An Overview of Taste Masking Techniques and Recent Trends in the Pharmaceutical and Nutraceutical Industry

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Abstract

Over 70% of India's population is shifting towards traditional treatment approach, making herbal medicines a significant component of the nation's legally acknowledged healthcare systems. These formulations, derived from phytoconstituents present in various plant parts, such as leaves, roots, flowers, and seeds are available in different dosage forms, including tablets, capsules, teas, extracts, and powders. Given the growing popularity of natural remedies, enhancing the palatability of these products becomes increasingly important to ensure patient compliance and therapeutic efficacy. One of the biggest challenges in herbal and nutraceutical formulations are their unpleasant taste thereby significantly affects the consumers acceptance due to heightened sensitivity, particularly in paediatrics and geriatrics. To overcome this, the field of taste masking has therefore gained considerable attention, with innovations aimed at improving patient experience. Recent advancements focus on modifying taste perception, creating physical barriers to prevent taste receptor activation, and altering drug solubility profiles. This review provides a comprehensive overview of conventional and emerging taste masking approaches used in the pharmaceutical and nutraceutical sectors, with a focus on recent trends, technologies, and patent literature relevant to the masking of bitterness in herbal and bioactive formulations.

Keywords Taste masking, Nutraceuticals, Herbal formulation, Drug solubility, Patents

Introduction

The palatability of oral dosage form is one of the most important determinants of patient compliance, but sometimes the undesirable organoleptic properties (unpleasant taste/odour) of many herbal and synthetic drugs severely affect their therapeutic efficacy, particularly in paediatrics and geriatrics [1-3]. Herbal medicine, the backbone of traditional healthcare systems, with approximately 70% of Indian population relying on Ayurveda, Unani etc for their treatments. Although the plant-based formulations are effective in addressing a variety of ailments, their unpleasant taste or bitterness mainly due to the presence of polyphenolics, terpenoids, alkaloids, and amino acids in their bioactive compounds, limits their acceptance [4,5]. This is best seen in traditional Chinese medicines (TCMs) which often consist of multiple bitter components, posing significant challenges during formulation. Similarly, modern synthetic drugs, including antibiotics or antihistamines often have unpalatable tastes that require masking [6]. In synthetic drugs, the poor taste is often associated with the

physiochemical properties of active pharmaceutical ingredients (API), non-steroidal anti-inflammatory drugs [7].

These drawbacks upon lead to poor patient compliance and ultimately treatment failure. To overcome the shortcomings associated with the taste there is an utmost need to mask the undesirable taste without altering the pharmacological activities of the herbal drugs. In this regard, the taste masking technology forms an integral part of pharmaceutical and nutraceutical formulation development, especially for active substances with inherently unpleasant or bitter flavours.The primary objective of taste masking is to enhance the palatability of drugs, particularly those with bitter and unpleasant flavours. An effective taste masking has therefore become essential to ensure both the acceptability and accuracy of oral drug delivery. A bitter-tasting drug could be spit out or not fully ingested, leading to a reduced effect of the drug or poor dose accuracy. Therefore, the effective masking techniques could ensure that the patient receives the full therapeutic benefit of the medication. It may also concern the pharmacokinetic profile of the drug, especially the release rate and bioavailability [8,1].

The process of taste masking works on the principle of inhibiting the stimulation of the taste receptors in the mouth, especially the bitter taste receptors (TAS2Rs) present on the tongue's taste buds. When a drug is dissolved in saliva, drug molecules are free and bind to these receptors, producing a chain of cellular events that generate nerve impulses propagated via gustatory neurons to the brain, giving rise to bitterness or other distasteful tastes. Masking of the taste inhibits or diminishes this process by reducing the availability of the drug in saliva or by modifying its molecular interaction with the receptor sites (Fig. 1). The release of a drug is often diffusion-controlled and depends on the solubility of the drug in the gastrointestinal tract, which in turn depends on the interaction of the drug with saliva and the taste receptors. Therefore, taste masking not only could make the formulation sensorially more attractive, but it could also optimize the release of the drug to ensure that it goes to the target as soon as possible in the appropriate dose [7].

This comprehensive review provides a brief overview of taste masking technologies used for herbal as well as synthetic drugs with a focus on the challenges faced and highlights the recent trends and patents, offering a concise resource for improving palatability, compliance, and therapeutic efficacy in oral dosage forms.

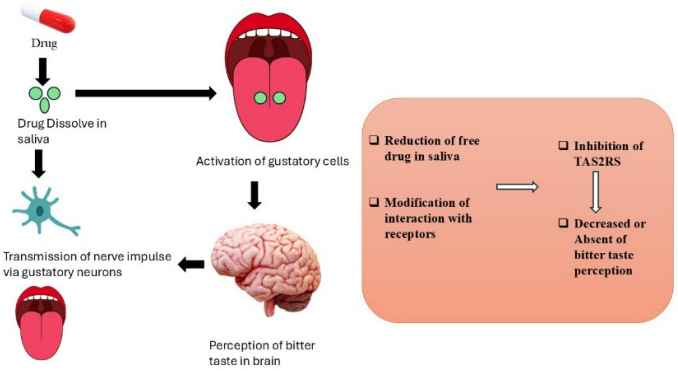


Fig. 1: Mechanism of Taste Masking

Technologies Used for Taste Masking

Many technologies have emerged over the years to conceal the unpleasant taste of herbal and synthetic drugs. These mechanisms mainly fall under broad categories of physical, chemical, and biotechnology techniques (Fig. 2). Every technology seeks either to minimize or prevent the association of the drug with the receptors of taste or to form a barrier that impedes the discharge of bad flavours upon oral consumption of the drug [9].

Coating

Coating one of the most common practices in taste masking where drugs are coated with compounds that prevent the release of the drug in the oral cavity [10]. Polymeric coatings, including ethylcellulose (EC), hydroxypropyl methylcellulose (HPMC), and polyvinyl alcohol (PVA), are widely used as coating material. These coatings are dissolved at certain locations in the gastrointestinal (GI) tract and ensures that the drug is released only after it has passed the taste-sensitive regions of the oral cavity. [11,12].The unpleasant taste of an antihistaminic agent, triprolidine HCl, can be masked with a dispersion coating of hydroxypropyl methylcellulose, a plasticizing agent, a sweetener, and a flavouring agent [9].

A study conducted on solvent free dry coating showed that tannic acid, coated with glycerol monostearate and amino methacrylate copolymer via dry melt mixing displayed delayed dissolution and reduced astringency. This approach was effective and makes a promising taste masking approach [9] [13].

Another study evaluated the use of Eudragit E coatings on dimenhydrinate granules for masking and observed that when the polymer thickness was increased it enhanced the taste and delayed the drug release [10] [14].

Core elements of drugs coated with a water-insoluble polymer such as ethyl cellulose offer taste masking and reduced dissolution profiles for a variety of drugs, including paracetamol, ranitidine HCl, doxycycline HCl, pseudoephedrine HCl, sodium naproxen, theophylline, and aspirin [15].Examples of different coating technologies and polymers are summarized in Table 1.

Table 1: Examples of drugs with polymer-based coating technologies used for taste masking, their applications

Drug Name	Coating Technology / Polymer Used	Application	References
Ibuprofen	HPMC + EC	Hydrophilic polymer coatings to mask bitterness in oral tablets	[16]
Raltegravir	Aqueous EC dispersion + Hypromellose (HPMC)	Barrier membrane coating to mask intense bitterness; immediate release in stomach	[17]
Gatifloxacin	Multilayer coating with EC and hydroxypropyl cellulose	Taste-masked granules for chewable dosage forms	[18]

Dextromethorphan	Multilayer polymer coating	Taste-masked granules for improved palatability	[19]
Erythromycin	Coating with cellulose derivatives + viscosity enhancers	Taste masking in suspensions to maintain stability and mask bitterness	[20]

Microencapsulation

Microencapsulation is the encapsulation of a drug within a tiny biocompatible material shell. It successfully masks the taste by entrapment of the drug in lipid-based, polysaccharide-based, or protein-based polymers. When the microcapsule is inside the stomach or intestine, there is controlled drug release [21]. This technique can be achieved using spray dying, air suspension, solvent evaporation methods [10].

To mask the bitter taste of drug-Enoxacin (ENX), a novel microencapsulation process combined with the wet spherical agglomeration (WSA) technique was developed by using a modified phase separation method. The spherical agglomerates of ENX with various additives including disintegrants were successfully produced in the system of acetone-n-hexane-ammonia water or acetone-n-hexane-distilled water by the WSA, using flocculation phenomena of particles in liquid. Resultant agglomerates were microencapsulated continuously with Eudragit RS utilizing the phase separation method in the same system as agglomeration under stirring. 'Explosible' microcapsules completely masked from the bitter taste were produced in formulating finer particle size of ENX and 50 per cent of Primojel in core agglomerates, using distilled water as a bridging liquid, and treating with 20 per cent polymer coating level [22].

Bitter taste of Levofloxacin wasmasked by microparticles prepared using the emulsion solvent evaporation technique with polymers such as ethyl cellulose and Eudragit L100. This method produced microspheres that significantly concealed the bitter taste, improving palatability and patient compliance [23]. Examples of different microencapsulation technologies and polymers are summarized in Table 2.

Table 2. Examples of microencapsulation-based techniques used for taste masking

Drug Name	Microencapsulation Approach/Polymer Used	References
Ofloxacin	Eudragit-based microspheres	[24]
Ciprofloxacin	Polymeric microcapsules (various polymers)	[25]
Acetaminophen	Coacervation-phase separation	[26]
Chlorpheniramine	Microencapsulation with polymeric membranes	[27]
Clarithromycin	Hot-melt extrusion	[28]

	microencapsulation	

Complexation

Another approach utilized in taste masking involves the use of complexing agents that chelate the drug molecule and encapsulate into a complex, thereby lessening its solubility or inhibiting it from binding to taste receptors. Cyclodextrins, the cyclic oligosaccharides obtained from starch are largely utilized as a masking agents. The molecules can enclose hydrophobic drugs, essentially conceal their taste and enhance their stability. The technique has been utilized in synthetic and natural herbal medicines for palatability improvement [29].

In a study, the bitter taste of Famotidine was effectively masked using a ternary complexation technique that involved the drug, β-cyclodextrin, and HPMC [30,31]. Similarly, Ciprofloxacin, a commonly used antibiotic, has been taste-masked through inclusion complex formation with cyclodextrins [32]. Cetirizine, Chlorpheniramine, and Loratadine, widely used antihistamines, have also been successfully complexed with β-cyclodextrin to mask their bitter taste [32].

Flavouring Agents

Taste masking through the addition of sweeteners and flavouring agents is the simplest and widely adopted masking process. They may mask unpleasant taste by providing a stronger, more appealing sensory stimulus. Artificial sweetener such as sucralose and aspartame or natural sweetener like stevia are commonly added to the products for their ability to improve taste without altering the therapeutic effect of the drug. Fruit, herb and spice based flavouring agents are also frequently employed in herbal medicines products [9].This method involves blending the APIs with sugars, artificial sweeteners, or natural flavours to improve palatability and ensure better patient compliance.Acetaminophen (Paracetamol), a commonly used antipyretic and analgesic, is frequently formulated as syrups or suspensions containing sucrose, aspartame, or saccharin along with flavouring agents such as cherry, orange, or grape to effectively mask its inherent bitterness. Similarly, cough syrups containing Dextromethorphan are typically masked with strong flavours like menthol, cherry, or orange, in combination with high-intensity sweeteners [9].

Other drugs have also been successfully formulated using a combination of sweeteners and flavouring agents or through complexation with cyclodextrins and the incorporation of essential oils. For example, Metronidazole has been taste-masked using cyclodextrin complexes along with mint or lemon essential oils, while Ciprofloxacin formulations have employed fruit flavours in combination with cyclodextrins to improve taste acceptability [24]. Chlorpheniramine is commonly combined with simple syrup and fruit flavours, and Prednisolone formulations often utilize mannitol, sorbitol, and fruit-based flavouring agents to enhance palatability [24]. Azithromycin is generally taste-masked using a blend of sweeteners and general flavorants [33].

Spray-drying

Spray drying is another popular method employed for taste masking. It involves dissolving the medication in a solvent, which is subsequently sprayed into a hot room where the solvent is evaporated, and the resulting fine powder of the active material left over. This powder can be used in tablet, capsule, or liquid form. The process

can be altered to mask the taste through the utilization of appropriate excipients, such as gums and resins which reduce bitterness as well as other undesired flavours [34].Ondansetron hydrochloride (intensely bitter)- To mask the taste polymers like Chitosan, Methocel E15 LV, Eudragit E100 were used, the drug was combined with each polymer in different ratios and spray dried to form microspheres [35].

Acetaminophen: Spray drying with Eudragit E-PO or EC as the polymer has been shown to produce taste-neutral powders suitable for chewable or fast-dissolving tablets [36].

Table 3: Pharmaceutical drugs and the taste-masking materials or techniques employed for improving palatability

Drug Name	Taste-Masking Material(s) Used	References
Ondansetron Hydrochloride	Chitosan, Methocel E15 LV, Eudragit E100	[35]
Famotidine	Mannitol (core), Eudragit EPO (coating)	[30]
Sumatriptan Succinate	Not specified (spray drying technique)	[30]
Paracetamol	Colloidal silica, EC	[30]
Ibufropen	Povidone, gelatin, methylcellulose, EC (general masking agents)	[30]

Organoleptic Methods:

These involve the use of trained panels to assess taste and include the addition of effervescent substances or bitterness blockers to disguise unpleasant flavours. Organoleptic methods are often used in combination with other techniques to ensure that the final product is both effective and palatable [37].Pioglitazone Hydrochloride ODTs: Sodium chloride was added to mask bitterness in orally disintegrating tablets of pioglitazone hydrochloride, demonstrating the use of simple organoleptic agents for taste masking [38].

Ion exchange resins

Resins are high molecular weight polymers containing either anionic or cationic functional group. For complexation the resin used is based on the drug's nature. If the drug is anionic then it will combine with cationic resins and vice versa. When taken orally, the resin releases the bound drug by exchanging it with counter ions present in the stomach, enabling the active ingredient to be released and observed. In taste-masking uses, the resin is designed to block release at oral cavity pH, thus inhibiting interaction with taste buds, while allowing for normal release in the stomach and intestine. In this process, the drug is suspended in a solvent which dissolves the drug. When the drug is complexed with the resin, the drug–resin complex is called a resinate. The physical separation of the drug from taste receptors is achieved by this complex, thus hiding unpleasant tastes during its administration. Some of the common ion-exchange resins are Dowex-50 (strong cation exchange resin) and Amberlite IRc-50 (weak cation exchange resin) [10]. In a study, Dowex-50 resin was prepared to taste mask nizatidine and it was observed that 1:5 drug ratio this complex released 4.3% of drug in the oral cavity pH within 5 minutes, in contrast 99.7% was released at stomach pH within 60 minutes [39].

Solid dispersion

Solid dispersion method involves the dispersion of one or more active agent in an inert carrier or matrix in the solid state, which is made up by fusion or by evaporation of the solvent. Typical carriers are povidone, polyethylene glycol (different grades), HPMC, urea, mannitol, and ethyl cellulose. Their preparation techniques involve [40]:

Melting solvent method: Molten polyethylene glycol (≈70 °C) is added to drug solution without the removal of solvent.

Melting method: Here the drugs and carriers are melted together by heating followed by rapid solidifying and cooling, and the final solid is pulverized.

Solvent method: Carrier and drug are dissolved in a common solvent, and then solvent is evaporated with recovery of the solid dispersion.

Granulation

Granulation is a cost effective, easy and rapid procedure to mask the bitterness of the drug by lowering the drugs surface area that interacts with the taste buds. Liquids and low melting point waxes such as glycerol palmitostearate, glyceryl behenate and hydrogenated castor oil are widely used as a masking agent [10].

Prodrug approach

Prodrug approach is a drug design strategy where the drug is taken in an inactive form, and it get activated inside the body through metabolic process such as ester hydrolysis. This approach helps in reducing the bitterness of the drug and adjust solubility. Depending on the drugs intended application their solubility can either be increased or decreased. The marketed product in 2015 CRESEMBA (isavuconazoniumsulfate) was the prodrug of isavuconazole, an azole antifungal drug is used for the treatment of invasive aspergillosis and invasive mucormycosis [41].

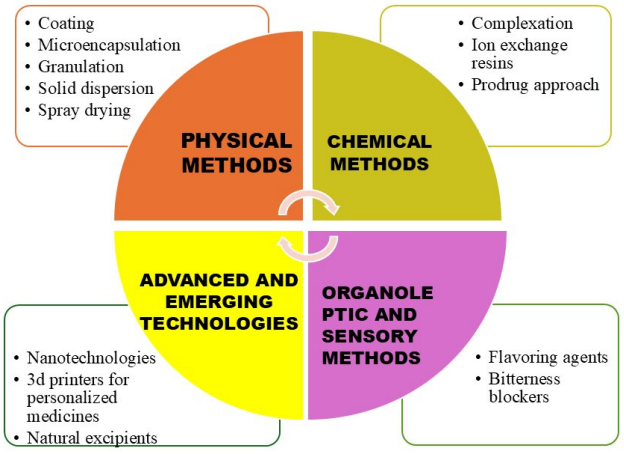


Fig. 2: Classification of taste-masking methods

Advantages of Taste masking

Taste masking methods are helpful in oral drug delivery, enhancing patient compliance by making the dosage form more acceptable. Active coating with pH-sensitive polymers allows site-specific release of the drug while maintaining taste masking in the mouth, can be scaled up easily using existing technology, and maintains product stability [42, 43]. Microencapsulation creates a barrier around bitter-tasting APIs, minimizing the requirement for sweeteners, allowing targeted release, preventing bioactive from environmental degradation, and enhancing bioavailability [44, 45]. Complexation techniques, for example, with cyclodextrins or ion-exchange resins, greatly inhibit drug–taste receptor interaction, are usable with diverse compounds, and are compatible with contemporary dosage forms such as ODTs [27]. Spray drying provides a fast, economical method to generate homogeneous, stable particles at mild conditions, enhancing dissolution without impacting drug release [46, 47] Organoleptic methods, including flavouring and sweetening, are inexpensive, versatile, easy, and can be rapidly adopted alone or in conjunction with other technologies [48].

Challenges and critical factors in taste masking strategies

Taste masking is a critical aspect for pharmaceutical formulations that involves both the patient acceptability and sensory perception of the drug. The preparation of inclusion complex, such as those involving cyclodextrins or ion-exchange resins often requires multiple processing steps, including controlled mixing, solvent removal, and drying, which can lead to increased production time and cost (Fig. 3).

There are several parameters that significantly influences the effectiveness of taste masking approaches such as [49, 8]:

API Dosage

API dose is critical in determining the taste masking of the formulation. In paediatrics usually the dose is minimal so flavouring agents may be adequate to mask the taste. However, in higher dosage including acetaminophen, adding a flavouring additive in not effective alone. Instead coating it with sweeteners is recommended to achieve the masking. Added flavours or sweeteners might interact with the API, potentially affecting its stability or efficacy. Achieving the desired taste masking efficiency requires careful optimization of polymer ratios and process parameters as there may be material loss during atomization or collection stages, reducing yield efficiency [46, 47].Furthermore, potential chemical interactions between flavouring agents and APIs must be thoroughly evaluated, as such interactions could alter the pharmacokinetic or pharmacodynamic properties of the drug. This imposes constraints on the selection and compatibility of flavouring agents in certain formulations [28, 25].

Drug particle size and Distribution Profile

Non-uniform dissolution and incomplete masking can occur mainly due to the irregular size and shapes of the active ingredient. Furthermore, the non-uniform coating thickness, coating faults like dust generation, abrasions, agglomerations, are some challenges in the masking procedure. These can delay drug release in the stomach, affecting therapeutic onset. These hurdles can be overcome by using multiple coating layer.

Bitter taste threshold

Drug leakage is another crucial challenge as it leads to interaction of the drug with the taste buds. Viscosity enhancers can be applied to effectively mask the bitter taste.

Dosage form

The dosage form is another crucial factor for taste masking. Dosage form like capsules, hard tablets need to be effectively masked using coating, microencapsulation, resin complexation to reduce their bitterness and improve patient compliance.

Drug solubility

The degree of bitterness is highly depended on the degree of the drug solubility. The more soluble the drug is the higher will be their taste bud's sensitivity. It's important to reduce the solubility of the drug and this can be achieved by adding sodium bicarbonate, esterification can be done to achieve the masking of hydroxyl groups [50].

In a nutshell, evaluating the effectiveness of taste masking remains a challenge, particularly in paediatric populations, where sensory testing is limited by ethical and practical constraints. Standardized, reproducible in vitro and in vivo evaluation methods are still evolving, making it difficult to assess the palatability of complexed formulations with high precision [51-53].

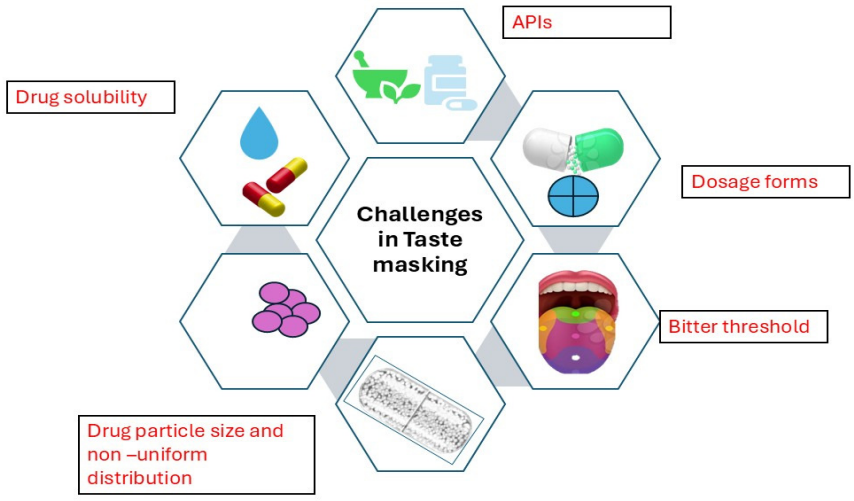


Fig. 3: Key-challenges in taste-masking of pharmaceuticals

Materials Used for Taste Masking

The materials used for taste masking vary widely, depending on the technique and the nature of the drug being formulated. Polymers play a key role in many of the taste masking technologies, as they are versatile and biocompatible. Some of the commonly used materials include [53, 12, 54]:

Polymers: EC, HPMC, PVA, and acrylic polymers are frequently employed for coating and microencapsulation. They can form a barrier around the drug, preventing it from coming into direct contact with taste receptors.

Cyclodextrins: These molecules are used in complexation technologies to encapsulate drugs and mask their taste. Cyclodextrins, such as α-, β-, and γ-cyclodextrins, can form inclusion

complexes with a variety of drugs, reducing their solubility and masking their bitterness.

Lipids: Lipid-based systems, such as glycerides, phospholipids, and fatty acids, are used in microencapsulation and spray-drying techniques. These materials can also provide controlled release properties while masking taste.

Sweeteners and Flavouring Agents: Artificial sweeteners like sucralose and natural ones like stevia are incorporated to mask unpleasant tastes. Similarly, natural flavours derived from fruits, spices, and herbs are often added to enhance the sensory profile of herbal drugs.

Recent Trends and Future Perspective in Taste Masking

The field of taste masking is evolving rapidly, with several recent trends and future directions emerging to address the increasing demand for patient-friendly formulations.

Personalized Medicine using 3d printing: As the field of personalized medicine advances, there is a growing focus on tailoring formulations to the individual needs of patients. This includes modifying the taste masking strategies to suit the specific preferences and requirements of different patient groups, such as children, elderly, or individuals with specific health conditions. The use of 3d printing is a promising technology for the formulation of personalized medicines including the preparation of instant-disintegrating tablets that exhibits rapid dispersion and drug release [55].

Nanotechnology: Nanotechnology has gained significant attention in the pharmaceutical industry for its potential to revolutionize drug delivery systems. Nanocarriers, such as liposomes, solid lipid nanoparticles, nanomicelles, nanosuspensions, and nano emulsions, are being explored for their ability to encapsulate drugs, mask taste, and enhance drug absorption. These nanomaterials offer precise control over drug release and can be designed to target specific sites in the GI tract. Nanocarriers systems mask the taste by presenting an active physical barrier that traps the bitterness of drug away from the sensory taste buds. They are helpful for enhancing the palatability of drug with low solubility, allowing them to higher patient acceptability without compromising its therapeutic values [56].

Natural and Herbal Medicine: With the rise in the popularity of herbal medicines, there is an increasing need for effective taste masking strategies for these formulations. Advances in natural excipients, such as plant-based polymers and biodegradable materials, are being explored to enhance the palatability of herbal formulations while maintaining their therapeutic efficacy.

Improved Regulatory Approaches: Future trends in taste masking will also be shaped by evolving regulatory guidelines that emphasize patient-centred approaches. This includes standardized testing methods for taste masking and clearer guidelines on the safety and efficacy of taste-masking agents, particularly in paediatric and geriatric populations.As the science of taste masking progresses, increasingly sophisticated technologies and techniques will become available. Increasingly, artificial intelligence and machine learning in drug development could be used to forecast the best taste masking agents for drug. There will also be increased attention to sustainable and green processes for taste masking as part of the overall trend towards “green” pharmaceutical production. Overall, taste masking is an important element of drug development, especially in the case of herbal and synthetic medicines with off flavours. Through the utilization of different technologies and taking advantage of recent innovations in the sector, it becomes feasible to formulate products that are both pleasant in taste and functional, thus enhancing patient compliance and therapeutic efficacy [57-61].

Patents

A wide range of patents have been reported on taste masking techniques and their formulations strategies, aimed at enhancing the patient compliance and palatability. A summary of the patents based on taste masking approaches were presented in the Table 4.

Table 4: Various Patents reported on Taste masking Formulation

Patent Number	Date of Patent	Drug Masked	Technique and Material Used
United State Patent-5,489,436	Feb. 6, 1996	Dimethylaminoethyl methacrylate and neutral methacrylic acid ester and cellulose ester, e.g. cellulose acetate, cellulose acetate butyrate, cellulose triacetate	Natural Alginates, Starch (Coating)
United State Patent-5,633,006	May 27, 1997	Acetaminophen, ampicillin, Azithromycin, Chlorpheniramine Cimetidine, Erythromycin Clarithromycin, Diphenhydramine Ibuprofen, Penicillin	Flavouring agents and sweeteners (Coating)
United State Patent-6,139,865	Oct. 31, 2000	Ranitidine, Cimetidine (Any bitter drug)	EC, Ethylene vinyl acetate or Polyethylene etc. (Microencapsulation)
United State Patent-US 6,551,617 B1	Apr. 22, 2003	Acetaminophen or caffeine powder.	polyvinyl acetate, and a dimethylaminoethyl methacrylate and neutral meth acrylic acid ester. Additionally, the composition may include an alkaline modifier.
United States Patent-6551617B1	Apr. 22, 2003	Acetaminophen, aspirin	Polyvinyl acetate, Dimethylaminoethyl (Fluidized Bed Coating)
International Publicatio	Dec 28, 2017	Bacopa Monnier extract	Eudragit E, Polymethyl, Methacrylate etc. (Microencapsulation coating)

n number WO/2017/ 22126881			
United States Patent- US9884014B2	February 6, 2018	Analgesics (e.g., ibuprofen, acetaminophen) Antibiotics Antidepressants Antipsychotics Other bitter drugs requiring patient compliance improvement	Different Polymeric Coating (Microparticle coating)

Natural Alternatives for Taste masking of drugs

Natural alternatives to synthetic materials for taste masking in drug formulations include a variety of biopolymers, gums, and other natural substances. These materials are effective due to their ability to coat, encapsulate, or modify the drug's interaction with taste receptors. Below are some examples [62]:

Natural Materials for Taste Masking-

Gelatin: Derived from collagen, it forms a tasteless coating around tablets and capsules, effectively masking unpleasant flavours.

Acacia Gum: Extracted from the acacia tree, it provides a glossy coating and can regulate drug release while masking taste.

Alginates: Sourced from brown seaweed, alginates are used in liquid formulations to mask bitterness.

Starches: Potato, cornstarch, and tapioca are utilized in chewable pill coatings for their taste-masking properties.

Pectin: Found in fruits, pectin enhances the taste of chewable tablets or gummies.

Chitosan: Derived from crab shells, it aids in taste masking and enhances drug release properties.

Guar Gum: Obtained from guar beans, it serves as a binder and taste-masking agent in tablets and granules.

Agar: Extracted from seaweed, it is used in oral formulations to mask bitter tastes.

Xanthan Gum: Produced by fermenting carbohydrates, xanthan gum acts as a suspending and taste-masking agent in liquid formulations.

Gellan Gum: Obtained from bacteria, it facilitates controlled drug release while masking bitter flavours [62,8].

Advantages of Natural Materials [8]

- Biodegradable and environmentally friendly.
- Reduced risk of adverse reactions compared to synthetic polymers.
- Often multifunctional (e.g., controlling drug release while masking taste).

Challenges [8]

- Potential variability in quality due to natural sourcing.
- Interaction with APIs may affect stability or efficacy.
- These natural materials provide effective alternatives to synthetic polymers like polymethacrylates, or polyvinyl derivatives commonly used for taste masking in pharmaceutical formulations.

Conclusion

Taste masking remains a critical aspect of pharmaceutical formulation, ensuring patient compliance and improving the acceptability of oral dosage forms. Advanced technologies such as microencapsulation, complexation, and polymeric coatings have revolutionized taste masking by creating physical barriers or modifying solubility to suppress bitterness effectively. Recent patents highlight innovative approaches like nanohybrids, melt extrusion, and cyclodextrin-based systems that address limitations of conventional methods while maintaining drug efficacy and release profiles.Natural alternatives, including sweeteners, bitter blockers, and flavour modifiers, offer functional masking solutions that are particularly useful in paediatric formulations and traditional medicines can be combined with other techniques to enhance efficiency, leveraging their safety and biocompatibility. The future progress will emphasize on innovations such as AI-driven formulation design and smart delivery systems for a precise drug release without unpleasant taste.Overall, the advancements in taste masking technologies and patents pave the way for tailored solutions to meet diverse pharmaceutical needs while improving patient quality of life.

Abbreviations

Active pharmaceuticals ingredients: APIs

Oral disintegrating tablets: ODTs

Gastrointestinal tract: GI tract

Ethylcellulose: EC

Hydroxypropyl methyl cellulose: HPMC

Ayurvedic nutraceutical preparation: ADS

Enoxacin: ENX

wet spherical agglomeration: WSA

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None.

Data Availability

None.

Declarations

Competing Interests

The authors declare no competing interests.

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