ijpbs 2024;doi10.22376/ijpbs.2024.15.4.b18-23

International Journal of Pharma and Bio Sciences

ISSN 0975-6299

Original Research Article

Biotechnology for health care

# Evaluation and Comparison of the Safety and Efficiency of Formulated Oral Herbal Care and Market Toothpaste.

**Akshita Jangid[1], Dr. Geeta Chaudhary[2*] and Vanisha Sharma[3]**

*[1,2,3] Department of Biotechnology, S. S. Jain Subodh P G (Autonomous) College, Jaipur, Rajasthan, India*

**Abstract:** Many people find maintaining proper dental and oral hygiene difficult, but elderly adults and young children may find it particularly difficult due to poor motor abilities. Dental health has been fundamental to all societies and civilizations for centuries. Controlling the microorganisms that cause dental plaque and bad breath is essential for maintaining good oral health. This study aims to analyze the ingredients and composition of both formulated oral herbal care products and market toothpaste and assess the antimicrobial efficacy against common oral pathogens, to evaluate the safety profiles of herbal and market toothpaste and to measure their effectiveness in maintaining oral hygiene, reducing plaque, and preventing dental caries. This study examines product performance and preferences for formulated oral herbal care products compared to commercial toothpaste. Based on the comparative analysis, the study provides recommendations for consumers seeking safe and effective oral care solutions. Herbal toothpaste used in the current study was assessed for its physical and organoleptic qualities, including color, flavor, the potential of hydrogen, spreadability, moisture content, fineness, and foamability.

**Keywords:** Oral Herbal Care, Foamability, Antimicrobial activity, Minimal inhibitory concentration.

***Corresponding Author**

Dr. Geeta Chaudhary , Department of Biotechnology, S. S. Jain Subodh P G (Autonomous) College, Jaipur, Rajasthan, India

| | |
|---|---|
| **Date of Receiving** | 11 June 2024 |
| **Date of Revision** | 10 September 2024 |
| **Date of Acceptance** | 25 September 2024 |
| **Date of Publishing** | 4 October 2024 |

**Funding** This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

**Citation** Akshita Jangid, Dr. Geeta Chaudhary and Vanisha Sharma , Evaluation and Comparison of the Safety and Efficiency of Formulated Oral Herbal Care and Market Toothpaste..(2024).Int J Pharm Sci.15(4), 18-23 http://dx.doi.org/10.22376/ijpbs.2024.15.4.b18-23

## 1. INTRODUCTION

Oral hygiene is paramount in people's lives, representing the initial daily routine.

1. The quest for a stellar appearance, a positive self-perception, and a boost in confidence all hinge on the foundations of impeccable oral hygiene[1]. On a global scale, dental caries ranks among the most pervasive health concerns that damage tooth tissue and can hurt chewing and aesthetics. The crucial catalyst for dental caries lies in its dependency on plaque and fermentable carbohydrates for its onset. Numerous elements, including carcinogenic microbiota, fermentable carbohydrates, plaque, and duration, are thought to be potential causes of caries. These variables interact with human susceptibility to cause dental caries, and the acidogenic bacteria frequently use sucrose as a substrate[2]. Following dental depression, plaque-induced gingivitis emerges as the predominant oral condition, affecting an estimated 75% of the global population. The prevalence of gingivitis rises with aging and starts in childhood. According to reports, people with dentations of all ages have plaque-induced gingivitis[3]. Herbal toothpaste can help minimize oral disease and cavity issues that, are a global problem, and has no negative side effects compared to other toothpastes on the market[4]. A smooth, semisolid, homogeneous dentifrice containing acceptable elements such as abrasives/polishing agents, surface active agents, humectants, binding agents, and other suitable materials for maintaining oral health is called toothpaste[5]. The efficacy of toothpaste is affected by variables, including the number of abrasives, particle size, surface structure, and the chemical effects of its diverse components[6]. A well-formulated toothpaste should maintain oral hygiene and protect against bacterial tooth decay[7]. Indian traditional remedies have a long history of being used for many different illnesses. People are now likely to use herbal formulations and non-alcoholic toothpaste after learning about the negative effects of commercial toothpaste. Natural toothpaste does not contain artificial fluoride, Flavors, or colours[8]. Herbal products have become more prevalent worldwide for dental and general health care. Individuals desiring to use herbal products generally consider these products to be relatively safer than products containing synthetic constituents. Recently, herbal products have been proposed as an economical, secure, and potentially effective option for preventing and controlling oral disorders. However, certain items still need to be assessed. One such product is propolis to evaluate and contrast the effectiveness of "Miswak" and "Colgate complete" toothpaste with an herbal dentifrice containing Propolis in preventing plaque formation[9]. Halitosis is recovered using toothpaste containing fluoride, which helps to prevent gum problems like gingivitis. [10] But children below 6 years are not recommended with toothpaste containing fluoride, triclosan, and chlorhexidine, which leads to enamel weakening. [11] To maintain dental health, toothpaste is generally helpful. Toothpaste helps prevent gingivitis and tooth decay, which leads to more severe dental concerns. Plants contain a variety of active chemical components that are used to cure various disorders. Due to its safety and effectiveness in decreasing dental caries and preventing other dental problems, herbal toothpaste made of natural ingredients is currently preferred over synthetic formulations based on chemicals in oral dental care. Making herbal toothpaste is done to combat the microorganisms that can lead to gum disease, dental caries, and gingivitis. [12]. Herbal toothpaste is free of synthetic fluoride, tastes, or colors in many artificial brands[13]. Clove oils from the buds exhibit natural behavior and have major antioxidant, insecticidal, antifungal, and antibacterial activities[14]. The therapeutic action of plants has been beneficial to oral health for thousands of years worldwide. Investigating the efficacy of herbal toothpaste is the goal of the current disquisition[15].

## 2. MATERIALS AND METHODOLOGY

Fresh, disease-free, and healthy plant materials from many plants, such as clove buds, peppermint, Guava, betel, babul, turmeric, and leaves and stems. The bark of the neem was collected; the plant materials were washed with clean water and then shade-dried, crushed, and powdered with an electrical grinder. Using a hotplate, 25g of the powder was boiled down with 250 ml of distilled water. Then, the solvent was evaporated using a vacuum evaporator, and the crude extracts were kept in airtight bottles at 4°C until the analysis was performed.

### *2.1 Formulation of Toothpaste*

The ingredients, such as calcium carbonate, sodium chloride, and glycerine, were weighed accurately. After combining these materials in a mortarand, the pestle was triturated precisely with glycerine to produce a semisolid mixture. The precisely measured herbal extract was added to the calcium carbonate base mentioned above. Then, preservatives (sodium benzoate) and sweeteners (Honey) were added to a mixer. After forming a homogeneous paste, flavoring agents such as camphor and peppermint were added. Then, the foaming agent sodium lauryl sulfate was added last under slow-speed agitation to minimize foaming, mixed, milled, deaerated, and tubing.

**Table 1: Herbal Tooth Paste Formulation**

| S.no | Ingredients | Quantity used (%) f1 | Quantity used (%) f2 | Quantity used (%) f3 | Quantity used (%) f4 |
|---|---|---|---|---|---|
| 1. | Banana peel | 0.5 | - | - | - |
| 2. | Guava leaf extract | 0.5 | 0.5 | 1 | - |
| 3. | Orange peel | 0.5 | - | - | - |
| 4. | Neem stem and bark extract | - | 0.5 | - | - |
| 5. | Acacia leaves extract | - | 0.5 | - | - |
| 6. | Cinnamon bark | - | 0.5 | - | - |

| | | | | | |
|---|---|---|---|---|---|
| 7. | Neem leaf extract | - | - | I | - |
| 8. | Clove oil | - | - | 0.5 | 1.5 |
| 9. | Betel leaf extract | - | - | I | - |
| 10. | Turmeric | - | - | I | - |
| 11. | Peppermint Extract | - | - | 1.5 | - |
| 12. | Calcium carbonate | 3.5 | 3.5 | 13 | 22 |
| 13. | Sodium chloride | 0.2 | 0.2 | 0.2 | 0.2 |
| 14. | Glycerine | 4 | 4 | 3.5 | 20 |
| 15. | Sodium benzoate | 0.3 | 0.3 | 0.3 | 0.3 |
| 16. | Honey | 0.5 | 0.5 | I | I |
| 17. | Camphor | 0.2 | 0.2 | - | 0.5 |
| 18. | Sodium lauryl sulphate | 1.5 | 1.5 | 1.5 | 1.5 |
| 19. | Distilled water | q.s | q.s | q.s | q.s |

Table 1 illustrates the ingredients used in the formulation of different herbal toothpastes.

### *2.2 Antimicrobial Test*

In vitro, an antibacterial study of formulated and marketed toothpaste was performed in triplicate using the agar well diffusion method with nutrient agar media against a pathogenic bacterial strain, Bacillus subtilis.

### *2.3 Physical Examination*

#### *2.3.1 Determination of Sharp and edge abrasive particles*

The contents were placed on the finger and scratched on the butter paper 15-20 cm long to check for sharp or abrasive particles. The process was repeated 10 times.

#### *2.3.2 Determination of spread ability*

In this method, the slip and drag characteristics of the paste were evaluated. Formulated paste (2g) was placed on the ground slide under study. The formulated paste was sandwiched between this slide and another glass slide for 5 minutes to expel air and provide a uniform film of the paste between slides. The excess paste was scrapped off from the edges.

#### *2.3.3 pH determination*

10 g of toothpaste was dissolved in 10 ml of deionized water, stirred well to make a suspension in a 100 ml beaker, and the pH was measured.

#### *2.3.4 Homogeneity*

The toothpaste must extrude a homogenous mass from the collapsible tube or any suitable container by applying normal force. In addition, the bulk of the contents need to be extruded from the crimp of the container and then rolled gradually.

#### *2.3.5 Foaming*

The foamability of formulated toothpaste was evaluated by taking a small amount of formulation with water in a measuring cylinder. The initial volume was noted, and then it was shaken 10 times. The final volume of foam was noted.

Determination of froth power foaming power =V1-V2

V1- Volume in ml of foam with water.
V2- Volume in ml of water only.

#### *2.3.6 Stability*

The formulated and marketed toothpaste was filled in a tube and stored at different temperature and humidity conditions.

### *2.4 Determination of moisture and volatile matter*

5g of formulation was placed in a porcelain dish 6-8 cm in diameter and 2-4 cm in depth. The sample was dried in an oven at 105°C.

Calculation by mass = 100MI/M

MI-Loss of mass (g) on drying
M- Mass (g) of the material taken for the rest.

The formulation was formed by using three herbal extracts: banana peel (*Musa acuminate*), guava leaves (*Psidium guajava*), and orange peel (*Citrus* practicum). The second formulation contained natural ingredients like Neem stem and bark, Acacia leaves, Guava leaves, Cinnamon bark, Camphor, etc. The third formulation contains natural ingredients like Neem, Clove, Betel, Peppermint, Turmeric, and Guava. The fourth formulation contains active ingredients of clove oil.

## 3. RESULTS

In the physical evaluation of the toothpaste, no sharp or edge abrasive particles were found, indicating the absence of potentially harmful abrasives. The toothpaste demonstrated appreciable spread ability and maintained a pH between 6 and 8. It also showed notable homogeneity, suggesting a well-mixed formulation. Additionally, the stability assessment revealed that after storage, the toothpaste did not exhibit any phase separation, fermentation, or gassing, indicating its stability over time. The results were tabulated in Table 2.

**Table 2. Evaluation results of formulated toothpaste and Marketed toothpaste**

| Formulation | Color | pH | Foamability | Spreadability | Moisture content | Homogeneity | Smoothness |
|---|---|---|---|---|---|---|---|
| **F1** | Dark brown | 6.6 | 18 | 3.1 | 23.16% | Yes | Smooth |
| **F2** | Light brown | 8 | 7 | 4.8 | 31.2% | Yes | Smooth |
| **F3** | Greenish brown | 7.2 | 13 | 5 | 25.8% | Yes | Smooth |
| **F4** | White | 6.2 | 15 | 3 | 21.2% | Yes | Smooth |
| **Dabur Red** | Red | 7.3 | 17 | 3.5 | 22.8% | Yes | Smooth |
| **Colgate** | White | 7.5 | 7 | 3 | 26.2% | Yes | Smooth |

Table 2 compares the formulated toothpaste with the marketed formulation by comparing its pH, spreadability, foamability, homogeneity, and smoothness.

**Table 3. Zone of Inhibition of lab formulations and Marketed toothpaste**

| Formulations | Zone of inhibition (cm) | | |
|---|---|---|---|
| | 50 mg/ml | 100mg/ml | 150mg/ml |
| **First Formulation** | 1.3±0.01 | 1.36±0.01 | 1.66±0.02 |
| **Second Formulation** | 1.33±0.01 | 5.88±0.02 | 2.2±0.01 |
| **Third Formulation** | 0.36±0.01 | 0.53±0.02 | 0.63±0.01 |
| **Fourth formulation** | 1.6±0.01 | 2.46±0.03 | 2.8±0.02 |
| **Dabur Red** | 1.43±0.01 | 1.66±0.01 | 2.13±0.02 |
| **Colgate** | 0.6±0.01 | 0.83±0.02 | 1±0.01 |

Table 3 compares the zone of inhibition of formulated toothpaste with that of marketed formulation. According to our results, the maximum zone of inhibition occurs in the second formulations compared to the first, third, and fourth formulations. When comparing toothpaste amounts (mg/ml), the maximum zone of inhibition occurred in 100mg/ml of the second formulation. The above table shows that formulated toothpaste shows significant antimicrobial activity at different levels. concentration

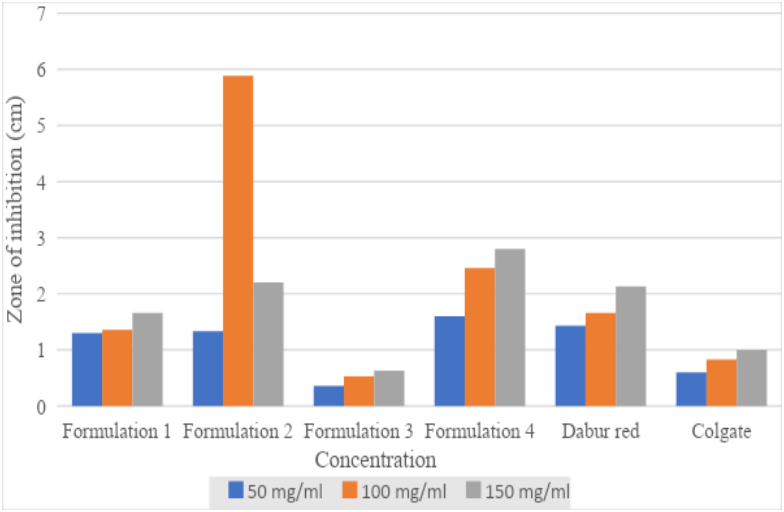


**Fig:1 Histogram showing the zone of inhibition of toothpaste.**

Figure 1- The above histogram compares the inhibition zone between 50 mg/ml, 100mg/ml, and 150mg/ml in marketed and lab-made formulated toothpaste. The maximum zone of inhibition occurred at 100mg/ml of the second formulation and the minimum at 50mg/ml of the third formulation.

## 4. DISCUSSION

The toothpaste has been used since the ancient past[16] and is one of the main irreplaceable components of oral health care[17]. The study indicated that both types of toothpaste demonstrated significant antimicrobial activity, critical in preventing dental plaque and gingivitis. However, the herbal formulations enriched with natural extracts often exhibited a broader spectrum of antibacterial efficacy, likely due to the synergistic effects of their multiple bioactive components. Safety profiles of the tested products were equally important in this evaluation. The herbal formulations, which typically lack synthetic chemicals such as triclosan and sodium lauryl sulfate (SLS), were associated with fewer adverse reactions like mucosal irritation and allergic responses. This suggests that herbal toothpaste offers a safer alternative for individuals with sensitivities to conventional toothpaste ingredients. Efficiency in terms of plaque reduction and gingival health improvement was comparable between the two categories. However, certain herbal formulations showed a slightly higher efficiency

in reducing plaque indices over extended use, which might be attributed to many herbal ingredients' anti-inflammatory and antioxidant properties. Secondary metabolites, bioactive substances with pharmacological activity in plants, comprise the phytochemical components that makeup plants[18]. Tooth color is one of the most crucial elements for satisfaction with dental appearance. While dull and discolored teeth make people unhappy with their dental look, pearly white teeth give a beautiful smile and confidence. There are several methods in cosmetic dentistry to increase patient compliance with dental appearance, but teeth whitening is the easiest and least expensive option to boost smile confidence[19]. As the root cause of caries and periodontal disease, the oral microflora's biofilms must be controlled to prevent plaque-mediated disorders. It can be done through mechanical debridement and adjuvant antimicrobials in toothpastes[20]. Sometimes scaling removes calcified plaque that is hard and darkish in colour[21]. Some toothpaste contains chitosan, having antibacterial properties against bacteria that cause oral infection[22]. *Aloe vera* is now widely used as a dentifrice, and because of its beneficial qualities, it is regarded as the best option for microbial plaque management. According to studies, herbal toothpaste has far safer and more effective anti-microbial properties than synthetic ones[23]. It has been found that the herbal toothpaste made from *Cajanus cajan* leaf extract contains flavonoids and is safe, efficient, and less expensive than the synthetic close-up toothpaste that is available [24]. The anti-ulcer, anti-caries, anti-bacterial, and wound-healing characteristics of clove oil, neem powder, *Aloe vera* gel, and pomegranate peel powder constitute some unique characteristics[25]. Trikatu was also used in toothpaste formulations because of its unique properties[26]. The Punica granatum extracts, Citrus limon, and Mangifera indica demonstrated the *potential for suppressing gram-positive and gram-negative bacteria*. All the studied microorganisms were significantly resistant to the antibacterial activity of the developed polyherbal toothpaste. The study showed that their existence27 causes the activity of many different phytoconstituents in the extract. Flavonoids and phenolic acids in Propolis provide antioxidant, antimicrobial, and anti-inflammatory effects[28]. This study yielded favorable findings regarding the antibacterial activities of orange peel extract. The methanolic extract revealed effective results against S. aureus and E. coli, demonstrating antimicrobial activity.

Similarly, the banana peel extract also exhibited confirmed antimicrobial activity. The same is true for guava leaf methanolic extract, which is antibacterial against *S. aureus* and *E. coli.* The flavonoid found might have antibacterial properties. The presence of different phytoconstituents could be the cause of the antibacterial activity[29]. Numerous bases have been employed in formulating dental paste preparations for herbal toothpaste[30] to treat dental plaque, gingivitis, and periodontal disease. The investigation showed that both the marketed and laboratory versions were discovered to be more stable. Both marketed and in-lab formulations had a nearly constant pH, were homogenous, appeared spreadable, and had stability.

## 5. CONCLUSION

The study also highlighted consumer preferences and perceptions, revealing a growing inclination towards natural and organic oral care products. This trend underscores the importance of further research and development in herbal oral care to meet consumer demands while ensuring high safety and efficacy standards. While formulated oral herbal care products offer a natural alternative and are perceived as safer by some consumers, their efficiency and safety can be inconsistent due to less regulatory oversight. On the other hand, market toothpastes benefit from stringent safety standards and proven effectiveness, though they may contain ingredients some users wish to avoid. Therefore, choosing between these options should consider individual health needs, preferences, and the specific dental issues being addressed. In conclusion, while both formulated oral herbal care and market toothpaste effectively maintain oral hygiene, herbal formulations provide a promising alternative with potentially enhanced safety and comparable, if not superior, efficacy. Future studies should have focused on long-term clinical trials and broader demographic samples to validate these findings and support the integration of herbal products into mainstream oral care.

## 6. ACKNOWLEDGMENT

We are very grateful to the supporting researchers, teachers, lab technicians, and friends who helped us directly or indirectly in our research at S.S. Jain Subodh PG. (Autonomous) College, Jaipur, Rajasthan, India.

## 7. AUTHORS CONTRIBUTION STATEMENT

Akshita Jangid and Dr. Geeta Chaudhary conceptualized and gathered the data for this work. Dr. Pawan Katariya and Vanisha Sharma analyzed those data, and valuable inputs were given to the design of the manuscript. All authors read and discussed the methodology and results and contributed to the final version of the manuscript.

## 8. CONFLICT OF INTEREST

Conflict of interest declared none.

## 9. REFERENCES

1. Halakatti K, Prabhu Desai A, Moogi M, Patted M, Gumtaj A. and Jakati P. Development and evaluation of multi herbal toothpaste. Journal of Pharmaceutical Advanced Research. 2022 Aug 5(8):1639-1645.
2. Karadağlıoğlu Öİ, Ulusoy N, Başer KH, Hanoğlu A, Şık İ. Antibacterial activities of herbal toothpaste combined with essential oils against Streptococcus mutans. Pathogens. 2019 Feb 1; 8(1):20.
3. Hosadurga R, Boloor VA, Rao SN, MeghRani N. Effectiveness of two herbal toothpaste formulations in reducing plaque and gingival inflammation in patients with established gingivitis–A randomized controlled trial. Journal of traditional and complementary medicine. 2018 Jan 1;8(1):113-9.
4. Akotakar AM, Thenge RR, Patil AV, Ghonge AB, Bhaltadak MB. Formulation and comparative standardization of toothpaste. International journal of pharmaceutical science and research. 2018 Apr; 3(4):12-5.
5. Dafal GB, Khare NK. Formulation and evaluation of toothpaste by using eggshells. World Journal of Pharmaceutical Research. 2017 Jan ;6(2):534-43.

6. Singla MG, Virdi I. Abrasive action of different herbal toothpastes: a profilometric analysis. Journal of Dental Research and Review. 2021 Oct 1;8(4):312-6.
7. Deshmukh P, Telrandhe R, Gunde M. Formulation and Evaluation of Herbal Toothpaste: Com-pared with Marketed Preparation. International Journal of Pharmaceutics and Drug Analysis. 2017 Oct 26:406-10.
8. Panda, K. S., and Sethi, A. Formulation and evaluation of a Herbal toothpaste compared with different marketed preparations. Int J Pharm Res Appl. 2020 Nov;*5*(2):557-60.
9. Bhat N, Bapat S, Asawa K, Tak M, Chaturvedi P, Gupta VV, George PP. The antiplaque efficacy of propolis-based herbal toothpaste: A crossover clinical study. Journal of natural science, biology, and medicine. 2015 Jul;6(2):364.
10. Shaikh AA. Comparative evaluation of herbal toothpaste formulations: A preliminary in-vitro study. Indian Journal of Pharmacy and Pharmacology. 2023 Oct;10(3):172-6.
11. Amalunweze A, Ezumezu C. Production of herbal toothpaste using Moringa root essential oil extract. Int. J. Adv. Biochem. Res. 2022 May; 6(2):49-51.
12. Apeksha, S. and Charishma, K. Development of Herbal Toothpaste Containing Mango Leaves Extract. *Studies*. 2021 Oct;10(13):1973-1982.
13. Abhay S, Dinnimath BM. Formulation and evaluation of new polyherbal toothpaste for oral care. Indian Journal of Health Sciences and Biomedical Research kleu. 2015 Jan 1;8(1):24-7.
14. Shukla KV, Kumari D. Formulation development and evaluation of herbal toothpaste for treatment of oral disease. Journal of Drug Delivery and Therapeutics. 2019 Aug 15;9(4-s):98-104.
15. Tatikonda A, Debnath S, Chauhan VS, Chaurasia VR, Taranath M, Sharma AM. Effects of herbal and non-herbal toothpaste on plaque and gingivitis: A clinical comparative study. Journal of International Society of Preventive and Community Dentistry. 2014 Dec 1;4(Suppl 2): S126-9.
16. Davies R, Scully C, Preston A.J. Dentifrices- an update. Med Oral Patol Oral Cir Bucal. 2010 Nov 1;15(6):976-82.
17. Ersoy, M, Tanalp, J, Ozel, E, Cengizlier, R, Soyman, M; The allergy of toothpaste: a case report. AllergoletImmunopathol. 2008 Nov-Dec ;36(6):368-70.
18. Adeleye OA, Bamiro O, Akpotu M, Adebowale M, Daodu J, Sodeinde MA. Physicochemical evaluation and antibacterial activity of Massularia acuminata herbal toothpaste. Turkish Journal of Pharmaceutical Sciences. 2021 Aug;18(4):476.
19. Salman SG, Bokhari SW, Ahmed H, Asad U, Naqvi S, Kiran R, Shah SF, Gilani SU, Noor A, Abidi S, Mujahid S. Formulation And Evaluation Of Novel Herbal Toothpaste In Oral Care Cosmetology. Journal of Pharmaceutical Negative Results. 2022 Dec 31:2310-23.
20. Anushree B, Fawaz MA, Narahari R, Shahela T, Syed A. Comparison of antimicrobial efficacy of triclosan-containing, herbal and homeopathy toothpastes-an invitro study. Journal of clinical and diagnostic research: JCDR. 2015 Oct;9(10): DC05.
21. Singh K, Singh P, Oberoi G. Comparative studies between herbal toothpaste (dantkanti) and nonherbal Toothpaste. Int J Dent Res. 2016 Sep 30;4(2):53-6.
22. Verkaik MJ, Busscher HJ, Jager D, Slomp AM, Abbas F, van der Mei HC. Efficacy of natural antimicrobials in toothpaste formulations against oral biofilms in vitro. Journal of dentistry. 2011 Mar 1;39(3):218-24.
23. Nasiri P, Shafaroudi AM, Moosazadeh M, Poorkazemi D, Sabet JM. The Potential of Aloe vera as an Active Ingredient in Toothpaste Formulations: A Narrative Review. Jundishapur Journal of Natural Pharmaceutical Products. 2022 May 31;17(2):e117500.
24. Malgi R, Mane DV, Kumar DN, Paramshetty V, Kobanna S. Formulation and evaluation of herbal toothpaste by Cajanus cajan (L.) Leaf extract. Journal of Pharmacognosy and Phytochemistry. 2022 Jan;11(1):175-8.
25. Senthilkumar S, Venkateswaran A, Vasanthan A, Chiranjeevi P. Formulation development and evaluation of novel herbal toothpaste from a natural source. International Journal of Pharmaceutical Chemistry and Analysis. 2022 Apr;9(1):17-21.
26. Gautam D, Palkar P, Maule K, Singh S, Sawant G, Kuvalekar C, Rukari T, Jagtap VA. Preparation, Evaluation, and Comparison of Herbal toothpaste with marketed Herbal toothpaste. Asian Journal of Pharmacy and Technology. 2020 Sep;10(3):165-9.
27. Sekar M, Abdullah MZ. Formulation, evaluation, and antimicrobial properties of polyherbal toothpaste. Int J Curr Pharm Res. 2016 Jun;8(3):105-7.
28. Biria M, Rezvani Y, Yadegari Z, Rahmati MH, Iranparvar P. Antimicrobial Efficacy of Herbex and Himalaya Herbal Toothpastes: An: In Vitro: Experimental Study. Dental Hypotheses. 2021 Jul 1;12(3):118-23.
29. Sekar M, Noor Jasmin SA. Formulation, evaluation and antibacterial properties of novel polyherbal toothpaste for oral care. International Journal of Pharmaceutical and Clinical Research. 2016 Aug;8(8):1155-8.
30. Jagtap AM, Kaulage SR, Kanse SS, Shelke VD, Gavade AS, Vambhurkar GB, Todkar RR, Dange VN. Preparation and evaluation of toothpaste. Asian Journal of Pharmaceutical Analysis. 2018 Dec;8(4):191-4.