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Natural Hand Wash Formulation from Pods of *Gymnocladus burmanicus* C.E. Parkinson.: A Promising Herbal Cleanser

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Abstract

Gymnocladus burmanicus is a soap tree endemic to Arunachal Pradesh bearing about 13-17cm and 3-6 cm-sized pods. The pods were used as soap before commercial soap was available in the early days, but they have lost their utility in the locality today. Hand washing is a good hygiene practice to remove many infectious microbes and dirt before and after a meal. Hand washing has become increasingly vital since the COVID-19 pandemic, highlighting the importance of effective and safe cleansing practices. The aim of this study was to formulate a natural hand wash using the cleansing and foaming properties of *Gymnocladus burmanicus*. The formulation is designed to be self-preservative, self-cleansing, self-lathering, and incorporates table salt as a natural scrubber and preservative, without synthetic detergents or preservatives. Cold extraction and Soxhlet extraction techniques were employed, with specific conditions detailed to ensure reproducibility. The study reports three methods of Gymnocladus hand wash formulation with table salt (ethanol Gymnocladus solution, water Gymnocladus solution, and Gymnocladus extract) that are free from added synthetic surfactants and preservative with an option to employ skin care additive extracts like neem, aloe vera, Vitex negundo and glycerine, and other additive like aroma, and color as per the need and demand of the final product requirements. Xanthan gum was used to provide appropriate viscosity. Quantitative evaluation parameters, including pH (mean values with standard deviations), foaming capacity (measured as foam volume), and microbial growth were used to assess the formulations. The hand wash formulations demonstrated promising results, including stable pH (range 6.3–7.2, SD ±0.3), effective foaming (20–30 mL foam volume), and absence of microbial growth over two weeks. The formulation of the hand wash indicated a promising natural product for a broader research scope that would benefit both consumers and the environment. This study presents the first natural hand-wash formulation made from *Gymnocladus burmanicus* pod.

Keywords: Clean and green product, *Gymnocladus burmanicus*, Natural hand wash, Saponins, Table salts, *Vitex negundo*

1. Introduction

Washing hands is a basic hygiene practice that prevents the transmission of many infectious microbes[1]. When washing hands with soap and water, it cleans the palms and keeps away pathogens[2]. It is one of the best health practices to keep away from getting infected[3]; hand washing compliance is recognized as an efficient health and hygiene practice all over the world[3]. Hand washing has become a more hygienic habit as part of good health practice due to the COVID-19 outbreak[4]. Hand washing before and after handling food is the most effective way to prevent diarrhea[5]. Hand washing is a must hygiene practice for food handlers to avoid the outbreak of food-borne diseases[6]. Hand washing is crucial for managing the spread of infectious diseases and for lowering the global toll of respiratory infections, cholera, food-borne illnesses, and other infections linked to healthcare[7]. Proper hand washing is a must-follow practice for health workers to prevent the spread of infectious diseases[8].

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According to the World Health Organization's "Hand Hygiene: Why, How & When?", healthcare-associated infections claim thousands of lives globally each day, largely due to the transmission of germs via hands. Proper hand hygiene is considered the most effective method for interrupting the spread of dangerous pathogens and lowering the incidence of infections within healthcare settings[9]. The World Health Organization advises cleaning hands with either alcohol-based hand rub or soap and water. Hand hygiene is not limited to health centers; it is equally important when we eat food and handle physical work. Hands can harbor pathogenic species, including meticillin-resistant *Staphylococcus aureus* and *Escherichia coli,* particularly in high-risk environments such as healthcare and food-handling settings[10,11]. Numerous studies have shown that both hand washing and the use of alcohol-based hand rubs are effective in decreasing the presence of pathogenic bacteria on hands, as well as in lowering infection rates across various institutional environments[12,13]. The United States Centers for Disease Control & Prevention highlights that washing hands with soap and water is among the most effective strategies to prevent the transmission of viruses[14]. According to the British Columbia Center for Disease Control[15], washing your hands frequently has been shown to significantly reduce the frequency of many common infections, including gastrointestinal illness, colds, COVID-19, and influenza (the "flu"). Frequent hand washing not only supports personal health but also plays a vital role in reducing the transmission of infectious diseases within the community. According to the British Columbia Centre for Disease Control[15], regularly cleaning your hands is among the most effective measures to limit the spread of infections. As mentioned above, hand washing plays a primary role in good hand hygiene and is essential for soap and water. Commercial hand wash is made of a high percentage of synthetic ingredients, such as Sodium Lauryl Sulfate (83%) as the primary surfactant and Ethylene Glycol Mono Sulfate (17%) as a secondary surfactant[16]. Household cleansers and washing pose dangers when inhaled, ingested, or come into contact with the eyes and skin[17]. Likewise, during the pandemic, detergents and soaps, as high-volume cleaning agent products, are released after use directly into the sewage system and, eventually, into the environment. People use 0.4 to 9 ml of soap per hand wash[18]. With frequent hand washing and the significant increase in soap cleaners, the chemical ingredients of these detergents are transferred to the ecosystem[19]. The vital ingredients in soaps and detergents are derived from petrochemicals. Therefore, there is a need for eco-friendly cleaning agents for human and environmental safety[20,21]. Numerous naturally derived substances—including vegetable oils as well as extracts from plants and fruits—are recognized for exhibiting antimicrobial, antifungal, and antioxidant activities[22, 23,24]. These natural compounds are readily biodegradable and do not produce any additional dangerous waste[21].

Industrial and hand-cleaning formulations typically contain a surfactant like sodium lauryl sulfate that solubilizes or emulsifies oils, debris, and soil on a substrate. If the chemical formula is too aggressive in its solubilizing or emulsifying power, skin can be harmed by the de-fatting of the dermal oils, particularly when the cleanser is used repeatedly[25]. Therefore, there is a need for hand wash products that are natural, eco-friendly, and user-friendly. The demand and supply of natural products have increased rapidly in recent years due to their benefits for users and the environment, compared with the potential adverse effects of synthetic products[26]. Various workers have worked on the formulation of herbal hand wash as follows: Shukla and Bagla[27] formulated a hand wash using the antimicrobial properties of zinger. Another coconut shell charcoal-containing hand wash was formulated and reported to be most acceptable at 2% charcoal[28]. Then, a lemon juice hand wash containing tulsi and honey[29]. A polyherbal hand wash containing aloe vera and lemon juice, which reduces side effects and improves hand cleaning, was also formulated[30]. Formulated a polyherbal handwash containing *Moringa olifera* leaves, *Clove oil* and Tulsi extract and Reetha were used for the preparation in powder and liquid forms and it was evaluated and various parameter such as organoleptic evaluation, particle size, Angle of

repose, bulk density, tapped density, washability, pH, color, odor, foaming index, extractive values, dirt dispersion and skin and eye irritation test were determined and reported[31]. Another hand wash was formulated with various herbs, such as lemon, tulsi, honey, turmeric, and aloe vera, and showed better antibacterial, antimicrobial, and antiseptic activities. A separate herbal hand wash was formulated incorporating neem extract for its antibacterial activity, aloe vera juice for its soothing effect, glycerin for moisturization, sodium lauryl sulphate as a surfactant, carbopol 934 as a gelling agent, rose oil for fragrance, and distilled water. Upon preparation and comprehensive evaluation, the formulation demonstrated stability across all tested parameters and exhibited effective cleansing performance[33].

A herbal hand wash using plant-based ingredients known for their antimicrobial and skin-soothing properties. Herbal extracts of neem (*Azadirachta indica*) and aloe vera (*Aloe barbadensis*) were selected due to their proven antibacterial, antifungal, and antioxidant activities. The formulation was prepared using a mild soap base and natural additives such as glycerin and essential oils, with results indicating that the herbal hand wash exhibited favorable physical characteristics and significant antimicrobial activity, comparable to standard commercial hand washes. The product was also stable over time and non-irritant to the skin. This study demonstrates that a natural, cost-effective, and safe herbal hand wash can be formulated using readily available plant materials, offering a promising alternative to synthetic products[34]. A herbal hand wash containing extract of *Ocimum sanctum* leaves known to have antimicrobial properties, By employing these herbal extracts as antimicrobial agents, the disc diffusion method was applied to assess the hand wash's activity against skin pathogens. The prepared formulation demonstrated superior efficacy in decreasing microbial counts on hands compared to conventional hand washes, while also minimizing potential side effects. Therefore, due to their pronounced antimicrobial effectiveness, these herbal extracts show potential for use in the large-scale production of herbal hand wash formulations[35]. Another herbal handwashes, formulated using a Combination of natural extracts comprising beetroot peel, lemon juice, Aloe vera gel, mint, honey, and turmeric rose oil, was found within the desired ranges without any adverse effects[37].

Despite several refereed herbal hand wash formulations, there is currently no record of any hand wash formulation containing *Gymnocladus burmanicus*. *Gymnocladus burmanicus* (Figs. 1-5) is a natural cleansing pod (fruit) bearing tree that grows in Arunachal Pradesh[38]. This study reports three methods of Gymnocladus hand wash formulation: (a) Gymnocladus ethanol solution hand wash, (b) Gymnocladus aqueous solution hand wash, and (c) Gymnocladus extract hand wash, with the option to use skin care herb extracts such as *Vitex negundo*, neem, and aloe vera, as well as aroma and color additives. This study focused on creating a cleaning formulation featuring naturally derived detergents that are cost-effective, user-friendly, environmentally friendly, and easy to manufacture. Gymnocladus is a genus of the Leguminous family. The *Gymnocladus burmanicus* tree, called Dikang or Dika in Arunachal Pradesh, India, thrives at elevations ranging from 350 m to 700 m.G. *Burmanicus possesses* excellent cleaning and lathering properties. The pod of *Gymnocladus burmanicus* measured up to 15 cm in length and up to 4 cm in width, elongated and brownish in color. A healthy, mature tree can yield over 100 kg of pods annually. The primary composition of Gymnocladus pod is saponin. Saponins have antibacterial and antifungal properties, offering a less irritating alternative to chemical formulations of soap and shampoo. Saponins are natural surfactants with a variety of qualities, including foaming and cleaning capabilities[39].

2. Material and Methods

2.1 Materials

The research was conducted in the laboratory of the Department of Botany at Jawaharlal Nehru College, Pasighat, Arunachal Pradesh, from February' 2025 to March' 2026. The pods of *Gymnocladus burmanicus* were collected from Ledum village in Arunachal Pradesh, while *Vitex negundo* was obtained from the garden of the Author, Mone Village, Pasighat, in September' 2025. Xanthan gum, ethanol, glassware, and instruments were used by the Department of

Botany at Jawaharlal Nehru College, Pasighat, with support from the Department of Biotechnology under the DBT Star College Scheme project implemented at JN College, Pasighat, Arunachal Pradesh. Table salt was purchased from the local market of Pasighat town of Arunachal Pradesh.

2.2 Methods

Preparation of Gymnocladus solutions and extracts

G. burmanicus pods were washed with distilled water and chopped into pieces approximately 0.5–1.0 cm in length. The chopped pods were dried in a hot-air oven at 40°C until a constant weight was achieved. The dried samples were divided into three equal portions, labeled as samples A, B, and C.

Sample A was subjected to cold maceration in one litre of ethanol (analytical grade) for 48 hours at ambient temperature (25°C), with intermittent shaking every 6 hours, and filtered using Whatman No. 1 filter paper to obtain the Gymnocladus-ethanol solution. Sample B was similarly cold macerated in one litre of distilled water for 48 hours, at 25°C, then filtered to yield the aqueous Gymnocladus solution. Sample C underwent Soxhlet extraction using an equal volume mixture of petroleum ether and ethanol (v/v) at 65°C for a duration of 6 hours. Following extraction, the combined solvents were removed under reduced pressure, resulting in a brownish extract. The rationale for using the 1:1 petroleum ether:ethanol ratio was to ensure extraction of both non-polar and polar constituents, maximizing the yield and efficacy of saponins. This combination of solvents was specifically chosen to extract the full spectrum of bioactive components from the sample, ranging from low to high polarity extractable compounds, thereby enhancing the overall effectiveness of the final product. All solutions and extracts were subsequently used for hand wash formulation.

2. 2.1 Preparation of other biological extracts

Vitex negundo leaves were sourced from the author's farm, shade-dried, and milled into a coarse powder. The powdered leaves underwent cold maceration in ethanol for 48 hours with periodic agitation, followed by filtration through Whatman filter paper. The resulting solution was concentrated using a water bath to yield a dark green extract, which was subsequently incorporated into the hand-washing formulations.

2. 2.2 Preparation of Gymnocladus extract handwash

In a beaker containing 50g of Gymnocladus extract, 40g of 2%table salt solution in distilled water was added, and the mixture was stirred vigorously until a uniform Gymnocladus solution was obtained. 2g of xanthan gum powder was weighed, and the prepared Gymnocladus solution was slowly added to the Xanthan gum, agitating vigorously to obtain a gel hand wash. 1 gram of skin care *Vitex negundo* extract was added to the prepared hand wash; the pH was measured with a pH meter and recorded as given in (Table 1).

Table 1. Gymnocladus extract hand wash formulation

Ingredients	**Weight (g)**
Gymnocladus burmanicus extract	30
Table salt	2
Distilled water	40
Xanthan	2
Skin care additive	2 (Optional)
Glycerin	5 (Optional)
Essential oil (Lemongrass/others)	0.5 (Optional)
Colour	0.1 (Optional)
Final weight	100

2.2.3 Preparation of Gymnocladus-ethanol solution hand wash

In a beaker containing 2g Xanthan gum powder, 90 g Gymnocladus ethanol solution was added after mixing 2g of table salt, and the mixture was stirred vigorously until a uniform Gymnocladus gel hand wash was obtained. Then 1 g of *Vitex negundo* extract was added to the prepared hand wash. The pH was tested with a pH meter and recorded as given in (Table 2).

Table 2. Gymnocladus-ethanol solution hand wash formulation

Ingredients	Weight (g)
Gymnocladus burmanicus-ethanol solution	90
Table salt	2
Xanthan	2
Skin care additive	2 (Optional)
Glycerin	5 (Optional)
Essential oil (Lemongrass/others)	0.5 (Optional)
Colour	0.1 (Optional)
Final weight	100

2.2.4 Preparation of Gymnocladus-water solution hand wash.

2g of table salt was dissolved in a 90g Gymnocladus water solution, the prepared solution was added into a beaker containing 5g of xanthan gum and was stirred vigorously until a uniform Gymnocladus gel hand wash was obtained. Then 1 g of *Vitex negundo* extract was added to the prepared hand wash. The pH was tested with a pH meter and recorded as given in (Table 3).

Table 3. Gymnocladus-Water solution handwash formulation.

Ingredients	Weight (g)
Gymnocladus burmanicus-water solution	90
Table salt	2
Xanthan	5
Skin care (*Vitex negundo*)	2 (optional)
Glycerin	5 (Optional)
Essential oil (Lemongrass/others)	0.5 (Optional)
Colour	0.1 (Optional)
Final weight	100

2.2.5 Evaluation of developed Hand wash

To assess the quality of the manufactured formulations, various parameter tests were conducted according to recognized protocols.

2.2.6 Physical appearance

The developed hand wash was examined for its physical attributes, including color, clarity, texture, consistency, and the presence of any particulate matter. These characteristics were documented and are presented in Table 4.

Table 4. Comparative analysis of Gymnocladus-based hand wash formulations

Properties	Formulation A	Formulation B	Formulation C
Physical appearance	Gel	Gel	Gel
Colour	Light brown	Light brown	Light brown
Detergency capacity	High	High	High
Aroma	Rosy	Rosy	Rosy
Foaming	Medium	Medium	Low
Dryness/Smoothness after wash	Smooth	Smooth	Smooth
Growth of microbes	Nil	Nil	Nil
Dispersion	High	High	High

A visually attractive and well-presented face wash or hand wash plays a significant role in its market success. Shoppers frequently base their choices on the product's initial appearance—features such as appealing color, smooth consistency, and a clean look can greatly shape how consumers perceive quality and desirability. A visually pleasing product inspires confidence in its effectiveness and safety, while any visible defects (such as phase separation, cloudiness, or sediment) may lead to negative perceptions regarding quality and stability. For producers, enhancing the visual presentation of their formulations is key not only to attracting potential buyers but also to maintaining customer loyalty in a crowded marketplace. Consequently, achieving a desirable physical appearance is a fundamental aspect of both product development and successful commercialization.

2.2.7 Determination of pH

The pH measurement of the hand wash was carried out at room temperature with a digital pH meter, and the findings are shown in Tables 1, 2, and 3. Ideally, skin maintains a pH between 4.5 and 6.5, which aligns with the skin's natural acidic barrier. This mild acidity is crucial for safeguarding the skin barrier, minimizing irritation, and restricting the proliferation of harmful microbes and pathogens. A hand wash with a suitable pH ensures that the product cleanses effectively without disrupting the skin's delicate balance or causing dryness and sensitivity. Therefore, pH testing is a crucial quality control step in face wash formulation. Products with pH values outside the recommended range may lead to skin discomfort or exacerbate existing skin issues, while those within the ideal range are more likely to support healthy, resilient skin and higher user satisfaction.

2.2.8 Dirt dispersion test

Five drops of hand wash were incorporated into 25 ml of distilled water within a test tube. A single drop of ink was incorporated into the face wash and agitated vigorously ten times. The quantity of ink in the foam was documented as None, Light, Moderate, or Heavy.

2.2.9 Foam test

To assess foaming capacity and foam stability, 20 mL of hand wash was placed in test tubes and agitated 10 times. The foam volume after 1 minute of shaking was classified as high, low, or medium.

Foaming in hand wash products is primarily due to the presence of surfactants such as saponins (in natural formulations) or synthetic agents like sodium lauryl sulfate. Surfactants work by lowering the surface tension of water, which makes it easier for bubbles to develop during agitation and results in the formation of visible foam. In natural products like those made with *Gymnocladus burmanicus*, saponins provide foaming action, which not only aids in removing dirt and microbes but also offers a gentle cleansing effect that is less irritation likely to irritate the skin compared to some synthetic surfactants.

Foam is an important sensory attribute for consumers. High foaming capacity is often associated with effective cleaning and user satisfaction, as consumers perceive products that produce more foam as being more efficient at removing dirt and oil. Foam stability—how long

the foam persists—also influences user experience; stable foam suggests prolonged cleansing action. As a result, there is significant consumer demand for foaming hand wash products. Many users equate visible foam with cleanliness, even if the actual cleansing efficacy is not directly related to foam amount. Thus, manufacturers often formulate products to maximize foaming, balancing it with skin compatibility and safety, especially in natural and eco-friendly products.

2.2.10 Evaluation of cleansing performance

The cleansing efficacy of the hand wash formulations was evaluated through a blind user test with fifteen volunteers. Each participant received samples labeled A, B, and C, and was instructed to use each sample under identical conditions—specifically after exposure to food stains and oil residue. Users assessed the product based on three key parameters: the condition of their skin after use (categorized as clean/unclean, dry/normal, or soft), the hand wash's ability to remove oil and food stains, and their overall satisfaction with the product. Feedback was recorded anonymously to ensure unbiased responses, and participants were encouraged to focus on both the immediate cleaning results and the after-feel of their skin.

The cleaning capacity of a hand wash is a critical factor for consumers. Effective removal of dirt, oil, and food residues is essential not only for hygiene and health but also for the user's perception of product quality. Products that can deliver high cleaning efficacy while leaving the skin feeling soft and comfortable are more likely to be preferred and recommended by users. Therefore, optimizing cleaning capacity directly impacts customer satisfaction, brand reputation, and repeat purchase behavior.

2.2.11 Microbial growth Observation

The formulated samples were placed in unsealed Petri dishes and kept at room temperature for two weeks to monitor the potential growth of common microbes typically found on food items. As a control, another Petri dish containing a piece of bread was included under the same conditions. The absence or presence of visible microbial colonies was recorded to assess the preservative efficacy and microbial resistance of the hand wash formulations.

Maintaining microbial-free faces with a hand wash product is critically important for healthy skin. Contamination in cosmetic products can lead to skin infections, irritation, or allergic reactions, especially in individuals with sensitive or compromised skin barriers. A product that effectively resists microbial growth ensures user safety, maintains product integrity during storage, and extends shelf life without the need for synthetic preservatives. For consumers, the assurance of microbial-free facewash not only supports skin health and hygiene but also builds trust in the product's quality and safety. This aspect is especially significant for natural formulations, where the challenge is to balance efficacy with minimal use of synthetic additives.

Figure 1. *Gymnocladus burmanicus*

Figure 2. *Gymnocladus burmanicus* pod

Figure 3. *Gymnocladus burmanicus* solution

Figure 4. Gymnocladus hand wash

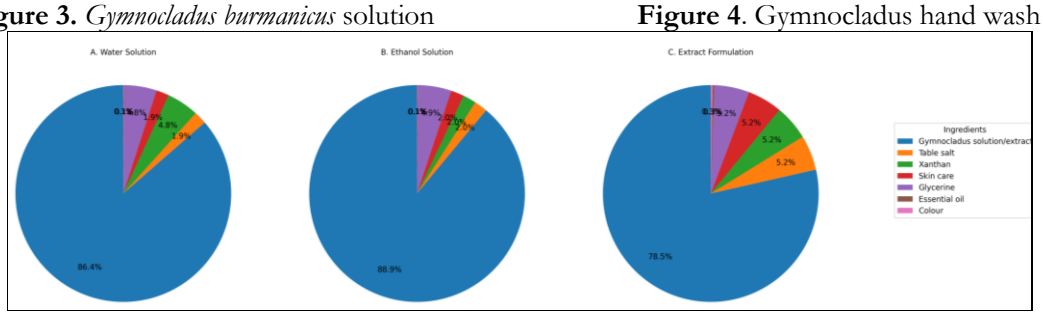

Figure 5. Comparative Pie Diagrams of Three Face Wash Formulations

3. Results and Findings

Gymnocladus burmanicus is a natural resource with cleansing and leathering properties; it has the potential to transform the soap, hand wash, and shampoo industries. The Gymnocladus extract, Gymnocladus–Eethanol solution, and Gymnocladus–water solution, when combined with table salt, demonstrated effective hand cleansing with self-lathering properties (foam volumes measured at 22 ± 2 mL, 25 ± 3 mL, and 20 ± 2 mL, respectively). The pH values for the respective formulations were 6.3 ± 0.2, 7.2 ± 0.3, and 6.5 ± 0.2, indicating consistency and skin compatibility. Detailed comparisons of these formulations are presented in Table 4. Microbial growth tests were conducted using unsealed Petri dishes exposed to ambient laboratory conditions for two weeks; no visible microbial colonies were observed, indicating robust preservative properties. Additionally, the formulations can be tailored with additives such as neem extract, aloe vera, color, aroma, and glycerine to meet user preferences. Comparative analysis with a standard commercial hand wash showed that the Gymnocladus-based formulations provided comparable cleansing efficacy and skin feel, with added benefits of being free from synthetic surfactants and preservatives. A blind user test (n = 15) reported high user satisfaction in terms of cleaning, skin softness, and absence of irritation

4. Conclusion

In comparison with commercially available hand washes, the Gymnocladus-based formulations exhibited similar cleansing efficacy, effective antimicrobial action, and superior skin compatibility as reported by users. The absence of microbial growth and consistent pH further supports the formulation's potential for safe and prolonged use. User evaluations indicated high satisfaction regarding skin safety, cleaning performance, and overall experience, suggesting suitability for sensitive skin and eco-conscious consumers. These findings highlight the potential of Gymnocladus-based natural hand washes as sustainable alternatives to conventional products, Future research should focus on large-scale user studies, extended antimicrobial spectrum analysis, and long-term stability assessments to strengthen the evidence base for commercialization and broader adoption. *Gymnocladus burmanicus* is a promising source of natural cleansers and table salt is a scrubber as well as a preservative. This natural soap pod has the potential to bring significant change to the cleansing industry, addressing sustainability, environmental friendliness, rural economies, and livelihoods. The initial study showed that it can

be formulated into an effective hand wash after proper processing and extraction. The present study used three extraction methods (aqueous, ethanol, and a combination of low- and high-polarity solvents), yielding effective extracts that were successfully formulated into hand-washing products. The presented formulations can be easily modified by adding additives and other skin care extracts, as per consumer preferences and market demand. The current research opens the door to further exploration of natural detergent resources. It is concluded that further studies are necessary for future commercialization and enhancement of overall quality.

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Use of AI statement

During the preparation of this manuscript, the authors employed ChatGPT to enhance the clarity and readability of the text. Following its use, the authors carefully reviewed and revised the content and assumed full responsibility for the accuracy and integrity of the publication.

Author's contribution

All the contribution related to this manuscript was carried out by Dr. Temin Payum alone.

Data Availability

This article contains data that supports the study.

Conflicts of Interest

Author states no conflict of interest.

Ethical Approval

Ethical approval was not required for this study.

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