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A Review on the Effectiveness of Herbal Ingredients in Maintaining Oral Hygiene



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ABSTRACT

Oral hygiene is very important practice of keeping mouth clean and other problems by brushing teeth. Oral diseases are one of the most common group of diseases affecting the globe. Most of the oral manifestations are the result of the lifestyle of people and thus are preventable. These includes dental caries, periodontal diseases, clip and cleft palate, NOMA, to name a few. There are many herbs available which can be used to maintain oral hygiene and are being put in use to formulate a herbal formulation i.e., herbal toothpaste. In this article we have reviewed few herbs which have great power in curing oral manifestations and maintaining oral hygiene.



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INTRODUCTION

HERBS

Herbs refers to the variety of species belonging to the plantae kingdom that contain medicinal properties. They are considered as the traditional system of medicines. In some countries, this is used interchangeably with the terms “complementary medicine” or “alternate system of medicine”. WHO defines herbal medicines as herbs, herbal material, herbal preparations and finished herbal products containing the active ingredients in the part of plants or other plant materials or combinations. Traditional medicine system includes Ayurveda, which is native to India is not new unlike conventional medicinal systems like allopathy and has long history. It includes the totality of knowledge, skills and practices based upon the theories and information collected indigenous to different cultures, whether explicable or not, used in the prevention, diagnosis, treatment and mitigation of the diseases. The medicinal herbs can be obtained from aerial or non-aerial plant parts and also from the resins or gums obtained from plants.

In present scenario, herbal drugs are widely used over conventional therapy due to less side-effects. WHO developed and launched the WHO Traditional Medicine Strategy (2014 - 2023). It aims in developing the policies and helping their member states to implement their action plans in order to promote and strengthen the use of traditional medicines/herbs in order to improve the health of the population.

DISEASE PROFILE

Oral diseases are one of the common diseases which people are suffering globally. As per the data obtained, around 3.5 billion people are affected by oral diseases and dental caries in permanent teeth is common. Oral problems are generally lifestyle-based diseases like intake of eatables with high sugar content; consuming tobacco and alcohol; not maintaining oral hygiene like brushing teeth twice a day; avoiding regular dental check-ups and inadequate exposure to flouride. These are generally preventable and treatable at early stages. Some of the oral diseases seen in the patients include:

Dental caries- It is the most common problems faced by people around the globe. Due to the continuous and frequent intake of diet with high sugar contents and not cleaning the teeth, the layer of the plaque is formed. This plaque converts the free sugars present in the eatables into acid which destroys the enamel thus forming cavities.

Periodontal disease- They are also called “gum diseases” and archronic local inflammatory disease generally involving the problems like gingivitis (the bleeding and swollen gums); pain; loosening of gums and bad breath. About 10% of the global population is affected by periodontal diseases and its causes include poor oral hygiene; excessive intake of tobacco and alcohol. Also, some studies suggest that hyperlipidaemia can be cause of periodontal diseases and it was noticed the presence of high triglycerides and LDL level in periodontal patients. In severe cases, the loosening of gums may cause tooth loss.

Oral cancer- It is one of the most common cancers and is generally seen in men and older population and also the economically weaker sections of the population. The incidence of oral cancer (majorly lip and oral cavity cancer) is around 4 in 1000 people globally, but this digit may vary from place-to-place from zero to 20 cases per 10000 people. The main causes include excessive consumption of tobacco; areca nut and alcohol and also infection by papillomavirus (majorly in North American and European populations).

Cleft lip and palate- It is the genetic manifestation and is a rare disease affecting 1 in 1000 new-borns. Its main cause includes the consumption of tobacco; alcohol and even poor diet by the expecting mother. The successful surgery of cleft lip and palate may lead to rehabilitation in life.

Structure of teeth

The teeth also called dentes, are the accessory digestive organs fitted in the sockets of the alveolar processes of the maxillae and mandible with the help gums (gingivae). A tooth has three parts namely: Crown (the upper visible part); Roots (embedded in the socket bone) and the lastly the Neck (constricted junction between the crown and the roots).

The dentin of the tooth is made up calcium and provides the tooth with its basic shape and rigidity. The dentin of the crown is covered with the hardest substance of the body i.e, enamel which is generally the composition of calcium phosphate and calcium carbonate. Enamel provides rigidity to the exposed crown part and provides protection from the wear and tear of dentin during chewing. Humans have two sets of teeth: deciduous (milk or primary teeth) and permanent (secondary teeth). The dental formula in adult human is $2123/2123$.

PLANT PROFILE

Turmeric

Turmeric has been used in Asian cuisines for both its flavour and colour and in Chinese and Ayurvedic medicine particularly as an anti-inflammatory and for the treatment of jaundice, menstrual difficulties, haematuria, haemorrhage, and colic. It is official in the Pharmacopoeia of China as well as in other Asian countries such as Japan and Korea and its usage covers a wide range of health indications.

Curcuminoids are the phenolic compounds richly present in the roots of the Zingiberaceae species and is the active ingredient of the *Curcuma longa*. Many researches data support that curcumin has many health beneficiary properties such as antioxidant; anti-inflammatory; chemopreventive; chemotherapeutic as well as antibacterial and antifungal activities.

Mechanism of Action of Turmeric- Curcumin has low solubility as well as poor bioavailability. But the recent researches in the field of development of suitable dosage forms have shown a promising scenario. The curcumin's beneficial properties show their effects by the possible modulations in signal pathways or direct interactions.

The curcumin shows the anti-inflammatory action by either inhibition of metabolism of arachidonic acid or inhibition of COX and LOX mechanism or inhibition of prostaglandin synthesis by inhibition of COX enzyme or in combination. It can also heal inflammation by inhibition of cytokines release of steroidal hormones from the adrenal gland and the stabilisation of lysosomal membrane.

The antioxidant property in curcumin is due to the presence of hydroxyl group in its chemical structure. It produces the hydroxyl radicals by reducing Fe^{3+} to Fe^{2+} using the reaction known as Fenton reaction. The study conducted proved that curcumin prevents the oxidation of Fe^{2+} along with that it prevents the formation of superoxide anion in xanthine-oxidase system by 40%. Evaluating the outcome of curcumin by an *in vitro* study on endothelial heme-oxygenase-1, an inducible stress protein, which was carried out by utilizing bovine aortic endothelial cells. Incubation (18 h) with curcumin ensued in intensified cellular resistance to oxidative damage. [8] Curcumin has great ability to remove the free radicals from the body but also prevents the generation of reactive oxygen species thus protecting the body cells from oxidative stress damage.

Another therapeutic effect shown by turmeric is its antimicrobial activity. It shows anti-bacterial; antifungal as well as antiviral. Turmeric's this antimicrobial is known from ages. A few studies have found that minimum conc. of curcumin to show its inhibitory action ranges from 4-16g/ml and its minimum bactericidal conc. ranges from 16-32g/ml. [6] Its possible bactericidal mechanism is the inhibition bacterial cell division finally leading the cell death.

Peppermint oil

Peppermint oil is used as carminative, stimulant and flavouring agent. It has mild antiseptic properties too. It is used in toothpaste, tooth powders, shaving cream and different pharmacological dosage forms. It is used in the preparations of chewing gums, candies, jellies and essences. Both the Mentha oil and menthol are calcium channel blockers causing spasmolytic and smooth muscle relaxant effect and hence found their use in the irritable bowel syndrome. They show better pharmacokinetic profile when given in enteric coated capsules for release in large intestine. Muscle relaxant activity is employed to reduce spasm during endoscopy of colon. For this purpose, emulsified oil is injected through biopsy channel of the endoscope. Mentha oil shows digestive activity by stimulating the bile flow. This is also supported by the presence of flavonoids. It is also used for inhalation in steam, as well as topical products and lozenges for its antitussive effects.

Uses of Peppermint Oil in Dentistry is known for its cooling and numbing effect which can effectively soothe muscle and toothache. Researches have proved that peppermint oil is a powerful alternative for oral pathogens and killing common bacteria that can lead to cavities and gum disease. Peppermint oil is popularly used in dental formulations like toothpaste, mouthwashes not only because of its anti-microorganism property but also because of its strong taste and cooling effect that gives the fresh breath. Antibacterial property: Peppermint oil shows an inhibitory effect on the proliferation of *Staphylococci*. Antifungal property studies show that the peppermint oil shows both fungicidal and fungistatic effects upon the strains of *Candida* species at the concentration range 0.5 to 8µl/ml and also show the same effect against the azole-resistant and azole-susceptible strains. Antibiofilm property: Biofilm inhibition in the fungal strains helps to decrease the pathogenesis and drug resistance. Studies show that the peppermint oil inhibits the biofilm formations of *Candida albicans* completely up to 2µl/ml in a dose-dependent manner.

Aloe vera

Aloe vera is known as a magical herb for its medicinal properties and its use long back to ancient time. It is said to contain 75 potentially active constituents which are of the categories namely vitamins; minerals; enzymes; salicylic acids; sugars; amino acids; lignin and saponins. The salicylic acids of *Aloe vera* breaks down into aspirin like compounds giving pain-killing effects. *Aloe vera* is said to have many medicinal properties. It is said to have healing power when used topically or orally which is said to be because of Glucomannan, which is a mannose-rich polysaccharide and gibberellin (a growth hormone) which interacts with the growth factor receptors on the fibroblast thus increasing their activity and also tightens the collagen fibres interlocking thus stimulating the faster healing of the wound. Along with the healing power, *Aloe vera* extract when applied topically on the skin helps to protect the skin from the damaging effects of UV and gamma radiations. Many studies have revealed the possible mechanism that on the application of the *Aloe* gel on to the skin causes production of an antioxidant protein called metallothionein in the skin which reduces the production and release of skin keratinocyte derived immunosuppressive cytokines thus prevents UV-induced suppression of delayed type hypersensitivity. Also, *Aloe vera* shows anti-inflammatory action by inhibiting the COX pathway inhibiting the production of the prostaglandin from arachidonic acid. Also, C-glucosyl, an anti-inflammatory compound is present in *Aloe* gel and is also being isolated from it successfully. Anthraquinones present in the latex of *Aloe* plant not only makes it a potent laxative agent but also an antiviral agent as well. Recent studies show that anthraquinones inactivates the various enveloped viruses such as *Varicella zoster*; *Influenza* as well as *Herpes simplex*. *Aloe vera* also is helpful in diabetes mellitus condition as it reduces the blood sugar level thus controlling diabetes.

Besides all these uses, *Aloe vera* gel extract has moisturizing, anti-aging as well as the anti-septic effect. The moisturizing and anti-aging effect is due to the mucopolysaccharides which entraps the moisture into skin thus preventing the skin from drying and also makes it soft and along with that amino acids also causes the softening of the skin while zinc present in it acts like an astringent thus preventing occurrence of the wrinkles. The antiseptic agents present in *Aloe vera* are namely Lupeol, Salicylic acid, Cinnamonic acid, Phenols and Sulphur.

Aloe vera has any applications in dentistry which includes:

- treating oral lichen planus

- treatment of oral submucous fibrosis
- treating problem of recurrent aphthous stomatitis
- providing relief in radiation-induced oral mucositis
- treating conditions like gingivitis and periodontitis.

Mulberry leaves

In ancient times as well, the mulberry leaves, fruits, barks and roots were exploited for the treatment for fever, cough, hyperlipidaemia, hypertension and hyperglycaemia. The mulberry leaves derived products are commercially available as dietary supplement and functional food in the dosage forms of capsules and powders for controlling the body weight and blood glucose level. [16]

Antihyperlipidemic effect: Many studies done by different people observed the same result that number and size of the lipid droplets in hepatocytes were small in treatment group than the control group thus leading to the conclusion the mulberry leaves extract can help to lower the blood lipid profile. The most probable reason for this activity is presence of DNj, phenolics and flavonoids in their leaves. They activated the AMP-activated protein kinase (AMPK) and peroxisome proliferator-activated receptor (PPAR)- α , causing an increase in the rate of β -oxidation of free fatty acid and the lipid breakdown. Along with that caffeic acid, quercetin and hydroxy Flavin decreased lipogenesis by regulating the activities of fatty acid synthase (FAS), glycerol-3-phosphate acyltransferase (GPAT), sterol regulatory element-binding proteins (SREBP)-1c and liver X receptor.

Antihyperglycemic effect: Animal studies have shown that the single administration of mulberry leaves significantly suppressed the peak level and the incremental area under the curve (iAUC) of glucose excursion after carbohydrate loading. While, long-term mulberry leaves ingestion tended to normalise the levels of fasting the plasma glucose (FPG), glycated haemoglobin (HbA1c), fructosamine and insulin indexes of diabetic animals to nearly normal values. DNj is considered to be a potent antihyperglycemic compound of mulberry leaves as DNj is chemically similar to the glucose thus DNj being agonist to the glucose competitively blocks the active site of polysaccharide-degrading enzymes in the digestive tract. When the enzymes are inhibited, digestion and absorption of dietary carbohydrates are eventually diminished. Clinical studies suggest that DNj was equal to Voglibose (α -glucosidase inhibitory drug) in effectiveness.

Anti-obesity Effect: It is been scientifically proven that mulberry leaves suppresses body weight gain by inducing the chronic ingestion of high fat diet. This property of mulberry leaves is being exploited as the capsules and the powder forms of mulberry leaves extract is marketed as a dietary supplement. The mechanism of action is that the mulberry leaves significantly lowered the number of adipocytes as well as the number and size of the lipid droplets in the cells. It is also been seen that the long-term ingestion of mulberry leaves caused a gradual elevation of circulating adiponectin levels (an anti-adiposity cytokine).

Antihypertensive Effect: Mulberry leaves reduces the blood pressure and heart rate by inhibiting angiotensin converting enzyme. Also, been reported in certain literatures that mulberry leaves act as calcium channel blockers thus decreases the contraction of the smooth muscles in response to phenylephrine. Thus, mulberry leaves are potent herbal drugs in decreasing the abnormally elevated systolic blood pressure; diastolic blood pressure; mean arterial pressure and heart rate to the normal range. Also, long-term use of mulberry leaves in such patients helps to improve the conditions like impaired reactivity of blood vessels including diminished dilatations and increased constrictions.

Anti-oxidant Property: The fractions of Mulberry leaves extract containing the higher values of phenolic and flavonoids, both are good antioxidant agents, makes mulberry leaves a potent antioxidant agent. Along with that mulberry leaves have an effect on lipid peroxidation. Uses of Mulberry leaves in dentistry includes:

Periodontal Diseases: Mulberry leaves extract when applied locally in oral cavity helps to relieve the pain and inflammation of the gums due to anti-inflammatory property by blocking the COX mechanism. Some studies also suggest that mulberry leaves possess dose-response relationship.

TOOTHPASTE

Toothpaste is a paste or gel dentifrice that is intended to promote oral hygiene. The basic ingredients of the toothpastes include surfactants, abrasives and fluorides. A good toothpaste must be having appropriate abrasive index so as to prevent the deposition of dental plaque and without destroying the enamel. The presence of fluoride ions in toothpaste helps to prevent dental cavities and gingivitis (gum disease). The concentration of fluoride must be balanced in the toothpaste as increasing or decreasing the conc. may increase the chances of harmful effects. Other ingredients may include like antibacterial agents, colouring and flavouring agents, remineralizers or herbal drug extracts.

Ideal properties of a toothpaste include:

- It should be non-toxic.
- It should be cheap and easily available.
- It should have ideal abrasivity range.
- It should be non-irritant.
- It should not leave stains on the teeth surfaces.
- It should keep mouth fresh and clean for long.
- It should make teeth and gums healthy.

S. No.	Common Name	Botanical Name	Part Used	Category	Quantity (%)
1.	Turmeric extract	<i>Curcuma longa</i>	Rhizome	Antiseptic, anti-inflammatory, anti-microbial	10.0
2.	Aloe vera gel	<i>Aloe vera</i>	Leaves	Humectant, faster wound healing, prevents bleeding	30.0
3.	Mulberry	<i>Morus nigra</i>	Leaves	Toothache	10.50
4.	Peppermint oil	<i>Mentha piperata</i>	Leaves	Fresh breath, antiseptic, flavouring agent; anti-biofilm	4.0
5.	Calcium carbonate	-	-	Abrasive	31.0
6.	Sodium lauryl sulphate	-	-	Surfactant	1.50
7.	Sodium saccharin	-	-	Sweetening agent	0.30
8.	Para hydroxyl benzoic acid	-	-	Preservative	0.15
9.	Gum tragacanth	-	-	Binding agent	3.0
10.	Water	-	-	Vehicle	q.s

REGULATION OF HERBAL FORMULATIONS IN INDIA

In India, herbal drugs are regulated under the Drug & Cosmetic Act 1940 which lays down the provisions for the regulation of production; packaging; labelling; marketing and licensing of herbal drugs and their formulations. The D&C Act 1940 defines the Ayurvedic, Siddha or Unani Drug as “all the medicines intended for internal or external use for or in the diagnosis, treatment, mitigation or prevention of disease or disorder in human beings or animals, and

manufactured exclusively in accordance with the formulae described in the authoritative books of Ayurvedic, Siddha and Unani systems of medicine.

In recent times, Government of India has published 4 volumes of Ayurvedic Pharmacopoeia and included 326 drugs and their standards and Herbal Pharmacopoeia with standards of 52 drugs. D&C Act, 1940 had included standards of GMP for herbal drugs under Schedule T which clearly contains the provisions as:

1. Raw materials to be used in the manufacturing process must be of prescribed quality, free from contamination, authentic and purchased from authentic source.
2. The manufacturing premises should be licensed and should be designed according to the norms listed by the govt.
3. Proper measures must be taken in order to maintain the quality of the product.
4. Drugs released should be of acceptable quality.
5. Quality control labs must be present within the premises should be provided with all the required equipment and a professional.
6. Proper documentation and must be preserved for future inspection as well as for reference.
7. They should follow the instructions and methodology prescribed by the regulatory body.

In India, Ministry of AYUSH (Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy) is the regulatory body that looks in to all the processes from manufacturing to marketing of herbal drugs and their formulations including provision of license, labelling norms, etc.

EVALUATION OF TOOTHPASTE

1. Determination of Fineness: Squeeze the toothpaste and feel the presence of agglomerates/particles/granules.

- Apparatus required: Ultrasonic Bath -Trans-O-Sonic Compact model or equivalent, (60 + 10 Watts power with 35 + 5 KHz Ultrasonic frequency, 1-2 Watts /inch 2 power density, L x B x H :225 x 125 x 60 mm tank), Sieves- 75 &150 microns, Glass beakers (250 & 500ml) and stirring rods.

- Determination of Particle feel on butter paper: Extrude the paste in about 15 to 20 cm length each from at least ten collapsible tubes or container on a butter paper. Test the paste by pressing it along its entire length by a finger for the presence of particles. The toothpaste suspension should be subjected to an ultrasonic treatment followed by a fineness test.

- Fineness tests: 1. Determination of particle size on 150 microns IS sieve: Place about 20g of the toothpaste, accurately weighed, in a 250-ml beaker. Add 200 ml of water and allow to stand for about 30 minutes with occasional stirring until the toothpaste is completely dispersed free of toothpaste/gel flocks trapping the agglomerates. Transfer the beaker in an ultrasonic bath. Fill the Ultrasonic bath (2 litre capacity) to about three-fourth height with water. Clamp the above beaker in the centre of the bath keeping about 1cm clearance from the bottom of the bath and subject ultrasonication for 10 min to completely loosen out the constituents. Transfer this suspension quantitatively to a 150micron IS Sieve and wash by means of a slow stream of running tap water and finally with a fine stream from a wash bottle until all the matter that can pass through the sieve has passed, Let the water drain out and then dry the sieve containing the residue in an oven. If there is any residue on the sieve, carefully transfer it to a tared watch glass and dry it to constant mass in an oven at 105 ± 2 -degree Celsius.

2. Determination of particle size through 75 microns IS sieve: Weigh accurately about 20 g of the toothpaste and proceed as said above using a 75-micron IS Sieve. If there is any residue on the sieve carefully transfer it to a tared watch glass and dry it to constant mass in an oven at $105 \pm 2^{\circ}\text{C}$.

- Calculation: Material retained on 150-micron IS Sieve, percent by mass = $M_1 * 100 / M$ where M_1 = massing of residue retained on the sieve and M = massing of the material taken for the test.

2. Determination of pH:

- Method: Dispense 10 g of the toothpaste from the container in a 50ml beaker and add 10 ml of freshly boiled and cooled water (at 27°C) to make 50% aq. suspension. Stir well to make a thorough suspension. Determine the pH of the suspension within 5 minutes using a pH meter.

3. Stability Testing: When the toothpaste is subjected to a $45 \pm 2^{\circ}\text{C}$ for 28 days it shall not show any signs of phase separation; gassing or microbial contamination in order to meet the

standards. Also, when the toothpaste is exposed to 5⁰C temp. for a period of 1 hour, the paste should be extrudable from the tube when taken out to meet the standards.

4. Colour, Taste & Odour Testing: These parameters were checked by physical analysis.

5. Packaging Material Inertness Evaluation: The tube filled with toothpaste is subjected to temp. of 45±2⁰C for 10 days, the paste is extruded out in parts and then shall be evaluated visually. The internal surface of the tube is slit open removing the remaining content to examine the container. There should be no sign of corrosion or damage or any chemical interactions on the container's inner wall in order to meet the standards.

6. Dispensing Evaluation: The paste shall be able to extrude from the collapsible tube or any other suitable containers at the temp. of 27±2⁰C in the form of continuous mass without the application of excessive pressure that would cause the injury to the tube. Other analytical tests may include determination of presence of heavy metals; arsenic; determination of foaming powder; determination of fluoride ions; abrasivity measurement test; determination of microbial presence. [22] Tests may also include to check the medicinal properties or action of the herbs in herbal toothpastes like test for determination of anti-microbial action of the herb ingredient. [23]

CONCLUSION

Herbal toothpastes have shown the same efficiency of action as the chemical toothpaste and also, ahead of that has an advantage that use of natural herbs or herbs extracts have very less or no side-effects on their usage. After studying the efficiency of the herbs namely, turmeric; mulberry leaves; aloe vera gel and peppermint oil in treating oral problems and giving good oral health gives a promising hope that these herbs extracts can be put together in a herbal toothpaste formulation and better results can be expected.

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