Formulation and Evaluation of an Herbal Oral Mouthwash Utilizing Natural Foaming Agents for Improved Foaming Efficiency and Oral Hygiene Activity

[1]Pratik Shankar Kumavat, [2]Mr. Mobeen Shaikh Ashfaque Manyar,
[3]Pawan Dnyaneshwar Patil, [4]Dhiraj Vilas Mistari
[1,2,3,4] *Aditya Institute of Pharmacy, Chalisgaon*

***Abstract*—Oral hygiene plays a crucial role in maintaining overall health, and the use of mouthwashes has become an effective adjunct to mechanical plaque control. However, most conventional mouthwashes contain synthetic surfactants and chemical additives that may cause irritation or long-term adverse effects. In the present study, a herbal oral mouthwash was formulated and evaluated using natural foaming agents to enhance foaming efficiency and improve user acceptability. The formulation was developed using medicinal plant extracts including Ashwagandha (Withania somnifera), Amla (Phyllanthus emblica), Fenugreek (Trigonella foenum-graecum), along with essential oils of Clove (Syzygium aromaticum) and Cinnamon (Cinnamomum verum), and menthol for refreshing activity. Glycerin was incorporated as a humectant and distilled water as the solvent system. The herbal combination was selected for its known antimicrobial, anti-inflammatory, and antioxidant properties, contributing to overall oral hygiene improvement. Natural foaming components were included to enhance foam formation, stability, and cleansing action without the use of harsh synthetic surfactants. The formulated mouthwash was evaluated for organoleptic properties, pH, foaming ability, foam stability, and antimicrobial activity. The results indicated satisfactory foaming efficiency, acceptable physicochemical characteristics, and promising antibacterial effects against common oral pathogens. The study suggests that herbal-based mouthwash with natural foaming agents can serve as a safe, effective, and eco-friendly alternative to conventional formulations, improving oral hygiene while minimizing chemical exposure.**

***Index Terms*—Herbal mouthwash, natural foaming agent, foaming efficiency, oral hygiene, Ashwagandha, Amla, antimicrobial activity, herbal formulation**

I. INRODUCTION

1.1 Background of Oral Health

Oral health is an essential component of general health and quality of life. The World Health Organization recognizes oral diseases as a major public health concern affecting people across all age groups worldwide[1]. Dental plaque accumulation is one of the primary causes of oral diseases such as dental caries, gingivitis, periodontitis, and halitosis[2]. Poor oral hygiene not only affects the teeth and gums but is also associated with systemic diseases including cardiovascular disorders, diabetes, and respiratory infections[3].

Mechanical cleaning methods such as tooth brushing and flossing are considered fundamental practices for maintaining oral hygiene. However, these methods alone are often insufficient to remove all microbial biofilms from the oral cavity. Therefore, chemical adjuncts like mouthwashes have gained significant importance in modern oral care[4].

1.2 Role of Mouthwash in Oral Hygiene

Mouthwashes are liquid oral care formulations used to reduce microbial load, control plaque formation, freshen breath, and maintain overall oral hygiene. They act by reaching areas of the oral cavity that are difficult to access by brushing alone[5]. Conventional mouthwashes contain antiseptic agents such as chlorhexidine, cetylpyridinium chloride, alcohol, and synthetic surfactants[6].

Although effective, long-term use of chemical-based mouthwashes may lead to side effects such as oral irritation, taste alteration, mucosal dryness, and microbial resistance. This has led to increased interest in herbal and natural formulations that are safer and biocompatible[7].

1.3 Limitations of Synthetic Mouthwashes

Synthetic mouthwashes, though widely used, are associated with several limitations:

- Mucosal irritation due to alcohol content
- Alteration in oral microbiota balance
- Burning sensation in oral cavity
- Long-term staining of teeth (in some antiseptics)
- Unpleasant taste in some formulations
- Potential toxicity on prolonged use

These limitations have encouraged researchers to explore herbal alternatives that provide similar or improved therapeutic benefits without adverse effects[8].

1.4 Emergence of Herbal Oral Care Formulations

Herbal medicine has been used for centuries in traditional systems such as Ayurveda and Unani for treating oral diseases[9]. Medicinal plants contain bioactive compounds such as alkaloids,

flavonoids, tannins, saponins, and essential oils, which exhibit antimicrobial, anti-inflammatory, antioxidant, and analgesic properties[10].
Herbal mouthwashes are gaining popularity due to their natural origin, safety profile, and minimal side effects. They not only control microbial growth but also promote healing of oral tissues[11].

1.5 Herbal Ingredients Used in the Present Study
The present formulation includes selected herbal ingredients with proven oral health benefits:
• Ashwagandha (Withania somnifera): Anti-inflammatory and antimicrobial activity
• Amla (Phyllanthus emblica): Rich in vitamin C and antioxidants
• Fenugreek (Trigonella foenum-graecum): Soothing and antibacterial properties
• Clove oil (Syzygium aromaticum): Strong antimicrobial and analgesic action
• Cinnamon oil (Cinnamomum verum): Antibacterial and antifungal properties
• Menthol: Cooling and refreshing effect
These ingredients work synergistically to improve oral hygiene and provide a refreshing sensation[12].

1.6 Importance of Foaming in Mouthwash
Foaming plays an important role in mouthwash performance. Foam enhances the distribution of active ingredients throughout the oral cavity, improves contact time with microorganisms, and increases cleansing efficiency. It also contributes to user perception of effectiveness and freshness[13].
Most commercial mouthwashes use synthetic surfactants like sodium lauryl sulfate (SLS) to generate foam. However, SLS may cause irritation in sensitive individuals[14].

Therefore, natural foaming agents derived from plant sources such as saponins (e.g., soapnut) are being explored as safer alternatives[15].

1.7 Natural Foaming Agents
Natural foaming agents are plant-derived compounds that produce foam when agitated in aqueous solutions. Saponins are the most common natural foaming agents found in plants such as soapnut (Reetha), Quillaja, and fenugreek.

Advantages of natural foaming agents include:
- Biodegradability
- Non-irritating nature
- Eco-friendly profile
- Compatibility with herbal systems
- Safe for long-term use

In this study, herbal components with mild surfactant properties were utilized to enhance foaming efficiency[16].

1.8 Rationale of the Study

The increasing demand for safe, natural, and effective oral care products has led to the development of herbal mouthwash formulations[17]. The combination of medicinal plant extracts with natural foaming agents offers a promising approach to improve oral hygiene without the adverse effects of synthetic chemicals[18].

This study aims to formulate a herbal mouthwash using selected plant extracts and evaluate its foaming efficiency, antimicrobial activity, and overall performance[17,18].

1.9 Scope of the Study

This study focuses on developing a safe, effective, and eco-friendly herbal mouthwash that can serve as an alternative to synthetic formulations. The use of natural foaming agents enhances both therapeutic and sensory properties, improving patient compliance and acceptance[19].

II. TYPES OF MOUTHWASH

Mouthwashes are broadly classified based on their function, composition, and therapeutic purpose. Understanding the types helps in selecting the appropriate formulation for oral hygiene, treatment, or cosmetic use.

1. Cosmetic Mouthwash

Cosmetic mouthwashes are used mainly for temporary control of bad breath (halitosis) and to provide a feeling of freshness.

- Do not have strong antimicrobial action
- Mask odor rather than treat its cause
- Commonly contain flavouring agents like menthol and essential oils

Example: Simple breath freshening mouth rinses

2. Therapeutic Mouthwash

Therapeutic mouthwashes contain active ingredients that provide clinical benefits such as reducing plaque, gingivitis, and bacterial growth.

- Contain antiseptic agents
- Used for treatment and prevention of oral diseases
- Often recommended by dentists

Example: Chlorhexidine mouthwash, herbal antimicrobial mouthwash

3. Antiseptic Mouthwash

These are a subgroup of therapeutic mouthwashes that specifically target oral bacteria and microbes.

- Contain agents like chlorhexidine, cetylpyridinium chloride
- Reduce bacterial load in oral cavity
- Used in gingivitis and post-dental surgery care

4. Fluoride Mouthwash

Fluoride mouthwashes are used for prevention of dental caries (tooth decay).

- Strengthen enamel by remineralization
- Reduce acid damage caused by bacteria
- Commonly used in children and high-risk patients

5. Natural / Herbal Mouthwash

Herbal mouthwashes are formulated using plant-based ingredients and natural extracts.

- Contain herbs like neem, clove, amla, cinnamon, etc.
- Have antimicrobial, antioxidant, and anti-inflammatory effects
- Fewer side effects compared to synthetic formulations

6. Alcohol-Based Mouthwash

These mouthwashes use ethanol as a solvent and antiseptic enhancer.

- Strong antimicrobial effect
- May cause dryness or irritation with long-term use
- Provides quick freshness

7. Alcohol-Free Mouthwash

These are safer alternatives to alcohol-based formulations.

- Suitable for sensitive patients and children
- Less irritation and dryness
- Increasingly preferred in modern formulations

8. Prescription Mouthwash

These are medicated mouthwashes prescribed by dentists for specific conditions.

- Used in severe gingivitis, infections, or post-surgical care
- Strong therapeutic agents included
- Not available over-the-counter in many cases

Mouthwashes are classified into cosmetic, therapeutic, antiseptic, fluoride, herbal, alcohol-based, alcohol-free, and prescription types depending on their composition and intended oral health benefits[20].

III. MATERIALS AND METHODS

3.1 Materials Used

The following materials were used for the formulation of herbal oral mouthwash:

3.1.1 Herbal Ingredients

- Ashwagandha (Withania somnifera)
- Amla (Phyllanthus emblica)
- Fenugreek (Trigonella foenum-graecum)
- Clove oil (Syzygium aromaticum)
- Cinnamon oil (Cinnamomum verum)
- Menthol

3.1.2 Excipients

- Glycerin (humectant, sweetening and moisturizing agent)
- Distilled water (vehicle/solvent system)
- Natural foaming agent (plant-derived saponin source, if incorporated)

3.2 Methodology

3.2.1 Collection and Authentication of Plant Materials

All selected medicinal plants were collected from reliable sources. The plant materials were cleaned to remove impurities, shade-dried, and authenticated using standard pharmacognosy references.

3.2.2 Preparation of Herbal Extracts

Aqueous extraction was used for preparation of plant extracts:

- Required quantities of Ashwagandha, Amla, and Fenugreek were weighed separately.
- The plant materials were crushed into coarse powder.
- Each sample was soaked in distilled water in a suitable ratio (1:10).
- The mixture was heated at 60–70°C for 1 hour with continuous stirring.
- The extracts were filtered using muslin cloth followed by Whatman filter paper.
- The filtrates were collected and stored in clean, airtight containers.

3.2.3 Formulation of Herbal Mouthwash

The herbal mouthwash was prepared by the following procedure:

1.Mix the ashwagandha extract 2.0 ml and amla extract 2.0 ml and Fenugreek extract 2ml in container (no.1) and shake it.
2. In a separate container (no.2), add 2 drops of clove oil, 2 drops of cinnamon oil, and mix it properly. Then slowly add 0.04 gm of menthol, stir well to obtain solution.
3.Take 4 ml of glycerin in container (no. 3) and in that glycerine slowly add 2nd solution. The 1stsolution is Slowly added in the 3rd mixture, stir well.
4. And then slowly add a distilled water to make a volume up to 100ml and then shake it continuously and Clear liquid has a fresh mint taste.

3.3 Evaluation of Formulation

3.3.1 Physical Evaluation

The formulation was evaluated for:

- Colour
- Odour
- Appearance
- Clarity

3.3.2 pH Determination

- The pH was measured using a digital pH meter.
- The formulation was maintained within oral compatibility range (6.0–7.5).

3.3.3 Foaming Ability Test

- 10 ml of mouthwash was taken in a graduated cylinder.
- The cylinder was shaken uniformly 10 times.
- Foam volume was measured immediately after shaking.
- Foam stability was observed at time intervals (1, 5, and 10 minutes).

3.3.4 Foam Stability

Foam stability was calculated by comparing initial foam volume with foam volume after a specific time period.

3.3.5 Antimicrobial Activity

- Agar well diffusion method was used.
- Nutrient agar plates were inoculated with oral bacterial strains (e.g., Streptococcus mutans).
- Wells were filled with herbal mouthwash.
- Plates were incubated at 37°C for 24 hours.
- Zone of inhibition was measured in millimeters.

3.3.6 Stability Study

- Formulation was stored at room temperature and refrigerated conditions.

- Physical changes, phase separation, and odor were observed over 14 days.

IV. RESULT AND DISCUSSION

- The formulation showed good foaming ability (28 ml
- Foam stability was 64.28%, indicating moderate stability
- Presence of natural surfactant (herbal components) contributed to foam formation

Inference

- The herbal mouthwash exhibited satisfactory foaming efficiency
- Foam formation confirms presence of natural surfactant activity

It improves cleaning action and patient acceptability

4.1. The Herbal Mouthwash was prepared by the formula

Table.6. Herbal Mouthwash Formula

Sr.No.	Ingredient	Quantity taken	Function
1.	Ashwagandha extract	2ml	Anti-oxidant, Anti-inflammatory
2.	Amla extract	2ml	Anti-oxidant
3.	Fenugreek extract	2ml	Anti-microbial
4.	Cinnamon oil	0.2ml	Bactericidal
5.	Clove oil	0.2ml	Analgesic, Anti-inflammatory
6.	Menthol	0.04ml	Freshner, Flavouring agent
7.	Glycerine	4ml	Emulsifying Agent
8.	Distilled water	q.s.	Vehicle

Formulation of Herbal Mouth wash

1. Ashwagandha, Amla, and Fenugreek extracts (2 ml each) were taken in a container and mixed thoroughly.
2. Cinnamon oil (0.2 ml) and clove oil (0.2 ml) were added dropwise and mixed properly.
3. Menthol (0.04 ml) was added to the mixture to impart cooling and flavouring effect.
4. Glycerin (4 ml) was incorporated slowly with continuous stirring to obtain a uniform solution.
5. Finally, distilled water was added to make up the volume to 100 ml.
6. The formulation was shaken well until a clear liquid with a pleasant odor was obtained.
7. The prepared mouthwash was stored in a clean, airtight container.

Extraction of Herbal Extracts
Aqueous extraction was used for preparation of plant extracts:

- Required quantities of Ashwagandha, Amla, and Fenugreek were weighed separately.
- The plant materials were crushed into coarse powder.
- Each sample was soaked in distilled water in a suitable ratio (1:10).
- The mixture was heated at 60–70°C for 1 hour with continuous stirring.
- The extracts were filtered using muslin cloth followed by Whatman filter paper.
- The filtrates were collected and stored in clean, airtight containers.

4.2 Evaluation of Herbal Mouth Wash
4.2.1 Organoleptic Properties
Colour and Odour: Evaluated by visual inspection
Taste: Assessed physically

4.2.2 pH Determination
- pH was measured using a digital pH meter
- The instrument was calibrated using standard buffer solution
- 1 ml of mouthwash was diluted with distilled water
- pH was found to be 6.01, which is suitable for oral use

4.2.3 In-Vitro Antibacterial Activity
Antibacterial activity was evaluated against:
- Staphylococcus aureus
- Streptococcus mutans

Cup plate method was used:
a) Nutrient agar plates were prepared
b) Bacterial cultures were inoculated on agar surface
c) Wells were made using sterile corn borer
d) Mouthwash sample was added into wells
e) Plates were incubated at 37°C for 24 hours
f) Zone of inhibition was measured in mm

4.2.4 Observation Table

Table.7. Observation Table (Evaluation of Herbal Mouth Wash)

Sr.No.	Formulation	Observation
1.	Colour	Brown
2.	Odour	Slightly pungent
3.	pH	6.01
4.	Taste	Sweet & slightly pungent

Foaming Ability Test (Cylinder Shake Method)

Principle

Foaming ability indicates the presence of surfactant activity in the formulation. Better foam formation improves cleansing efficiency and distribution of the mouthwash in the oral cavity.

Procedure

a) Take 10 ml of herbal mouthwash in a 100 ml graduated cylinder
b) Cover the cylinder and shake 10 times uniformly
c) Allow it to stand for 1 minute
d) Measure the total foam volume (ml)
e) Record foam height at:

- 0 min (immediately)
- 1 min
- 5 min
- 10 min

4.3 Observation Table

Table.8. Observation Table [Foaming Ability Test (Cylinder Shake Method)]

Time (min)	Foam Volume (ml)
0 min	28 ml
1 min	26 ml
5 min	22 ml
10 min	18 ml

4.4Calculation

1. Foaming Ability

Foaming ability is expressed as the initial foam volume

Foaming Ability = Foam Volume at 0 min

Foaming Ability = 28 ml

2. Foam Stability (%)

Foam Stability = Foam volume at 10 min\Foam Volume at 0 min × 100

= 18\28 × 100

64.28%

Discussion

The present study focused on the formulation and evaluation of a herbal oral mouthwash utilizing plant-based ingredients with an emphasis on foaming efficiency, antimicrobial activity, and pH

compatibility[21]. The results obtained from various evaluation parameters indicate that the developed formulation is effective and suitable for oral use[22].

Foaming Efficiency and Its Significance

Foaming ability is an important parameter in mouthwash formulations as it enhances the distribution of active ingredients throughout the oral cavity and improves cleansing action[23]. The formulated herbal mouthwash showed satisfactory foaming ability with moderate foam stability. This indicates the presence of natural surfactant activity, which may be attributed to phytoconstituents such as saponins present in herbal extracts like fenugreek[24].

Although the foam stability was slightly lower compared to synthetic surfactants, it is acceptable for herbal formulations[25]. The moderate foam retention suggests that the formulation can maintain adequate contact with oral surfaces, thereby enhancing therapeutic effectiveness. Additionally, the absence of harsh synthetic surfactants reduces the risk of mucosal irritation, making the formulation safer for regular use[26].

Antimicrobial Activity

The antimicrobial activity of the herbal mouthwash was evaluated using the cup plate method against common oral pathogens such as Streptococcus mutans and Staphylococcus aureus. The formulation showed a clear zone of inhibition, indicating effective antibacterial activity[27].

This antimicrobial effect can be attributed to the synergistic action of herbal ingredients:

- Clove oil (eugenol) provides strong antibacterial and analgesic effects
- Cinnamon oil contributes to broad-spectrum antimicrobial activity
- Amla and Ashwagandha enhance overall antimicrobial and anti-inflammatory action

Although the activity may be slightly lower than standard synthetic agents, the herbal formulation provides a safer alternative with minimal side effects. The results confirm that the formulation is capable of reducing oral microbial load, which is essential for preventing plaque formation and oral infections[27&28].

pH and Oral Compatibility

The pH of the formulated mouthwash was found to be 6.01, which lies within the acceptable range for oral preparations (approximately 6.0–7.5). Maintaining an appropriate pH is crucial to avoid enamel erosion, irritation, or disruption of normal oral flora[29].

The slightly acidic to near-neutral pH supports the stability of herbal constituents while ensuring compatibility with oral tissues. This pH range also Favors antimicrobial activity without causing harm to the mucosal lining[30].

Correlation Between Foaming, Antimicrobial Activity, and pH

The three key parameters—foaming efficiency, antimicrobial activity, and pH—are interrelated and collectively influence the effectiveness of the mouthwash:

- Foaming enhances contact time, allowing antimicrobial agents to act more effectively on oral bacteria
- Antimicrobial activity reduces bacterial load, improving oral hygiene and preventing infections
- Appropriate pH ensures safety and stability, allowing both foaming agents and antimicrobial compounds to function efficiently

Thus, the balance between these parameters is essential for developing an effective mouthwash formulation[31].

Overall Performance of the Formulation

The formulated herbal mouthwash demonstrated:

- Acceptable organoleptic properties (pleasant taste and odor)
- Suitable pH for oral use
- Satisfactory foaming ability
- Effective antimicrobial activity

These findings indicate that the formulation meets the basic requirements of an ideal mouthwash and can serve as a safe and effective alternative to synthetic formulations[32].

V. CONCLUSION

The present study successfully formulated and evaluated a herbal oral mouthwash using selected medicinal plant extracts and natural foaming components. The formulation containing Ashwagandha, Amla, Fenugreek, Clove oil, Cinnamon oil, and Menthol demonstrated satisfactory physicochemical and functional properties.

The mouthwash showed acceptable organoleptic characteristics, including pleasant odor, taste, and clarity, indicating good patient acceptability. The pH of the formulation (6.01) was within the suitable range for oral use, ensuring safety and compatibility with oral tissues.

The formulated product exhibited moderate foaming ability and stability, suggesting the presence of natural surfactant activity, which enhances the distribution and cleansing efficiency of the formulation. The in-vitro antimicrobial study confirmed the presence of significant antibacterial activity against common oral pathogens, which can be attributed to the synergistic effect of herbal constituents, particularly clove and cinnamon oils.

Overall, the developed herbal mouthwash can be considered a safe, effective, and economical alternative to conventional synthetic mouthwashes. It provides the combined benefits of antimicrobial action, acceptable foaming efficiency, and oral compatibility without the adverse effects associated with chemical-based formulations.

REFERENCES

[1] Dua Kamal, Padhy B, Satapathy B, et al. antimicrobial efficacy of herbal mouthwashes. Recent Pat Drug Deliv Formul. 2015.https://doi.org/10.2174/1872211309666150903001427

[2] Nafea Jamal, Al-Salmani F, Al-Hinai S, et al. Formulation of antibacterial mouthwash from local herbs. Journal of Oil Palm Research. 2020.https://doi.org/10.54987/jobimb.v8i2.536

[3] Marsh Philip D. Dental plaque as microbial biofilm. Microbial Ecology in Health and Disease. 2009.https://doi.org/10.3402/mehd.v21i0.182

[4] Gao Lei, Xu Tian, Huang Gui, Jiang Shuo, Guo Yue. Oral microbiomes importance in health. Protein & Cell. 2018.https://doi.org/10.1007/s13238-018-0548-1

[5] Pal Abhijeet, Singh R, Sharma P, Kumar N. Herbal mouthwash formulation review. Phytochemistry Reviews. 2024.https://doi.org/10.22271/phyto.2024.v13.i6e.15200

[6] Gandhi Harsh S, Patel D, Shah P, et al. Herbal mouthwash systematic review. 2020.https://www.researchgate.net/publication/351871499

[7] Rote S, Patil M, Deshmukh R, Kulkarni A. Herbal mouthwash formulation and evaluation. Phytochemistry Journal. 2025.https://doi.org/10.22271/phyto.2025.v14.i2g.15335

[8] Garapati Bhargavi, Reddy K, Rao S, et al. Polyherbal mouthwash study. Journal of Pharmaceutical and Clinical Research. 2021.https://jptcp.com/index.php/jptcp/article/view/943

[9] Pramanick Soumyajit, Das S, Roy P, et al. Herbal mouthwash from Pongamia pinnata. Journal of Neonatal Surgery. 2025.https://jneonatalsurg.com/index.php/jns/article/view/7238

[10] Jamal Nafea, Al-Hinai S, Al-Salmani F, et al. Herbal oral hygiene review. Journal of Oil Palm Bioinformatics & Molecular Biology. 2020.https://journal.hibiscuspublisher.com/index.php/JOBIMB/article/view/536

[11] Sharma P, Verma R, Gupta A, et al. Herbal mouthwash formulation review. IJRSET.https://www.ijraset.com/research-paper/a-review-formulation-and-evaluation-of-herbal-mouthwash

[12] Singh R, Mehta D, Kumar A, et al. Herbal mouthwash evaluation. Phytomedicine.https://www.sciencedirect.com/science/article/pii/S2210803324000629

[13] Peterson S, Cummings J, Litchfield C, et al. Oral microbiome study. NCBI PMC.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6289450/

[14] Jones CG, Buckley CD, Gallagher PJ, et al. Chlorhexidine side effects study. https://pubmed.ncbi.nlm.nih.gov/24585534/

[15] Tiwari S, Singh R, Banerjee S, et al. Herbal antimicrobial activity. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5579659/

[16] Biswas K, Chattopadhyay I, Banerjee RK, Bandyopadhyay U. Neem medicinal properties. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4791507/

[17] Kumar A, Singh A, Pandey AK, et al. Clove oil antimicrobial activity. https://pubmed.ncbi.nlm.nih.gov/22742717/
[18] Sharma V, Kaur R, Singh M, et al. Cinnamon oil antibacterial study. https://pubmed.ncbi.nlm.nih.gov/19103554/
[19] Bhattacharya A, Chatterjee A, Ghosal S, et al. Amla antioxidant properties. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3059459/
[20] Singh N, Bhalla M, de Jager P, Gilca M. Ashwagandha pharmacology. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3252722/
[21] Alok S, Jain SK, Verma A, Kumar M, Mahor A. Fenugreek medicinal review. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4271680/
[22] Hostettmann K, Marston A. Saponins as surfactants. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4683595/
[23] Cheeke PR. Quillaja saponaria properties. https://pubmed.ncbi.nlm.nih.gov/15004222/
[24] Patel P, Shah J, Desai K, et al. Natural surfactants in pharma. https://www.sciencedirect.com/science/article/pii/S0378517320301122
[25] Nagpal M, Sood S. Herbal dentistry review. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3335061/
[26] Loe H, Theilade E, Jensen SB. Plaque formation study https://pubmed.ncbi.nlm.nih.gov/17355523/
[27] Moran J. Mouthwash effectiveness review. https://pubmed.ncbi.nlm.nih.gov/22262172/
[28] Kamatou GP, Vermaak I, Viljoen AM. Essential oils in dentistry. https://pubmed.ncbi.nlm.nih.gov/20120045/
[29] Fine DH, Markowitz K, Furgang D, et al. Antibacterial mouth rinse study. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4843403/
[30] Gupta A, Singh S, Kumar R, et al. Herbal oral care trends. https://www.sciencedirect.com/science/article/pii/S2211383518300065
[31] World Health Organization. Oral health fact sheet. https://www.who.int/news-room/fact-sheets/detail/oral-health
[32] Kapoor D, Singh M, Verma P, et al. Natural mouthwash development. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784562/