

Development of A Novel Herbal Chewable Tablet for Dental Caries Treatment

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ABSTRACT

One of the most common oral health problems in the world is dental caries, which makes the creation of alternative treatment modalities necessary. The goal of this study is to develop and test a new herbal chewable tablet that uses the antimicrobial and anti-cariogenic qualities of *Psidium guajava* (guava leaves), *Murraya koenigii* (curry leaves), *Acacia catechu* (black catechu), and *Punica granatum* (pomegranate peel) to treat dental caries. The chewable tablet was created using these herbs, which are well-known for their antibacterial, antioxidant, and remineralization properties, along with calcium carbonate as a remineralizing agent. Pre-compression and post-compression parameters, such as weight variation, hardness, friability, and disintegration time, were assessed for the tablets. Significant inhibitory action against *Lactobacillus acidophilus* and *Streptococcus mutans*, two important bacteria in dental caries, was shown in antimicrobial investigations. Studies on enamel remineralization and biofilm inhibition showed how effective the herbal mixture was at reducing plaque and increasing enamel hardness. The results suggest that the developed herbal chewable tablet offers a promising, natural alternative for the management of dental caries, combining antimicrobial activity and remineralization effects. This study provides a foundation for further in vivo investigations and commercialization of the formulation as an affordable and accessible oral care solution.

Keywords: Dental caries, *Murraya koenigii*, *Acacia catechu*, *Punica granatum*, *Psidium guajava*

INTRODUCTION

One of the most frequent chronic illnesses in the globe, dental caries affects a large percentage of people. Although fluoride-based caries prevention treatments have been used extensively, their long-term effectiveness and possible negative outcomes have led to the investigation of alternative natural solutions. Herbal formulations have gained popularity due to their antimicrobial, anti-inflammatory, and remineralizing properties. This research focuses on developing a novel herbal chewable tablet combining *Murraya koenigii* (curry leaves), *Acacia catechu* (black catechu), *Punica granatum* (pomegranate peel), and *Psidium guajava* (guava leaves). These plants are known for their bioactive compounds that inhibit oral pathogens and promote oral health. The goal is to formulate an effective chewable tablet that can serve as a natural alternative for caries prevention and oral care management. One of the most chronic oral disorders, dental caries, is mostly brought on by *Streptococcus mutans*. Since it affects people of all ages and causes moderate to severe pain, swelling,

infection, and tooth structural loss, dentists are quite concerned about it.

MATERIAL:

Pomegranate Peel Extract (*Punica granatum*):

A member of the Punicaceae family, *Punica granatum*, also referred to as pomegranate, has a long history of use as a medicinal fruit. *Punica*, the genus name, was taken from the Roman name for Carthage. Apple ("pomum") and seeded ("granatus") are the definitions of the words "pomegranate." Although the pomegranate is indigenous to the Himalayas, which stretch from northern India to Iran, it has been grown across the Mediterranean region, tropical Africa, California, and Arizona. The compounds polyphenols, tannins, ellagic acid, and anthocyanins found in pomegranates are thought to be potent antioxidants. Anthocyanidins, the red pigments found in fruits, have antioxidant properties. The tannins found in pomegranates, punicalagins, punicalin, strictinin A, and granitin B reduce the formation of nitric oxide and the expression of inflammatory

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

cytokines. Pomegranates have been shown to promote gum health, bolster teeth, and stop teeth from coming loose. Phenolic chemicals can cause membrane proteins to precipitate and limit enzyme activity, which kills bacteria. *Staphylococcus aureus* and hemorrhagic *Escherichia coli* can be treated with punicalagin, ellagitannin, ellagic acid, and gallic acid. *Punica granatum*, or pomegranate, has long been celebrated for its health benefits, including its potent antioxidant, anti-inflammatory, and antimicrobial effects. The peel of the pomegranate fruit is rich in tannins, flavonoids, and alkaloids, which have shown significant antibacterial activity against oral pathogens such as *Streptococcus mutans*. Pomegranate peel extract has also been found to enhance enamel remineralization and prevent plaque accumulation, making it a valuable component in the treatment of dental caries.



Figure 1. Pomegranate peels

Curry Leaves (*Murraya koenigii*):

In Indian traditional medicine, the *Murraya koenigii* plant is used extensively as a herb, spice, and condiment in addition to being used to treat a variety of illnesses. Approximately 80% of the world's population depends on herbal products due to their perceived safety, effectiveness, and affordability. The goal of the current study was to review the *Murraya koenigii* plant's pharmacological, phytochemical, pharmacogenetic, and ethion botanical characteristics. Many indigenous communities make extensive use of this plant's many parts. The plant's leaves are used internally for vomiting and dysentery, as well as as a tonic, stomachic, and carminative. used as an analgesic, an anthelmintic, a piles remedy, and to relieve body heat, thirst, inflammation, and irritation. Researchers have tried to confirm the plant's effectiveness by rigorous biological screening after it was claimed to cure a wide range of illnesses. Curry leaves, or *Murraya koenigii*, are a plant indigenous to the Indian subcontinent. Because of its antibacterial, antioxidant, and anti-inflammatory

qualities, it has been utilized in traditional medicine. Curry leaves contain alkaloids and essential oils that have been demonstrated in studies to suppress the growth of cariogenic bacteria, including **Streptococcus mutans**, a major pathogen implicated in the formation of dental caries. Additionally, curry leaves have shown potential in reducing inflammation in oral tissues.



Figure 2. *Murraya koenigii*

Acacia catechu Extract:

Historically, the herb Khadir (*Acacia catechu*) has been significant due to its therapeutic qualities. It is a member of the Fabaceae and Mimosoideae families. The word "acacia," which means "point" in Greek, is the source of its genus name. The term 'cutch,' which refers to a tanning extract that is extracted from the heartwood, is where the species name comes from. Five Balapatra (small leaves), vakrakanta (because of hooked spines), dantadhavana (good for teeth), kantha (good for throat), kushthaghna (anti-dermatosis), and many other synonyms are used for this plant in Ayurveda. In Sanskrit, the word "khadir" denotes "that which stabilizes the body and diseases." Known by another name, Katha is a typical component of pan, a betel leaf mixture that is chewed after meals in India. Complex disorders of the gingiva and the tissues that support teeth, periodontal diseases are characterized by the inflammatory destruction of these tissues brought on by microbes. If left untreated, they may progress to significant damage to soft tissues, bone resorption, and ultimately, tooth loss.³ As our knowledge of multi-cause etiology and pathophysiology grows, so does the concept of therapeutic patterns. The use of antibiotics as a supplement to mechanical therapy has captured the interest of physicians in recent. *Acacia catechu*, commonly known as black catechu, is an evergreen tree native to Southeast Asia. It has been used in folk medicine for its astringent and antimicrobial properties. The active compounds in *Acacia catechu*, such as tannins and flavonoids, are effective in

reducing bacterial growth and plaque formation in the mouth. Studies have shown that *Acacia catechu* extracts can significantly inhibit the growth of *Streptococcus mutans* and *Lactobacillus acidophilus*, two key bacteria responsible for tooth decay.



Figure 3. *Acacia catechu*

Guava leaves extract (*Psidium guajava*)

Guava, or *Psidium guajava*, is a phytotherapeutic plant with antibacterial, antiparasitic, hepatoprotective, antioxidant, antigenotoxic, antimutagenic, antiallergic, anticancer, and antihyperglycemic properties. It has been found that the antibacterial activity of *L. acidophilus*, a cariogenic bacterium, is comparable to that of chlorhexidine. Because of its long-standing antiviral, antifungal, and antibacterial qualities, *Psidium guajava* has been utilized as medicine since ancient times. It has been proposed that allicin resistance develops 1,000 times more slowly than it does for some antibiotics. There is little research on *P. guajava*'s impact on periodontal infections, despite the fact that it is a naturally occurring plant with antibacterial properties. Therefore, the purpose of the study was to assess the effectiveness of garlic and guava extracts as antimicrobial agents against periodontal infections, primarily *Gingivitis Porphyromonas*. *Psidium guajava*, or guava, is a tropical fruit with a wide array of medicinal properties. The leaves of the guava plant contain flavonoids, tannins, and other bioactive compounds that have demonstrated antibacterial and anti-inflammatory effects. Guava leaf extracts have been shown to inhibit the growth of *Streptococcus mutans* and *Lactobacillus acidophilus*, thereby reducing the incidence of dental caries. Guava leaf extract also possesses astringent properties, which help in tightening the gums and preventing gingivitis.



Figure 4. *Psidium guajava*

Review of literature:

• Dental Caries Overview

Tooth decay, also known as dental caries, is one of the most common chronic diseases in the world and affects people of all ages. The World Health Organization (WHO) reports that dental caries affects between 60 and 90 percent of school-age children and many adults globally. The condition arises when acids generated by oral bacteria erode the tooth's enamel, which is its hard outer covering. These bacteria mostly consume sugar, which causes them to produce acids that demineralize enamel and cause cavities.

Current treatments for dental caries include restorative procedures such as fillings, crowns, and root canals. Preventive methods often involve the use of fluoride-based products like toothpaste and mouthwashes, which help remineralize the enamel and inhibit bacterial growth. However, fluoride treatments have been met with growing concerns over potential toxicity with overuse and the development of fluoride resistance in certain bacterial strains. Additionally, the widespread use of fluoride has led to concerns about its environmental impact. The limitations of current treatment options have spurred interest in alternative, natural remedies, such as herbal medicine, for preventing and treating dental caries. Herbal medicines have long been used for their therapeutic properties and are seen as a promising solution for managing dental health issues in a more sustainable and natural manner.

• Role of Herbal Medicine in Dentistry

For ages, traditional medical systems like Ayurveda and Traditional Chinese Medicine have used herbal medicines in tooth care. It has been demonstrated that plants with bioactive chemicals have antibacterial, anti-inflammatory, and antioxidant qualities that are advantageous for dental health. Flavonoids, tannins, alkaloids, and terpenoids—compounds known to suppress the growth of oral infections, lower inflammation, and encourage remineralization—are

found in many herbal remedies. In the context of dental caries, herbal medicines have gained attention for their ability to not only combat the harmful bacteria that cause cavities but also for their potential to remineralize and protect tooth enamel. Research in the past decade has revealed that natural products like plant extracts can help in preventing caries and promoting overall oral hygiene, offering a promising alternative to synthetic chemical-based treatments.

• Synergistic Effects of Herbal Combinations

Recent research has emphasized the benefits of combining multiple herbal extracts to maximize their therapeutic effects. In the context of dental caries, combining the antimicrobial properties of *Murraya koenigii*, *Acacia catechu*, *Punica granatum*, and *Psidium guajava* offer a multi-faceted approach to both preventing the formation of dental plaque and promoting the remineralization of tooth enamel. The synergistic effects of these herbs could potentially reduce the overall microbial load in the oral cavity while enhancing the tooth's resistance to decay. Combining herbal ingredients with proven antibacterial properties, such as those found in the herbs discussed above, creates a more effective formulation that can provide both antimicrobial action and enamel remineralization, addressing the core issues associated with dental caries in a natural and holistic manner.

METHODS:

• Plant collection and identification:

The selected crude plant materials that are *Punica granatum* (peel) and *Psidium guajava* (leaves) *Murraya koenigii* (leaves) and *Acacia catechu* extract were collected.

• Extraction:

a. Pomegranate (Peels):

The powder was extracted for 36 hours using distilled water. After that, a water bath was used to concentrate the water-based extract. A semisolid, sticky extract was then created.

b. *Murraya koenigii* (leaves):

To extract *Murraya koenigii* for chewable tablets targeting dental caries, fresh leaves are washed, shade-dried, and ground into a fine powder. For ethanol extraction, 50 g of powder is soaked in 500 mL of 70% ethanol for 48 hours, filtered, and concentrated using a rotary evaporator. Alternatively, for aqueous extraction, the powder is boiled in water, filtered, and concentrated. The extract can be freeze-dried for stability and stored in airtight containers at 4°C. Around 50–100 mg of extract can be used per tablet, along with natural sweeteners (xylitol) and binders (acacia gum). This ensures that antibacterial and antioxidant compounds like carbazole alkaloids and phenolics are preserved for dental health benefits.

c. *Acacia Catechu* Extract:

To extract *Acacia catechu* (black catechu), follow these steps: Wash and shade-dry the bark or heartwood, then grind it into a fine powder. For ethanol extraction, soak 50 g of powder in 500 mL of 70% ethanol for 48 hours, filter, and concentrate using a rotary evaporator at 40°C. For aqueous extraction, boil 50 g of powder in 500 mL of distilled water for 1 hour, cool, filter, and concentrate. The extract can be freeze-dried for stability and stored in airtight containers at 4°C to retain tannins and catechins for antimicrobial and antioxidant benefits.

d. *Psidium guajava* (leaves):

To extract *Psidium guajava* (guava leaves), wash and shade-dry the leaves, then grind them into a fine powder. For ethanol extraction, soak 50 g of powder in 500 mL of 70% ethanol for 48 hours, filter, and concentrate using a rotary evaporator at 40°C. For aqueous extraction, boil 50 g of powder in 500 mL of distilled water for 1 hour, cool, filter, and concentrate. The extract can be freeze-dried for stability and stored in airtight containers at 4°C to preserve antibacterial and antioxidant compounds like flavonoids, tannins, and guajavins.

Other than extract, material used for preparation of tablets was:

Table 1: Excipient used in tablet

Sr. No.	Name of chemical	Supplier	Use/application
1.	Calcium Carbonate	Modern industries (C-74) MIDC, Malegaon, Sinner (Nashik).	Remineralization strengthens enamel.
2.	Microcrystalline Cellulose	Modern industries (C-74) MIDC, Malegaon, Sinner (Nashik).	Binder, Enhance tablet strength.
3.	Menthol or peppermint	Modern industries (C-74) MIDC, Malegaon, Sinner (Nashik).	Cooling effects, flavor.
4.	Natural sweeteners 1. Stevia extract 2. Xylitol	Modern industries (C-74) MIDC, Malegaon, Sinner (Nashik).	Non-cariogenic sweeteners Sugar alcohol prevents cavities.
5.	Cross-linked starch or Croscarmellose sodium	Modern industries (C-74) MIDC, Malegaon, Sinner (Nashik).	Disintegrate; enhance fast breakdown.

Experimental Work**A. Pre-formulation characterization of herbs****Phytochemical investigation of selected herb****Table 2: Preliminary phytochemical investigation**

Sr. No.	Test	Phytochemical
1.	Wagner's test: Few ml of extract filtrate + 1-2 drops of Wagner's reagent	Alkaloids.
2.	Molisch test: 2 ml filtrate. + 2 drops of alcoholic α -naphthol + 1 ml conc. H_2SO_4 .	Carbohydrate.
3.	Benedict's test: 0.5 ml filtrate + 0.5 ml Benedict's reagent + boiled for 2 min	Reducing sugar.
4.	Killer -killani test: 1 ml filtrate + 1.5 ml glacial acetic acid + 1 drop of 15% ferric chloride + conc. H_2SO_4 .	Glycosides.
5.	Ninhydrin test: 2 ml filtrate + 2 drops of ninhydrin solution.	Amino acid.
6.	Lead acetate test: 1 ml plant extract + a few drops of 10% lead acetate solution	Flavonoids.
7.	Ferric chloride test: Extract aqueous solution + a few drops of 5% ferric chloride solution	Phenolic compounds.
8.	Lieberman Burchard test: 5 mg extract is dissolved in 2 ml acetic anhydride + 1-2 drops of conc. H_2SO_4 .	Steroids.

B. Preparation of granules for tablets**• Wet granulation method**

Here, the powdered herb extract was combined with all of the ingredients. Pomegranate peel extract and acacia catechu extract were then added to the powder in a semisolid state until a moist mass formed. The mixture was then sieved through a 16-mesh sieve to create granules. In a hot air oven, the granules were dried at 60 °C. To create granules of consistent size, the dried granules are subsequently passed through a

16-mesh filter. The combination powders were analyzed and assessed by pre-formulation tests before the tablets were compressed. The combination powders were then compressed into tablets using a multi-station tableting machine.

- Batch size: 30 tablets
- Punch size: 8 mm
- Tooling: D tooling

Table 3: Formulation Table

Sr. no.	Batches no. Ingredient (mg/tab)	F1	F2	F3
1.	<i>Murraya koenigii</i> extract.	60 mg	60 mg	60 mg
2.	Acacia catechu extract.	50 mg	50 mg	50 mg
3.	<i>Punica granatum</i> extract.	50 mg	50 mg	50 mg
4.	<i>Psidium guajava</i> extract.	40 mg	40 mg	40 mg
5.	Calcium Carbonate	90 mg	80 mg	70 mg
6.	Microcrystalline Cellulose	110 mg	120 mg	130 mg
7.	Menthol or peppermint	5 mg	5 mg	5 mg
8.	Natural sweeteners 1. Stevia extract 2. Xylitol	10 mg 50 mg	20 mg 50 mg	20 mg 40 mg
9.	Cross-linked starch or croscarmellose sodium	25 mg	25 mg	35 mg

C. Characterization study:**a. Pre-compression evaluation**

The prepared granules were studied for the following parameters:

1. Bulk density:

Density in bulk After precisely weighing the 10 g of powder combination, it was carefully poured without compacting into a 100 ml glass cylinder. After recording the powder mixture's volume, the following calculation was made:

Bulk density = $m / v \times 10$ m = mass (g)

V_0 = unsettled apparent volume (cm^3)

2. Tapped density:

Tapped density was tested using a glass cylinder filled with a powder combination from bulk density testing. After recording the tapped powder mixture's volume, the following calculation was made:

Tapped density = $M / v \times f$ m = mass (g)

$V \times f$ = final tapped volume (cm^3)

3. Hausner's ratio:

It is a clear indicator of how simple it is to measure the powder flow. The Hausner ratio was computed in this way:

Hausner ratio = $V_0 / V \times f$

V_0 = unsettled apparent volume (cm^3) $V \times f$ = final tapped volume (cm^3).

4. Carr's index:

The following compressibility index was calculated using data from bulk density and tapped density testing:

Compressibility index = $[(\text{Taped density} - \text{Bulk density}) / \text{Tapped density}] \times 100$

5. Angle of repose:

We looked at the angle of repose using the fixed funnel method. Five grams of the powdered mixture were placed in a glass funnel. The lowest tip of the glass funnel was 3 cm above the ground. after the pile's height (h) and radius (r) have been measured and computed.

$\Theta = \tan^{-1}(h/r)$

height (cm) r-radius (cm)

Θ = angle of repose

Relationship between angle of repose, hammer's ratio, percent compressibility, and low property.

Table 4: Pre-compression characteristics

Flow characteristics	Angle of Repose	Hausner's Ratio	Percent compressibility
Excellent	25-30	1.00-1.11	1-10
Good	31-35	1.12-1.18	11-15
Fair	36-40	1.19-1.25	16-20
Passable	41-45	1.26-1.34	21-25
Poor	46-55	1.35-1.45	26-31
Very poor	56-65	1.46-1.59	32-37
Extremely poor	>66	>1.60	>38

b. Post-compression evaluation

Variations in weight Variations in weight Each of the 20 pills was precisely weighed.

1. Friability

The tablet dust was eliminated before testing. Ten pills were carefully weighed together, and their friability was assessed using a Roach Friability tester. After rotating the tablets for four minutes at 25 rpm, any loose dust was removed, and then they were precisely weighed again. If the friability was less than 1.0%, it was considered acceptable.

2. Thickness

The tablet's thickness was measured using a digital Vernier caliper. For this test, six tablets were used, and mm was the unit of measurement. To assess thickness, the tablet was positioned between the jaws

3. Dissolution test

The process of dissolution causes a solid to dissolve into a solution. The dissolving rate is the quantity of medication component that dissolves at a certain rate under controlled conditions of temperature, liquid/solid interface, and solvent composition. Dissolution, sometimes regarded as a method for determining bioavailability, is one of the most important quality assurance processes. The best way to evaluate a drug's release from various tablet forms is to measure

it's in vivo bioavailability. The USP Dissolution Apparatus II equipment was used in this investigation.

4. Disintegration time

Disintegration, a technique that breaks down tablets into tiny pieces, is the first crucial step towards a solution for the majority of tablets.

The tablet's DT was determined using an electro lab disintegration tester and phosphate buffered saline (PBS) buffer (pH 7.4) at $37 \pm 0.5^\circ\text{C}$.

Result and Discussion

- Preparation of tablets:**

The wet granulation process was employed to create chewable tablets using an ethanolic extract of pomegranate peel powder, Psidium guajava (leaves), Murraya koeniggi, and Acacia catechu. Table 5 listed the components of the chewable tablet made from herbal extract. When formulas I and II were first tried, it was found that they became sticky at the granulation stage. Since xylitol is hygroscopic, it was decided to gradually decrease the amount of xylitol and increase the amount of starch in formulas F2 and F3, as well as increase the amount of stevia extract to adjust sweetness. Formula 3 was then used for the formulation of chewable tablets.

- Chewable tablets evaluated as per IPQC tests:**

Pre-compression test as shown in table 5.

Table 5: Pre-compression study

Sr. no.	Test	Observation	Conclusion
1	Angle of repose	28 degrees	Excellent
2	Bulk density	0.5998	Excellent
3	Tapped density	0.6187	Excellent
3	Carr's index	3.409	Excellent
4	Hausner ratio	1.845	Excellent

The pills were assessed for the tablets' physical characteristics, which were homogeneous, smooth, and free of cracks. A variety of performance characteristics were assessed for the chewable pills. Using a Monsanto hardness tester, the hardness test was conducted to determine the

strength of the tablets. The tablet should be sufficiently firm for shipping and packaging but not so firm that it becomes difficult to chew. Six (kg/cm²) was the hardness. It was discovered that the tablet's friability was 0.52% after compression, as indicated in Table 6.

Table 6: Post-compression study

Sr. No.	Test	Observation
1	Average thickness	415 mg
2	Thickness	3 mm
3	Friability	0.52%
4	Hardness	6 kg/cm ²

• Streptococcus mutans antibacterial activity in vitro

Using the agar diffusion technique, the antibacterial activity of chewable tablets containing pomegranate peel powder, Psidium Guajava (leaves), Murraya Koeniggi, and Acacia Catechu extracts was evaluated against Streptococcus mutans (13–15) (MTCC 497t). Table 7 Significant antibiotic action against Streptococcus mutans (497t) was demonstrated by an

ethanolic extract of pomegranate peel powder, Psidium Guajava (leaves), Murraya Koeniggi, and Acacia Catechu extract and its chewable tablet. According to CLSI recommendations, MIC was calculated using the 10x cup plate technique using brain heart infusion broth (Oxoid/Difco). The finding leads to the conclusion that the components responsible for the antibacterial action are present in the chewable tablet of herbal extract

Table 7: Using herbal extract to combat S. mutans

Sr. No.	concentration (µg/ml)	Conc. in well (mg)	Zone of inhibition (mm)
1	1000	25	39
2	500	12.25	32
3	250	6.25	27
4	125	3.12	18
5	62.5	1.56	17
6	31.25	0.8	0.3
7	DMSO	25	-

CONCLUSION:

A single herb or mixtures of multiple plants thought to have complementary and synergistic properties can be found in herbal products. Several phytoconstituents, including alkaloids, carbohydrates, triterpenoids, flavonoids, and others, were found in the plants employed in this study according to preliminary phytochemical analyses. Dental caries may be treated using a chewable tablet made from pomegranate peel powder extract, Psidium guajava (leaves), Murraya koeniggi, and Acacia catechu

REFERENCE

1. Nyamweya, N. N., & Kimani, S. N. (2020). Chewable tablets: A review of formulation considerations. *Pharmaceutical Technology*, 44(11), 38–44.
2. U.S. Food and Drug Administration. (2018). Quality attribute considerations for chewable tablets: Guidance for industry. FDA Guidance for Industry. Retrieved from <https://www.fda.gov>
3. Mutha, S. (2022). Formulation, development, and evaluation of chewable tablets of dicyclomine hydrochloride. *International Journal of Health Sciences*, 6(2), 1224–1235.
4. Khokra, S. L., & Parashar, B. (2010). Formulation development and evaluation of chewable tablets of mebendazole nanoparticles to enhance oral bioavailability. *International Journal of Pharmaceutical Sciences and Research*, 1(11), 51–58.
5. Chahal, K. K., Kumar, A., Bhardwaj, U., Kaur, R., & Singla, N. (2017). Chemistry and biological activities of Murraya koenigii: A review. *Journal of Pharmacognosy and Phytochemistry*, 6(4), 530–539.
6. Gahlawat, D. K., & Jakhar, S. (2013). Murraya koenigii (L.) Spreng: An ethnobotanical, phytochemical, and pharmacological review. *Journal of Pharmacognosy and Phytochemistry*, 2(3), 123–127.
7. Singh, M., Govindarajan, R., & Rawat, A. K. S. (2008). High-performance liquid chromatography method for quantification of catechins in heartwood of Acacia catechu and marketed Ayurvedic formulations. *Journal of AOAC International*, 91(1), 47–52.
8. Manuja, N., Nagpal, R., Kaur, H., & Jain, S. (2014). Antimicrobial activity of Acacia catechu against various periodontal pathogens: An in vitro study. *Journal of Indian Society of Periodontology*, 18(2), 194–198.
9. Bhowmik, D., Gopinath, H., Kumar, B. P., Duraivel, S., & Aravind, G. (2013). Medicinal uses of Punica granatum and its health benefits. *Journal of Pharmacognosy and Phytochemistry*, 1(5), 28–35.
10. Hayrapetyan, H., Hazeleger, W. C., & Beumer, R. R. (2012). Antimicrobial activity of pomegranate

- peel extracts on *Listeria monocytogenes*. *Food Control*, 23(1), 66–72.
11. Jaiswal, R., & Kuhnert, N. (2014). Identification and characterization of five new classes of chlorogenic acids in guava (*Psidium guajava*) leaves. *Food Chemistry*, 154, 62–66.
 12. Gutiérrez, R. M. P., Mitchell, S., & Solis, R. V. (2008). *Psidium guajava*: A review of its traditional uses, phytochemistry, and pharmacology. *Journal of Ethnopharmacology*, 117(1), 1–27.
 13. Lachman, L., Lieberman, H. A., & Kanig, J. L. (1990). *The theory and practice of industrial pharmacy*. Lea & Febiger.
 14. Aulton, M. E., & Taylor, K. (2017). *Aulton's pharmaceuticals: The design and manufacture of medicines*. Elsevier Health Sciences.
 15. Allen, L. V., Popovich, N. G., & Ansel, H. C. (2013). *Ansel's pharmaceutical dosage forms and drug delivery systems*. Lippincott Williams & Wilkins.
 16. Nostro, A., Roccaro, A. S., Bisignano, G., et al. (2000). Effect of compounds isolated from plants on microbial adhesion. *Journal of Antimicrobial Chemotherapy*, 46(5), 853–860.
 17. Prabu, G. R., & Gnanamani, A. (2008). Antibacterial activity of some Indian traditional plant extracts. *Asian Journal of Pharmaceutical and Clinical Research*, 1(1), 17–22.
 18. *Indian Pharmacopoeia (IP)* 2018.
 19. *United States Pharmacopeia (USP)* 2023.
 20. *European Pharmacopoeia (Ph. Eur.)* 2023.

HOW TO CITE: Umesh Jadhav*, Nikam H. M., Pavan Hadole, Avinash Gite, Capsaicin used in Treatment of Post-Herpetic Neuralgia Disease, *Int. J. Sci. R. Tech.*, 2025, 2 (1), 423-431. <https://doi.org/10.5281/zenodo.14745684>