability of taste-masked formulations to ensure that taste masking does not compromise drug efficacy [32].
4. To develop AI-based predictive models for taste masking using machine learning algorithms and electronic tongue (E-tongue) technology, allowing accurate assessment of bitterness reduction in pharmaceutical formulations [22].
5. To optimize taste-masking formulations for patient-specific needs, particularly in pediatric and geriatric populations, by incorporating patient-centric and personalized medicine approaches [24,25].
6. To assess regulatory and safety considerations related to taste-masking excipients and formulations in accordance with FDA, EMA, and WHO guidelines [29].

This study will contribute to advancing pharmaceutical research by providing scientific insights into innovative taste-masking strategies that improve drug palatability while maintaining therapeutic effectiveness. The findings will serve as a foundation for future patient-friendly and compliance-driven drug formulations.

The Importance of Bitter Taste Masking in Pharmaceuticals

Bitter taste masking is crucial in pharmaceutical formulations, particularly for oral dosage forms, as many active pharmaceutical ingredients (APIs) have inherently bitter or unpleasant tastes that can lead to poor patient compliance. This is especially important for pediatric, geriatric, and psychiatric patients who may refuse or struggle to take bitter medications.[27,28] Effective taste masking enhances patient compliance by making medications more palatable, ensuring patients, especially children and older adults, adhere to their prescribed treatments. It also improves medication acceptance and marketability, as pharmaceutical companies develop taste-masked formulations to enhance palatability and consumer preference. Furthermore, taste masking reduces the risk of drug refusal and spitting out, which ensures the full intended dose is consumed, leading to better treatment outcomes. The development of novel drug delivery systems, such as oral disintegrating tablets (ODTs), suspensions, and chewable tablets, also relies on effective taste-masking technologies like microencapsulation, ion-exchange resins, and polymeric coatings.[32,33] Additionally, taste masking minimizes the need for excessive sweeteners or flavoring agents by employing advanced techniques like complexation with cyclodextrins or lipid-based encapsulation, which provide superior masking effects. Ultimately, bitter taste masking plays a significant role in ensuring better therapeutic outcomes by improving patient adherence, optimizing drug absorption, and enhancing overall health results. With continuous advancements in pharmaceutical technology, taste masking remains a key factor in developing patient-friendly and effective drug formulations.[34,36]

Future Studies on Taste Masking

Taste masking is a continuously evolving field in pharmaceutical sciences, with ongoing research aimed at developing more efficient, patient-friendly, and technologically advanced approaches. Future studies will likely focus on the following key areas:

1. Advanced Nanotechnology-Based Approaches

Nanotechnology has revolutionized drug delivery, and its role in taste masking is expected to grow. Future research will explore nanocarriers, such as lipid nanoparticles, polymeric micelles, and nanoemulsions, to encapsulate bitter drugs and prevent interaction with taste receptors [20,21]. These nanosystems improve drug solubility and bioavailability while providing efficient taste masking. Studies have shown that solid lipid nanoparticles (SLNs) and nanostructured lipid carriers (NLCs) can enhance drug palatability without affecting its therapeutic effect [21].

2. Artificial Intelligence and Machine Learning in Taste Masking

With the increasing role of AI and machine learning (ML) in pharmaceutical development, future studies will incorporate AI-driven models to predict bitterness intensity and optimize taste-masking strategies [22,27,28]. AI-powered electronic tongues (E-tongues) can simulate human taste perception, allowing researchers to assess the effectiveness of different taste-masking techniques in silico before actual formulation [23,24]. These technologies will reduce the time and cost of formulation development while ensuring optimal palatability.

3. Personalized Medicine and Patient-Centric Approaches

Future research will emphasize personalized medicine, where individual taste preferences and genetic factors influencing taste perception are considered in drug formulation [24]. Advances in pharmacogenomics could help design customized formulations that cater to patients with heightened sensitivity to bitterness. This will be particularly useful in pediatric and geriatric populations, where taste perception varies significantly among individuals [25].

4. Smart Oral Film and Biopolymer-Based Formulations

Oral films and biodegradable biopolymers are gaining traction in the pharmaceutical industry due to their ease of administration and taste-masking capabilities. Future studies will explore novel polymeric matrices, such as chitosan, hydroxypropyl methylcellulose (HPMC), and alginate-based films, to mask the bitterness of drugs while ensuring rapid dissolution and enhanced bioavailability [26]. Additionally, multi-layered films with separate taste-masking and drug-release layers could be developed for controlled drug delivery [27,30,31,32].

5. Hybrid Approaches Combining Multiple Taste-Masking Techniques

While current taste-masking methods rely on a single approach, future studies will investigate hybrid techniques that combine microencapsulation, molecular complexation, and sweeteners to achieve superior taste masking. Research is already exploring coating techniques that use biocompatible polymers combined with cyclodextrin inclusion complexes to improve effectiveness [28]. These multi-layered and multi-mechanism approaches are expected to provide more robust and long-lasting taste-masking effects.

6. Regulatory and Safety Considerations in Taste-Masking Technologies

As new taste-masking technologies emerge, regulatory agencies such as the FDA, EMA, and WHO will need to establish updated guidelines to ensure their safety, efficacy, and compliance [29]. Future studies will focus on conducting long-term safety evaluations of taste-masking excipients and technologies to ensure they do not interfere with drug release, absorption, or therapeutic effects.

The future of taste masking will be driven by nanotechnology, AI-driven modeling, personalized medicine, advanced polymeric materials, and hybrid techniques. As these innovative strategies evolve, they will improve patient compliance, drug acceptability, and therapeutic effectiveness. Research in this field will continue to explore new ways to mask bitterness without compromising drug stability and efficacy, ensuring better treatment outcomes for patients worldwide.

Side Effects of Taste Masking in Bitter Drug Formulations

While taste masking is essential for improving patient compliance, it may introduce certain side effects that impact drug efficacy, absorption, or patient safety. One common concern is the alteration of drug release and bioavailability. Some polymer coatings and encapsulation techniques may delay drug dissolution, affecting the intended therapeutic response [32]. Similarly, ion exchange resins used for taste masking can interact with gastrointestinal fluids, leading to unpredictable drug release rates [31]. Another issue is the potential for allergic reactions and toxicity due to excipients used in taste-masking formulations. Artificial sweeteners, flavoring agents, and polymeric coatings may trigger hypersensitivity reactions in susceptible individuals, especially in pediatric and geriatric populations [4]. For instance, sorbitol and aspartame, commonly used as sweeteners, have been reported to cause gastrointestinal discomfort or metabolic concerns in certain patients [13]. Moreover, taste-masking agents may interact with active pharmaceutical ingredients (APIs), leading to stability issues. Lipid-based carriers and cyclodextrins, while effective for masking bitterness, may alter the solubility and degradation profile of certain drugs, potentially reducing their shelf life [17]. Finally, prolonged exposure to taste-masking agents can impact taste perception over time. Studies suggest that frequent exposure to artificial sweeteners and taste-masking excipients may desensitize taste receptors, altering a patient's ability to perceive natural flavors [33]. This could be particularly problematic for pediatric patients who rely on taste perception for food acceptance and dietary habits. Thus, while taste masking enhances drug palatability, it requires careful formulation design to minimize unintended side effects while ensuring therapeutic efficacy and patient safety.

Factors Affecting Taste Masking of a Bitter Drug

Taste masking is influenced by several factors that determine the effectiveness of the approach in improving the palatability of bitter drugs. These factors include drug properties, formulation techniques, and patient-related considerations.

1. Physicochemical Properties of the Drug

- **Bitterness Threshold:** The degree of bitterness of a drug is crucial in determining the extent of masking required. Drugs with a lower bitterness threshold need more intense masking techniques [34].
- **Molecular Weight & Structure:** The molecular size and structure influence the interaction with taste receptors. Larger molecules are generally less likely to bind to bitter taste receptors, reducing bitterness perception [35].
- **Solubility:** Poorly soluble drugs are easier to mask as they dissolve slowly, limiting their interaction with taste buds. In contrast, highly soluble drugs require advanced masking techniques such as complexation or microencapsulation [36].
- **pH Dependence:** Some drugs exhibit pH-dependent solubility and taste. Adjusting the formulation's pH can reduce solubility in the oral cavity, thereby reducing bitterness perception [37,38].

2. Taste Masking Techniques

- **Encapsulation Methods:** Techniques like microencapsulation, nanocarriers, and lipid-based coatings help in preventing drug dissolution in the mouth, thus masking its taste [38].
- **Complexation:** The use of cyclodextrins or ion-exchange resins can form complexes with bitter drugs, reducing their interaction with taste receptors [39].
- **Polymer Coating:** Hydrophobic and pH-sensitive polymers can delay drug release until the formulation reaches the stomach, preventing taste perception [40].
- **Use of Sweeteners and Flavoring Agents:** Artificial or natural sweeteners, along with flavor enhancers, can help in masking bitterness effectively [41].
- **Prodrug Approach:** Modification of the drug into a prodrug that is tasteless and undergoes enzymatic conversion in the gastrointestinal tract is another effective method [42].

3. Formulation and Processing Parameters

- **Particle Size Reduction:** Nanosizing or micronization can affect drug dissolution and taste perception. Smaller particles may dissolve faster, increasing bitterness, whereas larger coated particles can reduce it [43,44,45].
- **Choice of Excipients:** Certain excipients, such as lipids, polymers, and ion-exchange resins, help in taste masking by forming stable matrices around the drug [44].
- **Processing Methods:** Techniques such as spray drying, freeze-drying, and hot-melt extrusion influence the stability and effectiveness of taste-masking formulations [45].

4. Physiological and Patient-Related Factors

- **Age and Taste Perception:** Children and elderly patients have different taste sensitivities, requiring customized taste-masking strategies [46].
- **Saliva Flow and Composition:** Variability in saliva composition among individuals affects drug dissolution and taste perception [47].

- **Psychological and Sensory Factors:** Patient expectations and past experiences influence taste perception and the acceptance of taste-masked formulations [48,50].

Marketed Drugs Utilizing Taste-Masking Technologies for Bitter Drugs

Taste masking is a crucial aspect of pharmaceutical formulation, particularly for bitter drugs, to enhance patient compliance, especially among pediatric and geriatric populations. Various techniques are employed to mask the bitterness of drugs, including the use of flavoring agents, sweeteners, polymer coatings, and altering drug solubility [49]. One notable example of a marketed product utilizing taste-masking technology is FLAVORx. FLAVORx offers a range of sugar-free, dye-free, gluten-free, and casein-free flavorings that can be added to prescription or over-the-counter liquid medications to improve their palatability [50]. These flavorings are designed to suppress bitterness and enhance the overall flavor profile of medications. The use of such flavoring systems has been shown to improve pediatric drug compliance [50]. In addition to flavoring agents, certain compounds have been identified for their bitter-masking properties. For instance, neohesperidin dihydrochalcone (NHDC), an artificial sweetener derived from citrus, is particularly effective in masking the bitter tastes of compounds found in citrus, including limonin and naringin [51]. NHDC is used in various applications, including pharmaceuticals, to improve the taste of bitter drugs [51,52]. Advancements in taste-masking technologies continue to evolve. For example, the use of bitter receptor blockers has been proposed as an approach to create acceptable products from previously unpalatable ones, thereby improving patient compliance [52]. In summary, various strategies and products are currently available in the market to address the challenge of masking the bitter taste of drugs, thereby improving patient compliance and the overall effectiveness of pharmaceutical therapies.

Latest Studies on Taste Masking of Bitter Drugs

A 2022 study investigated chitosan as a taste-masking agent, demonstrating its ability to form hydrogen bonds with nucleophilic groups of bitter compounds, thereby preventing their interaction with taste receptors and effectively masking bitterness (Mdpi, 2022).[53] Multiparticulate dosage forms have gained attention, particularly for pediatric patients. A 2024 review highlighted the challenges and solutions in taste masking of mini-tablets and granules, emphasizing the importance of selecting appropriate techniques to ensure patient adherence (Acta Pharmaceutica, 2024).[54] Another promising strategy involves bitter-blockers, which inhibit bitter taste receptors. A systematic review in 2020 explored their potential for improving the palatability of oral medications without altering pharmacological properties (ScienceDirect, 2020).[55] A comprehensive 2023 study analyzed various taste-masking technologies, including cyclodextrins, ion-exchange resins, solid dispersions, and nanoemulsions, highlighting their effectiveness in modifying the taste profiles of bitter drugs (Springer, 2023).[56] These studies reflect a continuous effort in the pharmaceutical industry to enhance taste-masking strategies, ultimately improving patient compliance and therapeutic outcomes.

CONCLUSION

Taste masking is an essential aspect of pharmaceutical formulation, ensuring better patient compliance, particularly for pediatric and geriatric populations. Various strategies, including polymeric coatings, microencapsulation, ion exchange resins, and flavoring agents, have been employed to minimize the perception of bitterness without compromising drug efficacy. Recent advancements in nanotechnology, lipid-based carriers, and molecular techniques have further enhanced taste-masking efficiency.While significant progress has been made, the challenge remains in balancing taste-masking efficiency with drug stability and bioavailability. Future research should focus on personalized medicine approaches, leveraging biotechnology and artificial intelligence to optimize formulations. By continuously improving taste-masking strategies, the pharmaceutical industry can enhance drug acceptability, ultimately improving treatment adherence and therapeutic outcomes.

REFERENCES

1. Prashant Thakker, Jigna Shah, Tejal Mehta, Gaurav Agarwal , Taste Masking of Pharmaceutical Formulations: Review on Technologies, Recent Trends and Patents.(2020).Int. J. Life Sci. Pharma Res.10(3), P88-96 http://dx.doi.org/10.22376/ijpbs/lpr.2020.10.3.P88-96
2. Ke X, Ma H, Yang J, Qiu M, Wang J, Han L and Zhang D (2022), New strategies for identifying and masking the bitter taste in traditional herbal medicines: The example of Huanglian Jiedu Decoction. Front. Pharmacol. 13:843821. doi: 10.3389/fphar.2022.843821.
3. Xu, Y.; Sun, Q.; Chen, W.; Han, Y.; Gao, Y.; Ye, J.; Wang, H.; Gao, L.; Liu, Y.; Yang, Y. The Taste-Masking Mechanism of Chitosan at the Molecular Level on Bitter Drugs of Alkaloids and Flavonoid Glycosides from Traditional Chinese Medicine. Molecules 2022, 27, 7455. https://doi.org/10.3390/molecules27217455.
4. GAdamkiewicz, L.; Szeleszczuk, Ł. Review of Applications of Cyclodextrins as Taste-Masking Excipients for Pharmaceutical Purposes. Molecules 2023, 28, 6964. https://doi.org/10.3390/molecules28196964
5. Beltrán, L.R.; Sterneder, S.; Hasural, A.; Paetz, S.; Hans, J.; Ley, J.P.; Somoza, V. Reducing the Bitter Taste of Pharmaceuticals Using Cell-Based Identification of Bitter-Masking Compounds. Pharmaceuticals 2022, 15, 317. https://doi.org/10.3390/ph15030317
6. WHO. (2021). "Improving drug acceptability for pediatric and geriatric populations." World Health Organization Guidelines.
7. FDA. (2021). "Guidance for industry: Taste assessment of oral drug products." U.S. Food and Drug Administration.
8. Wang, J., et al. (2022). "Balancing taste masking and bioavailability in drug formulation." Expert Opinion on Drug Delivery, 19(7), 1123-1137.
9. Nasr, N.E.H.; ElMeshad, A.N.; Fares, A.R. Nanocarrier Systems in Taste Masking. Sci. Pharm. 2022, 90, 20.
10. Gupta, P., et al. (2022). "Complexation and molecular approaches for taste masking in pharmaceuticals." European Journal of Pharmaceutics and Biopharmaceutics, 174, 223-238.
11. Chen, Y., et al. (2023). "Advances in liposomal drug formulations for taste masking." Nanomedicine: Nanotechnology, Biology, and Medicine, 48, 103812.
12. Haiyang Li, Xuehua Fan, Xiangxiang Wu, Yousong Yue, Chenxu Li, Xinjing Gui, Yanli Wang, Jing Yao, Junming Wang, Lu Zhang, Xuelin Li, Junhan Shi & Ruixin Liu (2023) Study on the taste-masking effect and mechanism of Acesulfame K on berberine hydrochloride, Drug Development and Industrial Pharmacy, 49:1, 92-102, DOI:10.1080/03639045.2023.2183713.

13. Kumar, S., & Agarwal, R. (2023). "Sweeteners and flavoring agents in oral drug formulations." Pharmaceutical Development and Technology, 28(4), 687-699.
14. Zhang, H., et al. (2023). "Nanotechnology in pharmaceutical taste masking: A review." Advanced Drug Delivery Reviews, 191, 114792.
15. Lee, M., et al. (2022). "Electronic tongues for bitterness assessment in pharmaceuticals." Sensors and Actuators B: Chemical, 367, 132048.
16. Maha A. Marzouk, Manal K. Darwish & Marwa A. Abd El-Fattah (2020): Development of Medicated Chewing Gum of Taste Masked Levocetirizine Dihydrochloride Using Different Gum Bases; invitro and invivo Evaluation, Drug Development and Industrial Pharmacy, DOI: 10.1080/03639045.2020.1724130.
17. Verma, A., et al. (2021). "Solid dispersion strategies for taste masking of bitter drugs." International Journal of Pharmaceutics, 599, 120452.
18. Ghosh, S., et al. (2023). "Machine learning applications in pharmaceutical formulation development." Artificial Intelligence in Medicine, 130, 102375.
19. Li, J.; Li, C.; Zhang, H.; Gao, X.; Wang, T.; Wang, Z.; Zheng, A. Preparation of Azithromycin Amorphous Solid Dispersion by Hot-Melt Extrusion: An Advantageous Technology with Taste Masking and Solubilization Effects. Polymers 2022, 14, 495. https://doi.org/10.3390/polym14030495 .
20. Singh, S., et al. (2021). "Advances in nanotechnology for taste masking of bitter drugs." International Journal of Nanomedicine, 16, 1125-1138.
21. Patel, M., et al. (2022). "Solid lipid nanoparticles for taste masking and enhanced drug delivery." Journal of Pharmaceutical Sciences, 111(3), 732-749.
22. Ghosh, P., et al. (2023). "AI and machine learning applications in pharmaceutical taste masking." Artificial Intelligence in Medicine, 135, 104628.
23. Lee, H., et al. (2022). "Electronic tongue technology for taste assessment in drug formulations." Sensors and Actuators B: Chemical, 373, 131234.
24. Karan G, Choudhury P.K, Sharma R, Sharma M, Development of Taste Masking Strategies of Few Selected Bitter Drugs, Asian Journal of Pharmaceutical Research and Development. 2025; 13(1): 259-264-, DOI: http://dx.doi.org/10.22270/ajprd.v13i1.1525.
25. Verma, R., et al. (2021). "Patient-centric drug design: Enhancing compliance in pediatric and geriatric populations." Pharmaceutical Development and Technology, 26(4), 548-560.
26. Kumar, V., et al. (2022). "Advancements in oral film formulations for taste masking." Journal of Drug Delivery Science and Technology, 67, 103852.
27. Zhang, H., et al. (2023). "Multi-layered oral films for taste-masked drug delivery." Advanced Drug Delivery Reviews, 195, 115038.
28. Gupta, S., et al. (2022). "Hybrid approaches for taste masking: Combining polymer coatings and molecular complexes." European Journal of Pharmaceutics and Biopharmaceutics, 176, 321-334.
29. FDA. (2023). "Regulatory considerations for taste-masking technologies in pharmaceuticals." U.S. Food and Drug Administration Guidelines.
30. Alyami, H.S.; Ali, D.K.; Jarrar, Q.; Jaradat, A.; Aburass, H.; Mohammed, A.A.; Alyami, M.H.; Aodah, A.H.; Dahmash, E.Z. Taste Masking of Promethazine Hydrochloride

Using L-Arginine Polyamide-Based Nanocapsules. Molecules 2023, 28, 748. https://doi.org/10.3390/molecules28020748.
31. Patel, N., et al. (2023). "Taste masking of bitter drugs: A pharmaceutical perspective." Current Pharmaceutical Design, 29(1), 45-61.
32. Wang, J., et al. (2022). "Balancing taste masking and bioavailability in drug formulation." Expert Opinion on Drug Delivery, 19(7), 1123-1137.
33. Reddy, K., et al. (2022). "The long-term impact of artificial sweeteners on taste perception." Food Chemistry, 384, 132456.
34. K. L. Drewnowski, "Sensory and Receptor Mechanisms of Bitter Taste," Journal of Pharmaceutical Sciences, vol. 110, no. 3, pp. 1012–1025, 2021.
35. R. Patel et al., "Molecular Interactions of Bitter Drugs with Taste Receptors: Implications for Taste Masking," International Journal of Pharmaceutics, vol. 608, p. 120985, 2022.
36. H. M. Ahmed and T. Y. Kim, "Advances in Solubility Modulation for Improved Oral Palatability," Pharmaceutical Research, vol. 39, no. 8, pp. 1634–1648, 2023.
37. J. L. Chen et al., "pH-Dependent Solubility and Its Role in Oral Drug Delivery," European Journal of Pharmaceutics and Biopharmaceutics, vol. 178, pp. 51–62, 2022.
38. A. Bose et al., "Encapsulation Strategies for Taste Masking of Bitter Drugs," Drug Development and Industrial Pharmacy, vol. 48, no. 4, pp. 615–627, 2022.
39. S. R. Banerjee, "Cyclodextrin-Based Complexation for Bitter Drug Masking," Current Pharmaceutical Design, vol. 29, no. 6, pp. 1052–1064, 2023.
40. L. S. Wang et al., "Polymeric Coatings for Oral Taste Masking: Advances and Applications," Advanced Drug Delivery Reviews, vol. 182, p. 114113, 2022.
41. B. G. Martinez and R. C. Silva, "Flavor Masking Techniques in Pediatric Drug Formulations," Expert Opinion on Drug Delivery, vol. 19, no. 10, pp. 1253–1267, 2023.
42. D. K. Thakur et al., "Prodrug Strategies for Bitter Taste Masking: Recent Advances," Biomedicine & Pharmacotherapy, vol. 148, p. 112736, 2022.
43. J. P. Singh et al., "Impact of Particle Size on Drug Palatability and Oral Bioavailability," Journal of Drug Delivery Science and Technology, vol. 78, p. 103785, 2023.
44. K. V. Rao et al., "Role of Excipients in Taste Masking of Oral Formulations," Pharmaceutical Sciences & Research, vol. 14, no. 2, pp. 287–301, 2022.
45. A. S. Mehta and P. J. Sharma, "Spray Drying and Freeze-Drying for Taste-Masked Drug Formulations," Current Drug Delivery, vol. 20, no. 1, pp. 47–59, 2023.
46. P. F. Zhang et al., "Age-Related Changes in Taste Perception and Implications for Drug Palatability," Frontiers in Pharmacology, vol. 14, p. 1145879, 2023.
47. M. T. Roberts and Y. L. Chang, "Effect of Salivary Enzymes on Oral Drug Dissolution and Taste," Journal of Clinical Pharmacy and Therapeutics, vol. 48, no. 2, pp. 315–328, 2022.
48. N. K. Gupta et al., "Psychological and Sensory Influences on Drug Taste Perception," International Journal of Pharmaceutics: X, vol. 5, p. 100116, 2022.
49. ScienceDirect. "Taste Masking in Pharmaceuticals: Approaches and Techniques." Available at: https://www.sciencedirect.com/science/article/pii/S0939641120303179.
50. FLAVORx. "Custom Medication Flavoring." Available at: https://www.flavorx.com.

51. Wikipedia. "Neohesperidin Dihydrochalcone." Available at: https://en.wikipedia.org/wiki/Neohesperidin_dihydrochalcone.
52. ScienceDirect. "Bitter Receptor Blockers for Taste Masking." Available at: https://www.sciencedirect.com/science/article/pii/S0939641120303179.
53. Mdpi. (2022). Chitosan as a Taste-Masking Agent. Retrieved from https://www.mdpi.com/1420-3049/27/21/7455
54. Acta Pharmaceutica. (2024). Multiparticulate Dosage Forms for Taste Masking. Retrieved from https://acta.pharmaceutica.farmaceut.org/wp-content/uploads/2024/05/17724.pdf
55. ScienceDirect. (2020). Bitter-Blockers as Taste-Masking Agents. Retrieved from https://www.sciencedirect.com/science/article/pii/S0939641120303179
56. Springer. (2023). Comprehensive Overview of Taste-Masking Technologies. Retrieved from https://link.springer.com/article/10.1208/s12249-023-02520-z.

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