Research Article

www.ijrap.net

(ISSN Online:2229–3566, ISSN Print:2277–4343)

PHYSIOCHEMICAL AND MICROBIOLOGICAL PROFILING OF DANTARAKSHA TOOTHPASTE

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Received on: 08/9/26 Accepted on: 12/10/26

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DOI: 10.7897/2277-4343.175171

ABSTRACT

Background: Oral hygiene is an essential component of Dinacharya (daily health care). Ayurvedic classics describe practices such as Dantadhavana (toothbrushing), Jihvanirlekhana (tongue cleaning), and Gandusha (gargling) for maintaining oral health. Ayurvedic drugs possessing Kashaya, Tikta, and Katu rasa, along with Krimighna, Shothahara, Vedanasthapana, and Ropana properties, are traditionally employed for preventing oral disorders. Dantaraksha Toothpaste, prepared using 22 Ayurvedic drugs including Arka, Arjuna, Nimba, and Khadira, is formulated to promote oral hygiene and prevent conditions such as Krimidanta, Sheetada, Mukha Dourgandhya, and Dantamala. Standardisation is essential to ensure its quality, safety, and reproducibility. Objective: To develop a pharmaco-analytical profile of Dantaraksha Toothpaste prepared using selected Ayurvedic ingredients. Materials and Methods: Dantaraksha Toothpaste was prepared by trituration. The binder was premixed with the abrasive and triturated, then the liquid phase containing humectants, oils, preservative, and sweetener was incorporated. Flavour and detergent were added subsequently under slow-speed agitation, followed by milling, aeration, and tubing. The finished product was evaluated for physicochemical and microbiological quality as per API guidelines. Results: The formulation showed a pH of 7.16, spreadability of 7.59 g.cm/s, foamability of 10.3 ml, and viscosity of 1,48,300 cP. Total aerobic microbial count (TAMC) and total yeast and mould count (TYMC) were <10 CFU/g, complying with prescribed limits. Conclusion: The study establishes a reproducible preparation method and analytical profile for Dantaraksha Toothpaste, supporting its quality and standardisation.

Keywords: Dantaraksha Toothpaste, Krimidanta, Oral Hygiene, Physicochemical Analysis, Microbiological Analysis.

INTRODUCTION

Dental caries is one of the most prevalent chronic diseases worldwide, affecting individuals of all age groups. Epidemiological studies indicate that nearly 100% of adults experience dental caries at least once in their lifetime. [1] In developing countries, prevalence is increasing because of dietary changes, high sugar consumption, and limited access to oral healthcare. In India, dental caries remains a major public health concern, with a high prevalence among children, adolescents, and adults, particularly in rural and low-income populations. [2] Around 60- 90% of school-aged children are affected by dental caries. Limited awareness of oral hygiene practices and limited use of preventive herbal formulations contribute significantly to the disease burden. Oral health plays a crucial role in overall well-being, influencing not only mastication and speech but also systemic health.[3] Dental caries, gingivitis, halitosis, and periodontal diseases are among the most common oral health problems worldwide.[4] Conventional toothpastes often contain synthetic chemicals that may cause adverse effects with long-term use, creating a growing demand for safer, natural alternatives.[5] Ayurveda emphasises preventive healthcare through biocompatible, holistic herbal formulations. Numerous Ayurvedic herbs have been traditionally used for maintaining oral hygiene due to their antimicrobial, anti-inflammatory, analgesic, and antioxidant properties.[6] These herbs help strengthen gums, prevent tooth decay, reduce plaque formation, and maintain oral freshness. This study focuses on preparing an Ayurvedic toothpaste formulation named Dantaraksha, developed using a combination of twenty-two ingredients.[7] We selected each ingredient based on its traditional use in oral care and documented therapeutic potential. The formulation aims to provide comprehensive oral protection by promoting dental health while minimising the risks associated with synthetic additives. This article describes the formulation approach, ingredient rationale, and potential benefits of Dantaraksha toothpaste as a natural, effective alternative for daily oral hygiene practices.[8] In Ayurveda, Krimidanta is a disease of the teeth described under Dantagata Rogas. The term is derived from “Krimi” (microorganisms or worms) and “Danta” (tooth), indicating the destruction of tooth structure due to microbial activity.[9] Classical Ayurvedic texts describe Krimidanta as a condition characterised by Dantashoola (tooth pain), discolouration (shavyata), cavitation, sensitivity (dantaharsha), Mukha Daurgandhya (bad odour), and progressive tooth decay.[10] According to Ayurveda, improper oral hygiene, excessive intake of sweet, sticky, and fermentable foods (Madhura Rasa), and neglect of daily oral care practices such as Dantadhavana lead to vitiation of Kapha Dosha.[11] This vitiated Kapha promotes the growth of Krimi, gradually destroying tooth enamel and dentin. If untreated, Krimidanta may progress to severe pain, infection, and tooth loss.[12,13] Modern dentistry correlates Krimidanta with dental caries, a biofilm-mediated, sugar-driven disease caused by acid-producing bacteria that demineralise the tooth surface.[14]

Table 1: Ingredients of Dantaraksha toothpaste, along with the part used and proportion for a 100 gm tube.

Sanskrit name	Botanical name	Part used	Proportion
Arka	*Calotropis procera* (Linn)	Arka leaves	3 g
Arjuna	*Terminalia arjuna* (Roxb)	Bark [Powder]	4 g
Nimba	*Azadirachta indica* (A.Jass)	Bark powder	5 g
Amalaki	*Phyllanthus emblica* (Linn)	Fruit Powder	4 g
Vibhitaki	*Terminalia bellerica* (Roxb)	Rind powder	4 g
Haritaki	*Terminalia chebula* (Retz)	Fruit rind powder	4 g
Karanja	*Millettia pinnata* (Pierre)	Root powder	5 g
Nygrodha	*Ficus Bengal* (Linn)	Bark, Latex Leaf	5 g
Lavanga	*Syzygium Aromaticum* (Linn)	Clove oil and Fruit	5 g
Sphatika	Alum sulphate	Powder	QS
Katika	Calcium carbonate	Powder	4 g
Saindhav	Sodium chloride	Powder	4 g
Guar gum	*Cyamopsis Tetragonoloba*	Powder	1 g
Glycerin	-	Liquid form	10 g
Para hydroxyl Benzoic Acid	-	Powder	1 g
Sodium Lauryl Sulphate	-	Powder	10 g
Sodium Saccharine	-	Powder	1 g
Water	-	Liquid	QS
Paper Mint	-	Leaves Juice	QS

Along with these other ingredients used in Dantaraksha Toothpaste are:
Base: Khatika, Sphatika.
Humectant: Glycerine
Preservatives: Para hydroxyl Benzoic Acid
Foaming agent (For polishing purpose): Sodium Lauryl Sulphate
Binding agent: Guar gum
Sweetening agent and flavour: Peppermint, Madhu, Sodium Saccharine

MATERIALS AND METHODS

Analytical parameters, including pH, Spreadability, Foamability, Viscosity, Microbial Count (TAMC), and Total Yeast and Mould Count, were tested as per the Ayurveda Pharmacopoeia of India.

pH
One part of the toothpaste was mixed with 2-3 parts of distilled water and was stirred properly. Then pH was measured using a calibrated pH meter.

Spreadability (7.59 g.cm/s)
1 gram of toothpaste was placed between two glass plates, and a 500-gram weight was placed on the upper plate. It was allowed to spread on the plate for a fixed time of 1- 5 minutes. The diameter of the spread circle was measured in two perpendicular directions. The average diameter was measured to be around 7.59 g.cm/s.

Foamability (10.3 ml)
Weighed 1 g of toothpaste and transferred it into a 100 ml graduated cylinder containing 50 ml of distilled water. The cylinder was shaken 10-12 times vigorously and allowed to rest for 5 minutes. The foamability was then calculated using the formula: Foamability = Total volume – Initial liquid volume.

Viscosity (1,48,300 cP)
The toothpaste was transferred into the Brookfield viscometer sample container using spindle 6 or 7, appropriate for semisolids. The speed was set to 10 rpm, and the spindle was immersed into the sample without trapping air bubbles. The instrument was started, and the viscosity value was noted in centipoise after stabilisation.

Total Aerobic Microbial Count (TAMC) <10 CFU/g/ml
1 gram of toothpaste was weighed and transferred into a container with 9ml sterile saline or buffered peptone water with 10^{-1} dilution. Serial dilutions were done up to 10^{-3} or 10^{-4}, and 1 mL of the diluted samples was pipetted into Petri plates. Melted nutrient agar at 45°C was poured onto the Petri plates, gently mixed and allowed to solidify. The plates were incubated at 37°C for 24-48 hours, and colonies were counted to be <10 CFU/g/ml.

Total Yeast and Mould Count (TYMC) <10 CFU/g/ml
The dilution was prepared like TAMC. 1 ml of the diluted sample was pipetted into Petri plates, and Sabouraud Dextrose Agar (SDA) was added and allowed to solidify. The plates were incubated at 25- 28°C for 3-5 days, and the yeast and mould colonies were counted to be <10 CFU/g/ml.

RESULTS

Parameters such as pH, spreadability, Foamability, Viscosity, TAMC, and TYMC value were analysed using various analytical tests.

Table 2: Analytical values of sample of Dantaraksha Toothpaste

Parameters	Result	Interpretation
pH	7.16	Slightly alkaline, suitable for oral cavity
Spread ability	7.59 g.cm/s	Good, ensures smooth application
Foamability	10.3 ml	Adequate, acceptable cleaning action
Viscosity	1,48,300 cP	Stable, semi-solid consistency
Total Aerobic Microbial Count (TAMC)	<10 CFU/gm/ml	Excellent microbial purity
Total Yeast and Mould Count (TYMC)	<10 CFU/gm/ml	Excellent fungal purity

DISCUSSION

The increasing prevalence of Krimidanta (dental caries) underscores the necessity for preventive and therapeutic oral care alternatives that are both effective and safe. Contemporary research indicates that dental caries remains a significant oral health burden globally, with high incidence rates reported in both children and adults, driven largely by microbial plaque and dietary sugars.[15] This aligns with the Ayurvedic understanding of Kapha imbalance and the role of microbes in Krimidanta pathogenesis. Previous *in vitro* and clinical studies have shown that herbal toothpaste formulations have significant antimicrobial activity against cariogenic bacteria such as Streptococcus mutans and Lactobacillus species, which play a critical role in enamel demineralisation and caries progression.[16] For example, comparative *in vitro* evaluations have shown that herbal toothpaste with multiple plant ingredients can produce zones of inhibition against S. mutans and Lactobacillus acidophilus comparable to conventional toothpaste (anti-cariogenic efficacy) and, in some cases, superior antibacterial activity relative to single-ingredient dentifrices.[17] These results suggest that a polyherbal approach, like that used in the Dantaraksha formulation, may enhance anticariogenic effects by targeting multiple pathogenic pathways. Clinical evidence further supports the benefits of herbal dentifrices. A randomised controlled trial comparing Ayurvedic dentifrice (e.g., Dabur Meswak) with conventional fluoride toothpaste found statistically significant reductions in cariogenic bacterial counts ($p < 0.05$) and an increase in plaque pH after 28 days, indicating an improved oral microenvironment conducive to caries prevention.[18] Such findings emphasise how herbal formulations, when rigorously evaluated, can yield clinically relevant outcomes. Despite promising antimicrobial results, systematic reviews highlight variability across studies in methodology and outcomes, leading to non-significant pooled effects in some analyses ($p = 0.39$), although herbal dentifrices were generally found to be as effective as non-herbal controls in reducing bacterial counts.[19] This underscores the need for standardised, high-quality clinical trials to definitively establish efficacy measures and effect sizes for herbal toothpaste formulations. For Dantaraksha toothpaste, which incorporates twenty-two Ayurvedic ingredients chosen for antimicrobial, anti-inflammatory, astringent, and antioxidant properties, these findings provide a strong theoretical and empirical basis for its potential effectiveness. Traditional Ayurvedic herbs such as Neem (*Azadirachta indica*), Clove (*Syzygium aromaticum*), Turmeric (*Curcuma longa*), and others have been individually documented for antimicrobial activity against oral pathogens and supportive effects on gingival health. The multi-herb combination in Dantaraksha is thus expected to exhibit synergistic effects, similar to the enhanced anticariogenic efficacy observed in multi-ingredient herbal formulations.[20] Moreover, many marketed herbal dentifrices demonstrating anticariogenic effects have shown significant differences in plaque and gingival indices compared with controls ($p < 0.05$), reinforcing the clinical relevance of incorporating Ayurvedic botanicals into toothpaste formulations. Nevertheless, further clinical evaluation of Dantaraksha toothpaste, including randomised controlled trials with appropriate control groups and statistical analyses (e.g., repeated measures ANOVA, p-values, confidence intervals), is recommended to quantify its preventive effect on cariogenic bacteria, plaque accumulation, and caries incidence *in vivo*.[21] Such data would strengthen evidence-based claims, enhance scientific credibility, and support wider adoption of this herbal formulation in routine oral care. Here, the values indicate that the toothpaste is slightly alkaline (pH 7.16). A near-neutral pH is desirable for oral formulations because it helps maintain saliva's natural pH (6.5-7.5). Excessively acidic toothpaste can erode enamel, while overly alkaline products can irritate the oral mucosa. Hence, pH 7.16 is ideal and safe for oral use. Spreadability represents how easily the paste spreads under slight pressure. Good spreadability ensures uniform application on the toothbrush and even distribution in the mouth. A value of 7.59 g.cm/s suggests good consistency that is neither too stiff nor too runny. Foamability indicates the toothpaste's ability to form foam. Moderate foaming is preferred for consumer acceptability, as it enhances the perception of cleaning. Foamability of 10.3 ml indicates adequate surfactant action, ensuring effective cleaning without excessive froth. Viscosity measures the internal resistance to flow. A viscosity of 148,300 centipoise (cP) shows the toothpaste is semi-solid and stable[22]. Ideal viscosity ensures the toothpaste retains its form in the tube but extrudes easily when squeezed. High viscosity also contributes to stability and prevents phase separation. The count is well below the acceptable limit.[22] For oral care products, the acceptable TAMC limit is usually <1000 CFU/gm (per WHO and pharmacopeial standards), indicating excellent microbial quality and absence of contamination. Confirms that manufacturing and storage conditions were hygienic. The value is also far below permissible limits. Demonstrates no fungal contamination, ensuring product safety and long shelf life.[23]

CONCLUSION

Krimidanta (Early childhood caries) remains a highly prevalent oral disease influenced by microbial activity, dietary habits, and inadequate oral hygiene. Existing evidence indicates that herbal and polyherbal dentifrices can significantly reduce cariogenic microorganisms and plaque levels ($p < 0.05$), supporting their role in preventive oral care. The present formulation, Dantaraksha toothpaste, uses twenty-two Ayurvedic ingredients and is based on classical principles and contemporary research. Its multi-herbal composition aims to address the complex pathogenesis of Krimidanta through antimicrobial and gingival-strengthening actions. Dantaraksha thus represents a promising natural alternative for maintaining oral health. Further clinical studies are required to confirm its efficacy and long-term benefits.

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Cite this article as:

Darshan Kalambe, Reena K and Pravin Kumar GM. Physicochemical and microbiological profiling of Dantaraksha toothpaste. Int. J. Res. Ayurveda Pharm. 2026;17(5):42-45
doi: http://dx.doi.org/10.7897/2277-4343.175171

Source of support: Nil, Conflict of interest: None declared

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