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REVIEW PAPER

ADVANCES IN THE TECHNOLOGY OF TASTE- MASKING OF UNPLEASANT TASTING ORAL DOSAGE FORMS: A REVIEW

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ABSTRACT

Most of the pharmaceuticals are administered by the popular route of drug delivery, the oral route. Taste is an important and critical parameter in administering formulations which comes in contact with the taste buds. Many drugs have bitter taste, thus this is one of the important formulation problem encountered. Bitter taste of drugs has posed a constant problem in the treatment of patients due to their inability or unwillingness to swallow such formulation especially in children and elderly. Thus masking of unpleasant taste characteristics of drug is an important factor in formulation of these agents. This lead to the development of taste masking technologies which improved the characteristics of the dosage form and good patient compliance is achieved. This review describes the trend in taste masking technologies by studying various methodologies for masking the obnoxious taste of drugs, some of which includes Taste-masking by Granulation, Ion Exchange Resins, Sweeteners and flavorants, Microencapsulation, Formulation of Inclusion Complexes, adsorption, Prodrug Approach, Gelation, Solid Dispersion System, Development of Liposome, Multiple Emulsions. The recent techniques which include the use of bitter taste blockers which specifically block the bitter taste but not the pleasant taste of any additive as well as taste masking nanotechnology using nanolipidic particles were also discussed.

KEYWORDS: Taste masking, dosage form, palatability, and polymer.

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INTRODUCTION

Undesirable taste is one of several important formulation problems that are encountered with certain drugs. Oral administration of bitter drugs with an acceptable degree of palatability is a key issue for health care providers, especially for pediatric patients. Several oral pharmaceuticals, numerous food and beverage products, and bulking agents have unpleasant, bitter tasting components. So, any pharmaceutical formulation with a pleasant taste would definitely be preferred over a competitor's product and would translate into better compliance and therapeutic value for the patient and more business and profits for the company. The desire of improved palatability in these products has prompted the development of numerous formulations with improved performance and acceptability (Tripathi *et al*, 2011; Sohi *et al*, 2004).

Various methods like coating, inclusion complexes, microencapsulation, granulation, adsorption, prodrug approach, addition of flavors and sweeteners, ion exchange resins are used for masking the obnoxious taste of drugs. However,

there is no universal method for taste masking. Each method offers specific advantages and applications. One method is not suitable for masking obnoxious taste of all drugs. Several parameters like extent of bitter taste, dose, dosage form and type of the patient, influence the method to be used for masking the taste of the bitter tasting drugs. Evaluation of taste masking by electronic tongue is a recent innovation. Advatab, Microcaps, Liquitard, Kleptose, Formulplex and Formulcoat are the new taste masking technologies which are found to be better than existing orally disintegrating drugs (ODT) technologies like Zydis, Orasolv and Quicksolv etc. In addition to oral drug delivery, the taste masked drug delivery research is gaining importance for improving the quality of the treatment for pediatrics and geriatrics.

This review will be of importance especially to researchers in the pharmaceutical sector responsible for the formulation and provision of oral dosage pharmaceuticals since taste is an important consideration in oral dosage forms. It would equally be a useful reference point to students of pharmacy and other related discipline. In addition, interested members of the reading public will find it a useful and interesting piece of information and enlightment especially as it affects the compliance, therapeutic values for the patient and profit for the pharmaceutical industries. This study is essentially aimed at reviewing the earlier applications and methodologies for taste masking of bitter tasting oral dosage formulations as well as looking at the most recent development and approaches for the reduction and masking of unpleasant / obnoxious taste of oral pharmaceuticals.

TASTE AND ITS PHYSIOLOGY

Taste is the ability to detect the flavor of substances like food, drugs etc. Taste has now become an important factor governing the patient compliance. It gained importance as most drugs are administered through oral route. Physiologically, taste is a sensory response resulting from a chemical stimulation of taste buds on the tongue.

TYPE OF TASTE

Four fundamental sensations of taste have been generally described- Sweet, Sour, Bitter, Salty. These tastes consistently stimulate taste bud in specific parts of the tongue as sweet and salty mainly at the tip, sour at sides, bitter at back (Ayenew *et al*, 2009).

Taste buds are small sense organ in most vertebrates, helps in the detection of taste. Hence a group of cells, found especially on the tongue Taste buds have been identified on the soft palate, pharynx, epiglottis, which allows different types of taste to be recognized (Tripathi *et al*, 2011).

Salty Taste (Edge, Upper Portion)

The salty taste is one among the four taste receptors of tongue. It is due to simultaneous presence of anions and cations; e.g. potassium bromide, ammonium chloride and sodium salicylate. It is characteristics of acids, tannins, alum, phenols, and lactones. High molecular weight salts may have a bitter taste. They are located on the edge and upper front portion of the tongue (Reilly, 2006).

Sweet Taste (Tip)

The sweet taste is one among the four taste receptors of the tongue. It is due to polyhydroxy compounds, poly halogenated aliphatic compounds and amino acids. Amino and amide groups, especially if the positive effect is balanced by the proximity of a negative group, may produce a sweet taste. Sweetness increases with the number of hydroxyl groups, possibly, because of increased solubility. They are found on the tip of the tongue (Reilly, 2006).

Sour Taste (Along Sides in Back)

The sour taste is also one of the four taste receptors of the tongue. It is caused by hydrogen ions and it is proportional to the hydrogen ion concentration and the lipid solubility of the compound. They occur at sides of the tongue (Reilly, 2006).

Bitter Taste (Back)
The bitter taste is the last and one of the four taste receptors in the tongue that is located toward the back of the tongue. It is stimulated by a variety of chemical substances, most of which are organic compounds, although some inorganic compounds such as magnesium and calcium also produce bitter sensations (Reilly, 2006).

TASTE MASKING TECHNOLOGIES
Taste masking technology are very important for improving patient compliance and better therapeutic efficacy. Many oral drug delivery formulation have objectionable taste such as biterness, saltiness or sourness. Taste masking technologies include two aspect:

- Selection of suitable taste masking substances such as polymers, sweeteners, flavors, amino acids etc.
- Selection of suitable taste masking techniques.

A suitable taste masking technique can powerfully impact both, quality of taste masking and process effectiveness (Sharma and Lewis, 2010). There are many techniques developed for taste masking of bitter drugs these are:

Taste Masking by Granulation
Granulation is a less expensive, rapid operation and an easily scalable taste masking technology. This step can be exploited as a mean for taste masking of slightly bitter tasting drug. Granulation lowers the effective surface area of the bitter substance that come in contact with the tongue upon oral intake. Liquid and low melting point waxes such as glycerol palmitostearate, glycerylbehenate and hydrogenated castor oil are commonly used ingredients during the granulation to achieve taste masking. Taste masked granules prepared from saliva insoluble polymers which can act as a binding agent can be formulated in various types of tablet dosage forms, e.g. rapidly disintegrating tablet and chewable tablets helps to seal sensitive actives and increase patient compliance by masking tastes and odors. Taste masked granules of bitter tasting drug pirenzepine and oxybutynin have been prepared by the extrusion using aminoalkylmethacrylate copolymer (Appelgren and Eskilson, 1990; Ishikawa and Watanabe, 1999).

Ion Exchange Resins
Ion exchange resins (IER) have received considerable attention from pharmaceutical scientists because of their versatile properties as drug delivery vehicles. In past few years, IER have been extensively studied in the development of Novel drug delivery system and other biomedical applications. Several ion exchange resin products for oral and per-oral administration have been developed for immediate release and sustained release purposes.
Ion exchange resins are solid and suitably insoluble high molecular weight poly-electrolytes that can exchange their mobile ions of equal charge with the surrounding medium (Chatap *et al,* 2007).

An ion exchange resin is an insoluble matrix (or support structure) normally in the form of small (1-2 mm diameter) beads, usually white or yellowish, fabricated from an organic polymer substrate. The material has highly developed structure of pores on the surface of which easily traps and releases ions.

In taste masking by ion exchange resins, the resin-drug complexes formed will elute only a limited percentage of drugs in the saliva pH. Thus the taste of the drug is masked without interrupting the drug release profile (Deepthi, 2011).

Various studies have revealed that ion exchange resins are equally suitable for drug delivery technology. Some ion exchange resins used widely for taste masking purpose in industries are Amberlite IRP64, Amberlite IRP69, Indion 204, Indion 214, Kyron T-114 and Kyron T-104 (Jain, 2001).

Suther and Patel (2011) masked the highly bitter taste of tinidazole by novel ion exchange resin and minimize the taste problem associated with traditional medicine system. Taste masking was performed by complex formation of drug (Tinidazole) with Kyron T-114 and Indion 214 in different ratio. Drug resin complex was evaluated for drug

content, taste masking, stability studies, molecular characteristics and in vitro release of drug. The drug resin ratio (1:2) results of a good loading at pH 8 and shown good stability as well as retained its objectionable taste.

Sweeteners and flavorants

Taste enhancing additives includes the use of sweeteners and other flavorants that can disguise or mask the taste of an unpleasant active. Using a combination of sweeteners and flavors to overpower an unpleasant taste is, unfortunately, the most common approach to taste masking. This simplistic approach is problematic for a number of reasons. Sweet excipients do not provide a best stimulus for the receptors that are tuned for bitterness, and by themselves they are not completely effective at eliminating the taste of extremely bitter (especially extremely water-soluble) actives. They can, however, be more effective in covering up a sour taste. Taste enhancing additives such as sweeteners can be highly effective when used in combination with another primary taste masking strategy (Daharwal *et al,* 2009).

Flavoring and perfuming agents can be obtained from either natural or synthetic sources. Natural products include fruit juices, aromatic oils such as peppermint and lemon oils, herbs, spices and distilled fractions of these.

Sugar alcohols such as lactitol, maltitol and sorbitol can be used to decrease the after-taste perception of artificial sweeteners. Sucralose can be used with physiologically acceptable acids (e.g. citric acid) to increase the taste masking efficiency of the sweetener. Recently, sweeteners of plant sources such as stevia and glycyrrhizin have emerged as a viable alternative to the artificial sweeteners. Glycyrrhizin is extracted from glycyrrhiza root and is 50-60 times sweeter than sucrose. Stevia is obtained from 'honey leaf', which originated in Brazil and Paraguay. Non sucrose component of sugar beet extract was used as an edible flavor improving agent (Ayenew *et al*, 2009).

Taste Masking by Microencapsulation

Microencapsulation is a process by which very tiny droplets or particles of liquid or solid material are surrounded or coated with a film or polymeric material. Although coating is used primarily for production of sustained release, Gastro-intestinal dosage forms, it also has major applications in masking the unpleasant taste. It is important to understand that only soluble portion of the drug can generate the sensation of taste. Coating the active drug with a properly selected polymer film can reduce its solubility in saliva and thus taste could be masked. Coating the drug particles creates a physical barrier between the drug and the taste buds and taste of active could be masked.

Taste Masking by Formulation of Inclusion Complexes

Inclusion complexation is a process in which the guest molecule is included in the cavity of a host or complexing agent. The complexing agent is capable of masking bitter taste of drug by either decreasing its oral solubility on ingestion or decreasing the amount of drug particles exposed to taste buds thereby reducing the perception of bitter taste. Vander Waals forces are mainly involved in inclusion complexes (Pokharkar, 2005). Cyclodextrin is most widely used complexing agent for inclusion type complexes. Cyclodextrins are cyclicmacromolecules obtained by degradation of starch by glycosyltransferases. Depending on the specific character of the respective transferases, different cyclodextrins results consisting of 6(alpha-cyclodextrin), 7(betacyclodextrin), 8(gamma-cyclodextrin) glucose units. It is a sweet, non-toxic, cyclic oligosaccharide obtained from starch. The suppression of bitter taste by cyclodextrin was in increasing order of alpha, gamma, beta cyclodextrin. The following are the examples of drugs that the bitter taste can be suppressed by making inclusion complexes; primaquine phosphate, cefuroxime axetil, lornoxicam, duloxetine, fanotide (Roy, 1994).

Taste masking by adsorption

Adsorbents are commonly used in taste masking technologies. Adsorbate of bitter tasting drug can be considered as the less saliva soluble versions of these drugs. Adsorption involves preparing a solution of the drug and mixing it with an insoluble powder that will adsorb the drug, removing the solvent, drying the resultant powder, and then using these dried adsorbates in the preparation of the final dosage form. Many substrates like veegum, bentonite,

silica gel and silicates can be used for the preparation of adsorbate of bitter drugs. The bitter taste of ranitidine is masked by forming an adsorbate with a synthetic cation exchange resin. Stephen and Fiona, (1993); Sharma and Lewis, (2010) developed a taste masked loperamide formulation with magnesium aluminum silicate by blending the drug and the adsorbate and further granulating with hydrophobic polymers to achieve taste masking.

Taste Masking by Prodrug Approach

Chemical modification, including prodrug design is an effective method for reducing solubility, and thereby improving taste. A prodrug is chemically modified inert drug precursor which upon biotransformation liberates the pharmaceutically active parent compound. e.g. 3 hydroxymorphinans are well absorbed from the buccal cavity, many of these compounds have a bitter taste which makes them difficult to administer by that route. The present invention relates to prodrugs of 3- hydroxymorphinans which are devoid of any taste, and are thus more suitable for buccal, sublingual, or nasal administration (Sharma and Lewis, 2010).

Taste masking by Gelation

Water insoluble gelation on the surface of tablet containing bitter drug can be used for taste masking. Sodium alginate has the ability to cause water insoluble gelation in presence of bivalent metal ions. Tablet of amiprolose hydrochloride have been taste masked by applying an undercoat of sodium alginate and overcoat of calcium gluconate. In presence of saliva, sodium alginate reacts with bivalent calcium and form water insoluble gel and thus taste masking is achieved (Tripathi *et al*, 2011).

Solid Dispersion System

Solid dispersion has been defined as dispersion of one or more active ingredients in an inert carrier or matrix at solid state prepared by melting (fusion) solvent or melting solvent method. Recently solid dispersions were introduced as a taste masking technology. Tsau and Damani (1990) disclosed a drug-polymer matrix composition to achieve the taste masking of dimenhydrinate. Amine or amido group of dimenhydrinate can have a physical and chemical interaction with the carboxylic acid and esters groups of copolymers such as shellac, zein and cellulose acetate phthalate hydrophobic polymers and long chain fatty acids have been used to achieve the taste masking by solid dispersion. This approach usually requires a higher concentration of excipients compared to other taste masking techniques. Natural polymers such as shellac and zein, and enteric polymers like derivatives of acrylic acid polymers and phthalate are good choices to develop the taste masked solid dispersions (Josef and Nalinkant, 1993).

Development of Liposome

Another way of masking the unpleasant taste of therapeutic agent is to entrap them into liposome. Liposomes are carrier molecules comprising several layers of lipids, in which the bitter drug is entrapped within the lipid molecule. Oils, surfactants, polyalcohols and lipids effectively increase the viscosity in the mouth due to which the time of contact between the bitter drug and taste receptors is decreases, thus improving the overall taste masking efficiency. Inhibition of bitterness of drugs by phospholipids such as phosphatidic acid, phosphatidylinositol, soya lecithin etc has been reported (Sharma and Lewis, 2010). For example, the bitter taste of chloroquine phosphate in HEPES (N-2- hydroxyetylpiperzine-N'- 2- ethane sulfonic acid) buffer at pH 7 by incorporating into a liposomal formulation prepared with egg phosphatidyl choline masked (Kasturagi *et al*, 1995).

Multiple Emulsions

Multiple emulsions are also a good approach for taste masking of bitter drugs. Multiple emulsions are poly-dispersed systems where both water in oil and oil in water emulsion exists simultaneously in a single system. Lipophilic and hydrophilic surfactants are used for stabilizing these two emulsions respectively. Multiple emulsions can be water/oil/water (W/O/W) or oil/water/oil (O/W/O) depending on the dispersed phases in dispersion media. These are called as emulsions of emulsions because one simple emulsion is placed inside another one (Chatap *et al,* 2007).

Taste masking is achieved by dissolving the drug moiety in the inner aqueous phase of w/o/w emulsion with good shelf life stability. O/W/O emulsion is a type of multiple emulsions in which water globules themselves containing dispersed oil globules, conversely W/O/W emulsions are those in which internal and external aqueous phases are separated by the oil. The formulation is designed to release the drug through the oil phase in the presence of gastrointestinal fluid (Rao *et al*, 1993).

pH Modifiers

Many natural and synthetic polymers, resins and waxes alone or in combination have been employed for taste masking. The enteric polymers like eudragit L are used for taste masking but the pH of saliva is near 5.8 and these polymers solubilize at pH beyond 5.5 so there is a possibility of drug being partially leached. Therefore there is a need for the development of taste masking polymer such that the bitter taste is completely masked by the polymer at the pH of saliva in mouth and in the reconstitution medium as in case of the liquid orals and further which is able to protect the drug in a biologically active form, from the moisture in the dosage form and releasing the drug rapidly in the stomach without affecting its absorption and bioavailability (Kulkarni *et al*, 2005). In the application of pH modifying agent such as L-arginine for taste masking of bitter medicament, L-arginine maintains alkaline pH of suspending vehicle to promote in situ precipitation of des-quinolone in saliva. Redonds and Abanades (2003) developed taste masked liquid formulation of ibuprofen by using sodium saccharin and pH regulating agents.

Use of Amino Acids

Amino acids and their salts (alanine, taurine, glutamic acid, glycine) in combination with bitter drugs reduces the bitterness of the drugs. Some of the preferred amino acids include sarcosine, alanine, taurine, glutamic acid, and glycine (Sidharth, 2011). For example, the taste of ampicillin improved markedly by preparing its granules with glycine and mixing them with additional quantity of glycine, sweeteners, flavors and finally compressing them into tablets (Niazi and Shamesh, 1987).

Molecular complexes of drug with other chemicals

Molecular complexes can minimize the intensity of bitterness by modifying the solubility and absorption of drug by the formation of complex. Higuchi and Pitman reported that caffeine forms complexes with organic acids that are less soluble than xanthenes sand as such can be used to decrease the bitter taste of caffeine (Jha *et al*, 2008).

Salt formation

The salting-out taste-masking system is a multi-particulate system consisting of a drug core, a salting-out layer containing salts and water-soluble polymers, and a water penetration control layer containing water-insoluble materials. The system generates a long lag time (time when released drug is less than 1%) for numbness masking, and a subsequent immediate drug release for high bioavailability. Aiming to contain the system and drugs that cause numbness in oral disintegrating tablets, the system was optimized to reduce the particle size and contain drugs with high water solubility in this study. The amount of coating on the layers, the coating solvent, and the positioning of the components were also optimized

Attempts were made to modify the chemical composition of the drug substance itself, so as to render it less soluble in saliva and thus make it less sensitive to the taste buds. Adding alkaline metal bicarbonate such as sodium bicarbonate masks the unpleasant taste of water - soluble ibuprofen salts in aqueous solution (Daharwal *et al,* 2009). Aspirin tablets can be rendered tasteless by making magnesium salt of aspirin. D-chlorpheniramine maleate is taste-masked salt of chlorpheniramine (Roy, 1994). Sodium salts such as sodium chloride, sodium acetate, sodium gluconate have been shown to be potent inhibitors of some bitter compound. The mechanism is not known, however, research shows that sodium act at peripheral taste level rather than a cognitive effect.

EVALUATION OF TASTE MASKING EFFECT AND ANALYSIS

Taste is a subjective perception, through taste buds located on the tongue. Each taste bud contains several taste cells, which can respond to a variety of taste sensations. Depending on individual, the perceived taste may vary to different degrees. By controlling the experimental conditions, reproducible results can be obtained. The following methods have been used to evaluate taste sensation:

Multi-Channel Taste Sensors

The taste sensor consists of three parts; 1) the electrode part consisting of the reference electrode and the artificial lipid/polymer film sensor which imitates lipid bi-layer membranes, 2) the robot arm, and 3) the computer for data analysis. When the electrode part is soaked in the sample solution, the lipid membrane potential is changed by the electrostatic interaction of the lipid film with the medicine that is measured, and/or by the adsorption of the medicine to the surface of the lipid film. The difference between the electric potential of the each working electrode and the reference electrode becomes the output, and these signals are sent to the computer through the robot arm as the "taste information" (Mundada, 2008).

Flavor Profile Panel Method

The flavor profile is widely used descriptive analytical test. It is based on a natural process, often performed instinctively, for evaluating and comparing flavor. A flavor profile measures objectively, qualitatively the perceptible factors of a product that is aroma flavor by mouth, feeling factor and after use sensations. In the flavor profile method, a product flavor profile is created and refined with repeated panel sessions (Alashkar, 2006).

E-tongue

The electronic tongue is an instrument that measures and compares tastes. Chemical compounds responsible for taste are perceived by human taste receptors, and the seven sensors of electronic instruments detect the same dissolved organic and inorganic compounds. Like human receptors, each sensor has a spectrum of reactions different from the other. The information given by each sensor is complementary and the combination of all sensors results generates a unique fingerprint. Most of the detection thresholds of sensors are similar or better than those of human receptors. In the biological mechanism, taste signals are transducted by nerves in the brain into electric signals. E-tongue sensors process is similar: they generate electric signals as potentiometric variations (Anand, 2007).

Liquid samples are directly analyzed without any preparation, whereas solids require a preliminary dissolution before measurement. Reference electrode and sensors are dipped in a beaker containing a test solution for 120 seconds. A potentiometric difference between each sensor and a reference electrode is measured and recorded by the E-Tongue software. These data represent the input for mathematical treatment that will deliver results.

Measurement of Frog Taste Nerve Response

In this method, adult bullfrogs are anaesthetized intraperitoneally and the glossopharyngeal nerve is then identified and dissected from the surrounding tissue and cut proximally. An A.C. amplifier and an electronic integrator are used respectively to amplify and integrate the nerve impulse. The peak height of the integrated response is then taken as the magnitude of response. Quinine sulphate formulations, taste masked by PA-LG (phosphatidic acid-lactoglobulin) combination has been reported to be evaluated by this technique (Mundada, 2008).

Spectrophotometric Method

A known quantity of the supposedly taste masked formulation is mixed with 10 ml of distilled water in 10 ml injection syringe by revolving the syringe, end to end 5 times in 30 seconds. The test medium is then filtered through a membrane filter, followed by spectrophotometric determination of the concentration of drug in the filtrate. If this concentration is below the threshold concentration it may be calculated that the bitter taste would be masked in vivo. This technique has been applied to evaluate the taste masked granules of sparfloxacin with threshold concentration up to 100µg/ml (Mundada, 2008).

Sensory Analysis

Sensory analysis has been used in developed countries for years to characterize flavors, odors and fragrances. In recent times much progress has been made in development of instrumentation methods for characterizing odors and flavors. These methods are often more useful in aroma and flavor research than in product development where formulation are usually complex and sensory methods can provide equally reliable data on overall flavor character (Adjei *et al*, 1996).

FUTURE PROSPECTS IN TASTE MASKING

Amongst the strategies employed, bitter taste blockers which specifically block the bitter taste but not the pleasant taste of any additive are being explored as universal taste masking alternatives. Presently, they are limited in number, and most of them not being GRAS (Generally Regarded As Safe) listed. With ongoing advancements, using a combination of various taste masking technologies, future looks promising for taste masking of bitter drugs. Various formulations have been examined for the development of taste-masked oral pharmaceuticals in recent years. Especially many efforts have been made in the development of oral fast-disintegrating tablets, and dry syrup and liquid products which can inhibit bitter taste, for use in oral dosage forms for a wide array of drugs taken by infants or elderly patients.

The most widely used method for measuring the taste characteristics of pharmaceutical preparations is psychophysical evaluation by a taste panel. However, conventional chemical analyses, on the basis of release studies, have been shown to be useful subsidiary methods. More recently, novel in vitro taste assessment apparatus and methodologies have been developed for high-throughput taste screening and quality control. Bio-mimetic taste sensing systems (BMTSSs), such as multichannel taste sensors or electronic tongues with global selectivity, have been welcomed by both pharmaceutical scientists and the industry as a whole.

Taste-masking nanotechnology can be used to mask unpleasant tastes in pharmaceuticals and nutraceutical preparations, vastly improving consumer acceptance, patient compliance and user satisfaction. The Nanolipidic particles used in this study are safe and all-natural, marking the first successful testing of an all-natural integrated delivery system in taste-masking applications.

Further benefits of using these proprietary Nanolipidic particles in taste-masking includes the high-loading capacity of passenger molecules, an optically clear appearance, the ability to control population size, a 60 nm to 150 nm range and a system that is inherently non-precipitating.

CONCLUSION

Taste masking of bitter tasting drugs is a big challenge to scientist. However attempts have been made to describe various methods, techniques suitable for taste masking of obnoxious drugs. These techniques mentioned in this review can be used for bench scale and pilot scale also. In addition to the existing patented taste masking technologies, several new technologies for effective taste masking are also mentioned in this review. With application of these techniques, one can improve product preference to a large extent. In addition to oral drug delivery, the taste masked drug delivery research is gaining importance and commercial success for the quality of the treatment provided to suffering patients, especially children and the elderly.

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