Original Article

HERBAL TOOTH GEL FOR THE MANAGEMENT OF GINGIVAL BLEEDING AND TOOTHACHE

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Abstract

Periodontal disorders are caused by gum and bone infections and inflammation. Gingivitis is a bacterial infection that inflames the gingiva. In advanced periodontal disease, many patients need tooth extractions or other surgical operations, which can be lethal. Spilanthes acmella relieves toothaches and induces salivation. Green tea's polyphenolic catechins combat plaque and bacteria. This study intends to produce herbal tooth gel for managing gingival bleeding and toothache. This herbal gel contains *Spilanthes acmella*, Green Tea and clove oil. Decoction extracts *Spilanthes acmella* with green tea. The gel basis was made by combining carbomer 940, PEG400, TEA, sorbitol, and clove oil. Macroscopic and microscopic examinations were performed. Passing formulations were examined further to reach the necessary gel composition. All tests and trials for various parameters showed that the final formulation maintained a stable pH over 3 months, suggesting that clove oil performed its role as a natural preservative with satisfactory results, preventing microbial growth, decomposition, and incompatibilities among the components. The compositions retained viscosity and stability over 3 months, indicating that their constituents were compatible. It could be used as a dental gel for toothache and gingival bleeding.

KEYWORDS: gingivitis; green tea extracts; herbal tooth gel; microbial growth; natural preservative; *Spilanthes acmella*

1. INTRODUCTION

Degeneration and infection of the gums, periodontal ligaments, alveolar bone, and dental cementum characterise various clinical diseases known collectively as "periodontal disease" (1). When bacteria infiltrate a periodontal pocket and attach to subgingival plaque, an inflammatory response occurs locally (2). Gingivitis, a kind of periodontal disease, is widely regarded as the most prevalent of all periodontal conditions. Gingivitis comes in a wide variety of presentations, each with its own set of symptoms and possible causes. The most common kind of gingivitis, however, is the chronic form caused by plaque (3).

The soft tissue lining of the mouth, known as gingiva, forms a seal around the teeth. Contrary to the soft tissue linings of the cheeks and lips, the gingiva is firmly attached to the underlying bone and acts as a barrier against the wear and tear caused by food travelling over the teeth. Therefore, a healthy gingiva is an effective barrier against periodontal disease's ability to destroy deeper tissues. Multiple subtypes of gingivitis can be distinguished by their distinct clinical presentation, infection duration, aetiology, and degree of severity. Plaque accumulation in or around the gingival sulcus is the most common cause of persistent gingivitis. As a result of neglecting oral hygiene, a coating called plaque forms on the teeth's surface. Considering the bacterial load of plaque, inflammation of the gingival tissue around the gums is a real possibility (3). Biofilm formation and infections are the most common reasons for this, although other risk factors, including as tobacco use, obesity, stress, type 2 diabetes, low bone density, and vitamin D and calcium deficiency, all play a role (like genetic polymorphisms). There is inflammation, redness, discomfort, a glossy surface, and bleeding following light probing when gingivitis is present. Patients often fail to recognise the presence or progression of gingivitis since the condition shows no outward signs. In symptomatic cases, the patient often reports gingival bleeding during dental hygiene routines or after consuming particularly tough foods (3).

Extraction of affected teeth is often necessary when the situation worsens. There is always a chance that something could go wrong when getting a tooth pulled. Oftentimes, it is the result of a combination of organic and iatrogenic factors in the body. Postoperative complications include things like infection, nerve damage, dry socket, maxillary sinus perforation, and slowed healing. After a tooth is extracted, a blood clot forms in the socket. Dry socket occurs when a blood clot in the tooth's socket is dislodged before it should be. There is a 3% incidence rate overall, and a 30% incidence rate for impacted third mandibular extractions. Whenever teeth are extracted, especially molars, a tooth socket forms, and this often results in bleeding. The amount of bleeding depends on the tooth damaged and the severity of the tissue injury. Because the resulting blood clots are fragile and must be partially pressed out, in some cases bleeding continues for 1–2 days (4).

Incomplete extraction of the tooth, exposed bone, laceration of the soft tissues, infected sockets, and injury to surrounding nerves can all contribute to post-extraction pain. Poor surgical technique can occasionally cause gum edema.

The main goal of treating gingivitis is to reduce inflammation. For this purpose, a number of tools are used to scrape away tartar and plaque from teeth. Plaque can be removed mechanically, but some dentists additionally advocate using dentifrices and an antimicrobial mouthwash with chemical or herbal substances. Gingivitis treatments that involve the use of medicinal or herbal plants have been the subject of research. Gingivitis treatment using these herbs is based on their anti-inflammatory qualities. Dentifrices and mouthwashes based on either a single natural component or a combination of numerous medicinal plants have shown significant promise as a form of phytotherapy (herbal treatment) (5). Chamomile, tea, and pomegranate are just few of the medicinal herbs available. There is a synergistic effect when prescribing herbal plants in addition to the conventional mechanical methods of plaque and scale removal (3).

The purpose of this research is to create a novel herbal tooth gel for the treatment of gingival bleeding and toothache. For a long time, people have relied on herbal medicine's healing abilities to ward off and treat a variety of dental maladies. Insufficient research and historical understanding of the role of medicine in dental illness is the primary issue. The World Health Organization reports that 80 percent of the global population uses traditional medicine (herbal) to address their basic medical needs. This is likely due to the accessibility, affordability, and cultural acceptability of these plant extracts. The development of indigenous treatments and the use of herbal medicines to treat a wide range of conditions both contribute to a healthier economy. There may be variations in efficacy across herbal medicines, so it's vital to pick wisely (6).

2. MATERIALS AND METHODS

2.1 Collections of plant materials

The flowers of the plant *Spilanthes acmella* were collected from the local areas of Ri-Bhoi, Meghalaya, India in the month of January and February 2022. The freshly collected plant samples were then washed and half of it was sundried and the other half were dried at 45.C in a dryer for 4-5 hours.

The leaves of Green Tea were collected from the nearby Tea Estate. The Tea leaves were then washed and dried as well. Both the dried specimens were then prepared for extraction.

2.2 Chemicals and other constituents

In this study, Carbomer 940 (gelling agent), TEA (trimethanolamine) [neutralizer], Polyethylene glycol (PEG) 400, Sorbitol (binding agent), clove oil (as preservative), menthaoil (soothing agent) and food colour were used.

2.3 Equipments

Digital balance, Magnetic stirrer, Digital pH meter, Induction, Centrifuge, Dryer, Clevenger.

A decoction process was used to remove the plant material that had been dried. To get to the chemistry underneath the surface, we mash it up and boil it to get at the good stuff. The dried sample is rehydrated by boiling it in water for a predetermined amount of time, typically 10 minutes. Once the liquid has been brought to a boil, it is strained, and enough water is poured through the contents of the strainer to achieve the desired volume.

When trying to get rid of things that won't evaporate, decoction is the way to go. Extraction by decoction was selected because spilanthol is the active ingredient and it is a non-volatile chemical (7,8).

2.4 Preparation of gel

Table 1: Table showing compositions for different samples formulated for 30 ml each.

Trials	C940	Neutraliser (tea)	Sorbitol (70%)	Spilanthes Extract	Green Tea	Water	Clove Oil	Peg 400	Ph
T1	0.35g	0.4ml	3ml	6.5ml	3.5ml	15ml	10ul	2ml	6.1
T2	0.35g	0.5ml	4ml	6.5ml	3.5ml	15ml	15ul	1ml	5.9
T3	0.35g	0.25ml	4ml	6.5ml	3.5ml	15ml	10ul	1ml	6.7
T4	0.35g	0.30ml	4ml	6.5ml	3.5ml	15ml	25ul	1ml	6.8
T5	0.35g	0.30ml	4ml	6.5ml	3.5ml	15ml	20ul	1ml	7
T6	0.35g	0.30ml	4ml	6.5ml	3.5ml	15ml	20ul	1ml	7

Using the amounts on table 1, first 70% Sorbitol was dissolved in distilled water and then a specific amount of carbomer940 was mixed using a magnetic stirrer with 1200rpm for 30 minutes to achieve a homogenous mixture. Meanwhile, in another beaker (2) a mixture of spilanthes and green tea extract along with PEG400 was taken prepared. Specific amount of clove oil was added to the extract solution as a preservative. Additionally, food colour and menthaoil (soothing agent) were also added. Then, this extract solution was added slowly to the carbomer solution undergoing continuous stirring. TEA was added drop wise to the formulation while monitoring the pH of the entire composition with the help of a digital pH meter to obtain the required pH of mouth skin (i.e. 6.8-7) and to acquire the desired gel consistency.

In table 1, it has been found that the pH of each sample varies significantly. However, sample T5 and T6 tend to have a pH 7 which is sought to be an ideal parameter for the tooth gel. Thus, these samples having the desired pH with suitable compositions and other properties are further subjected to various tests and examinations in the laboratory.

2.5 Examinations

Centrifuge test: Each of the chosen formulations were separately centrifuged in test tubes for 5, 10, 15, 20, 30, 60 minutes with 2000 rpm and then studied for sedimentation and gel stability.

No sedimentation was observed in the samples after centrifugation and gels maintained their uniformity.

Temperature: Following are the readings for checking stability of the gel compositions at various temperatures.

Table 2: Table showing temperature readings of the gel samples.

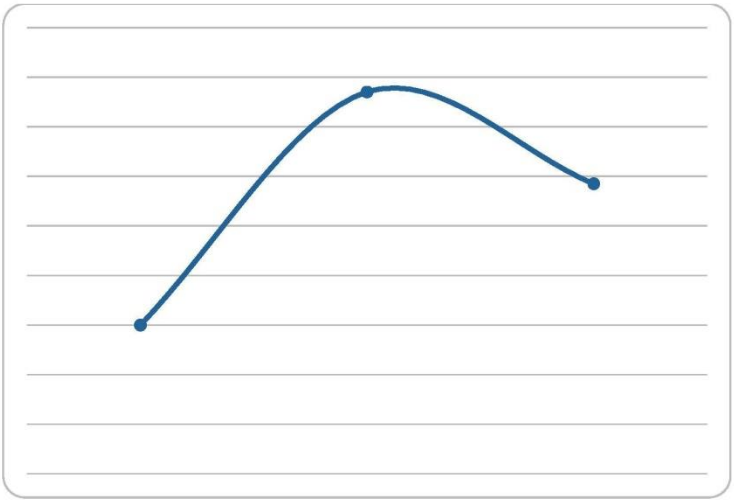
Samples	**Temperature (°c)**
T4	28
T5	28.2
T6	27.3

Viscosity: Following are the readings of viscosity test for the 3 different samples:

Table 3: Table showing viscosity readings of the gel samples

Sample	**Result (Centipoise)**
T4	5
T5	5.94
T6	5.57

Figure A: graph representing viscosities of the formulations



pH: The pH meter was calibrated with standard buffers before measurements and recorded.

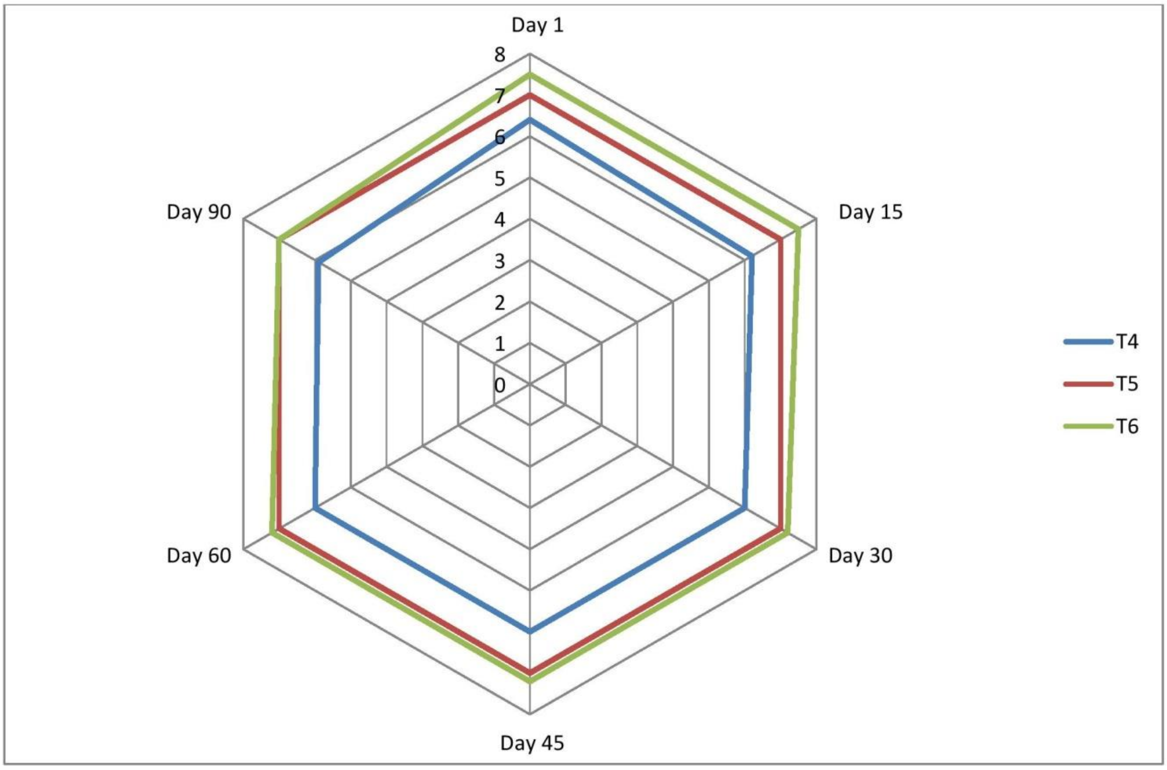
pH of the 3 samples were checked over a duration of 3 months and recorded as below:

Table 4: Table showing pH readings of the gel samples observed at certain intervals of time.

Samples	Day 1	Day 15	Day 30	Day 45	Day 60	Day 90
T4	6.4	6.2	6	6	6	5.9
T5	7	7	7	7	7	7
T6	7.5	7.5	7.2	7.2	7.2	7

Sample T4 and T6 shows a fluctuating pH which indicates that there is a possibility of microbial growth or incompatibility among the constituents or amount used for each constituent in formulating the gel. However, sample T5 maintained a stable pH over the period of recorded time (table 4) which suggests compatibility among its constituents with respect to their specific quantity and showing negligible microbial activity. Hence, it is suitable for application.

Figure B: Graph representing pH of the formulations.



3. RESULT AND DISCUSSION

From the above examinations it was found that "sample T5" has the ideal pH along with other parameters. The gel base for the T5 sample is fabricated by dissolving 0.35g of C940 in 15ml of water and 70% sorbital (binding agent) and the spilanthes and green tea extracts were added to the solution in the ratio of "13:7". 1 ml of PEG400 was added as a thickening agent to provide more gel like consistency. Additionally, clove oil amounting 20ul was added to preserve the formulation and increase its shelf life. TEA amounting 0.30ml was added which neutralized the solution and brought the pH to around 7 that matches the pH range of the mouth (saliva). Out of all the different formulations this sample has maintained a constant pH-7 over a period of 3 months. Thus, the combination of mentha oil and clove oil produced effective results as natural preservatives that extended the shelf life to at least 90 days and maybe more. It can be inferred from the findings that "Sample T5" has proven to be the ideal composition for the tooth gel.

Inflammatory periodontal disease, also known as gingivitis, is the most common form of oral infection worldwide. Gingivitis can lead to alveolar bone loss if not treated. Therefore, the primary goal in treating gingivitis is to lessen the buildup of plaque and the irritation of soft tissues. Problems caused by gingivitis could be cured with the right drugs and therapies. Nonetheless, herbal medicines have been able to get more attention than chemically based drugs have in recent years (9). There may be a number of positive outcomes from trying out herbal remedies. Several plants have been shown to be more effective than pharmaceuticals at repairing the body as a whole due to the synergistic effect of their active components (10). Herbal medicines have a higher tolerance and flexibility, thus their therapeutic effects last longer with fewer adverse effects (11).

Herbal supplements are becoming increasingly well-liked as complementary treatments and methods for avoiding plaque accumulation. The effects of polyherbal compositions on microbial count and plaque index reduction are two further outcomes that have been investigated. For example, a mouthwash called Triphala, which contains *T. bellirica, T. chebula,* and *P. emblica,* provides benefits that are on par with those of CHX. Gels containing extracts like turmeric and barberry have been created because of the relative safety of the plants used. Gingivitis treatment often includes the use of medicinal plants for their anti-inflammatory effects. Herbal supplements can be used as a supplemental therapy to boost the efficacy of conventional therapies, as shown by research comparing the effects of herbal medicines alone and those of typical mechanical dentistry procedures like scaling (5). Professional and consumer interest in mouthwashes made with all-natural ingredients (not just EO) has grown in recent years. Several dental practitioners have recently advocated the use of all-natural toothpaste as a means to promote oral health. Herbal remedies, such as herbs, herbal materials, herbal preparations, finished herbal products that incorporate sections of plants or other plant materials as active components, and other medicinal plants, have been used to maintain oral hygiene and reduce inflammation for over 2,000 years (12–14).

After considering its medical benefits and qualities, *Spilanthes acmella* was deemed to be the ideal primary ingredient for making the herbal tooth gel. The pain of toothaches is alleviated by the medicinal plant *Spilanthes acmella*, which also stimulates saliva production (15). Several illnesses, mostly related to its secondary bioactive metabolites, have been treated with it in traditional medicine. Spilanthol is the most important alkamide found, and alkamides are thought to be the most common phytochemicals in Spilanthes. The major ingredient in *S. acmella* is spilanthol, an N-isobutylamide responsible for a wide range of biological effects. In addition to its local anaesthetic and antipyretic properties, *S. acmella* also has antifungal, antiplasmodial, antibacterial, and insecticidal properties (16). Green tea, with its high concentration of antioxidants and other beneficial characteristics, has been used as a complement in the same way that *Spilanthes acmella* has. Green tea's high anti-oxidant content aids in the battle against mouth germs and plaque. Tea is mostly composed of polyphenols, such as catechins and flavonoids, and methylxanthine alkaloids, such as caffeine, theobromine, and theophylline. Catechin inhibits the growth of a wide variety of bacteria, including P. gingivalis (17). Positive changes in periodontal health were seen after patients underwent both mechanical treatment and applied green tea catechins using a slow-release administration technique (18). The catechins EGCG and ECG are particularly effective at combating and preventing the development of dental plaque and bacteria. Green tea's anti-inflammatory characteristics make it a useful tool in the fight against gum disease and gingivitis (19). In a clinical trial, green tea outperformed chlorhexidine (CHX) and neem in terms of improving the gingival index (GI), plaque index (PI), oral hygiene index (OHIS), and pH level. Patients with persistent gingivitis saw improvements in their periodontal health after using green tea gel (5,20).

Keeping the gel fresh for a longer period of time is essential. Sodium benzoate, potassium sorbate, methyl paraben, and ethyl paraben are commonly used chemical preservatives in herbal remedies containing herbal ingredients. The gel's shelf life can be prolonged without the use of harmful chemicals thanks to the use of essential oils from plants and herbs that have anti-microbial qualities, according to a number of studies. Oils extracted from plants using a variety of distillation techniques are known as essential oils (EOs). Essential oils (EOs) are a type of secondary metabolite found in plants, made up mostly of a wide variety of terpenic hydrocarbons and oxygenated derivatives. These EO-derivatives have been used in clinical dentistry and related research because of their anti-inflammatory and antibacterial properties. Antifungal and antibacterial properties have been observed in several essential oils, including lavender, peppermint, cinnamon, and clove. Recently, EO-derivatives' analgesic properties have been found to be useful in the treatment of orofacial pain (21). The use of essential oils as preservatives rather than additional chemicals has been stressed to reduce the overall chemical load of the formulation, in keeping with the study's overarching goal of creating a comprehensive herbal therapy to treat gingivitis. Two oils, clove and menthe (peppermint), were chosen from a wide variety of possibilities for this investigation.

With its antibacterial characteristics, clove oil is added to the gel to extend its shelf life. In addition, it has anti-inflammatory characteristics that safeguard the gums and includes an anaesthetic chemical substance called eugenol (22). Eugenol has many uses in dentistry. Due to its therapeutic, antibacterial, and anti-oxidant characteristics, it is useful in combating oral infections caused by periodontal disease and dental caries. One component of fungal cell membranes called ergosterol is decreased by clove oil and its principal component eugenol (23,24). Peppermint (*M. piperita*) oil is one of the most popular essential oils because of its main components, menthol and menthone (25). Peppermint oil's antibacterial properties, as well as its fungistatic and fungicidal action, operate as growth inhibitors for several infections. Industries have been decreasing their use of chemical preservatives in recent years. *M. piperita* essential oil, which has been shown to have active antibacterial properties, could be used as a non-chemical means of extending the longevity of packaged goods (26). A mucoadhesive gel formulation including both spilanthes flower extract and green tea extract has been developed by using Carbomer 940, a very high molecular weight polymer of acrylic acid, for the primary purpose of acting as a thickening agent. Carbomer 940 is a popular polymer that changes its viscosity depending on the pH of its environment. At slightly acidic pH, it remains in solution, while at alkaline pH, it forms a low-viscosity gel. When compared to other polymers, this one has many advantages due to the fact that it may be applied in liquid form directly to the site of drug absorption (6).

The gel-like texture and consistency can be achieved by adjusting the pH with a neutralizer to a range in which Carbomer 940 is more likely to thicken into a gel. In this research, TEA was used as a neutralizer; this compound is commonly used with carbomer in gel formulations. Oils and other components that aren't totally soluble in water can be dispersed throughout a solution with the help of TEA, which also neutralises fatty acids and adjusts and buffers the pH. After formulations were made, they were all evaluated to ensure they met certain criteria. Those formulations that proved to be the most stable and perfect were then put through additional testing. When applying gel to the impacted areas over the gum, viscosity plays a crucial function in keeping the gel's consistency. If you apply a gel with a low viscosity, you won't feel much of a difference, but a high viscosity will make the gel feel much thicker (27).

While it has been shown that a formulation with a low viscosity is preferred for initial application into the periodontal pocket, a high viscosity is necessary for the treatment to be retained in that area. A value of 5.8 centipoise was observed for the viscosity of the gel sample T5 that was chosen (Table 3). Next, we run the samples through a temperature change test to see how well the formulations hold up under varied conditions and to pinpoint the sweet spot where the attributes of the formulation are most stable. The optimal storage condition can be identified with the use of this test. The findings from the temperature tests on all of the samples were all positive. Gels should be stored in the best possible conditions by keeping them at a constant temperature of around 27 to 28.5 degrees Celsius, which is roughly the range of typical room temperature.

Changes in pH can be a sign of problems like microbial growth, chemical incompatibilities, or constituent disintegration, thus it's important to keep an eye on it during storage. Long-term exposure of oral tissues to either a low or high pH can have harmful effects. Demineralization of enamel and root resorption have both been linked to pH levels below 5.2. (28). Because T5's pH stayed the same throughout the duration of three months, it may be termed stable.

4. CONCLUSION

The outcomes of all tests and analyses point to high compatibility between the constituents and all the herbal substances led to a complimentary action on gingival problems. The formulation's ability to maintain qualities like viscosity and stability over the course of three months suggests that the formulation's diverse constituents were compatible with one another. Together with green tea, spilenthes acmellas hows good compatibility, and their separate benefits work synergistically to create the desired impact on toothaches and gingival bleeding. Additionally, mentha oil provides a shooting sensation when applied to the gum or affected areas, while clove oil delivers an anaesthetic effect to assist reduce pain. Both clove oil and mentha oil, which are primarily used as natural preservatives, performed admirably preventing any microbial growth. As observed for sample 'T5' in Table 1, the prolonged the gel's shelf life and assisted in keeping a steady pH. Hence it has the potential to serve as a herbal tooth gel product for the Management of toothache and gingivial bleeding.

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Author contribution

P.K and M.Z.S: conceptualized and designed the experiments. B.P., D.K., G.S., P.N., and P.B.: performed the experiments and wrote whole manuscript and performed the statistical analysis and edited the manuscript, M.Z.S.: edited and revised the manuscript.

Conflict of Interest:

The authors declare no conflicts of interest.

Declarations

Ethical approval: not applicable

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