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Formulation and Evaluation of the *Citrus maxima* Peel-loaded Herbal Soap

Dai Moki[1], Devojit Kuli[1], Aditya Narayan Barman[1], Amal Bawri[2], Nazim Hussain[1], Ahiya Noor[1], Md Safiqul Islam[1], Dubom Tayeng[1*], Angshuman Sonowal[1*]

[1]Faculty of Pharmaceutical Sciences,
Apex Professional University,
Pasighat, Arunachal Pradesh, India.
[2]NEIAFMR (An Autonomous Institute Under The Ministry Of Ayush, Govt. Of India),
Pasighat, Arunachal Pradesh791102, India
Corresponding Authors: sanuansu63@gmail.com (AS); tayengdubom@gmail.com (DT)
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Abstract

Ethnopharmacological significance:

Citrus maxima is widely used in herbal remedies for the treatment of various diseases and is also consumed as a fruit in India. In Assam and Arunachal Pradesh, India, the peels of this plant are believed to have various pharmacological activities.

Aim of the study:

The study aimed to formulate and evaluate a herbal soap containing *Citrus maxima* extract. The plant material was collected, authenticated, and extracted using suitable methods.

Materials and Methods:

Fresh peels of Citrus maxima were collected, dried, powdered, and used for the preparation of herbal soap using natural ingredients. The formulated soap was evaluated for physicochemical parameters, including pH, foam height, foam retention, moisture content, free alkali, alcohol insoluble matter, total fatty matter (TFM), hardness, and washability using standard methods. Organoleptic properties such as colour, odour, texture, shape, and appearance were also assessed. Skin irritation studies were performed to evaluate the safety of the formulation.

Results:

The formulated *Citrus maxima* herbal soap showed satisfactory physicochemical properties with a pH of 8.5, good foamability and foam stability, 72% total fatty matter, low free alkali content (0.18%), and acceptable moisture content (10.40%). The soap exhibited moderate hardness, easy washability, and no signs of skin irritation. Organoleptic evaluation revealed an attractive orange colour, pleasant citrus odour, soft, glossy texture, and translucent appearance, indicating good quality and consumer acceptability.

Conclusion:

The study successfully formulated a *Citrus maxima* herbal soap with good physicochemical properties, acceptable organoleptic characteristics, and no skin irritation. The findings suggest that the formulated herbal soap is safe, effective, and suitable for skin care applications.

Keywords: *Citrus maxima*, Herbal soap, Pomelo peel, Antimicrobial, Natural cosmetics.

Graphical Abstract

1.Introduction:

Herbal soaps, commonly known as natural soaps, are formulated from plant-based ingredients and botanical extracts, offering several advantages and having drawn considerable attention as an alternative to synthetic cleansing soaps due to their natural bioactive phytocompound compositions with skin-care attributes and their environmental friendliness (Gnaneshwari et al., 2025). Their natural fragrant qualities, antioxidant content, moisturizing qualities, and environmental sustainability make them popular. Botanical extracts are being studied more and more for their ability to cure dermatological disorders, including psoriasis, eczema, and acne, as the desire for natural, chemical-free personal care products rises globally (Das et al., 2024). Many medicinal plants and fruits are widely used in herbal remedies for the treatment of various diseases in Southeast Asia. The traditional knowledge system with herbal remedies has been practiced in India since ancient times, and in North-east India, this traditional medicinal system is still practiced by the local traditional healers of Arunachal Pradesh.

Antibiotics are among the most significant discoveries of the 20th century, since they have prevented millions of deaths from infectious diseases (Salam et al., 2023). Individuals' health is greatly impacted by bacterial infections, and the emergence of antibiotic resistance has become a global health concern, leading to high death rates in human populations (Doron & Gorbach, 2008). Microbes have a propensity to constantly evolve adaptive mechanisms to resist the effects of

antimicrobial drugs, despite the existence of several therapies and antibiotics. Therefore, there is a constant need for new antibacterial products to treat severe and chronic illnesses and stop the spread of infections that are becoming resistant to traditional antibiotics (Ochate et al., 2023).

Citrus maxima (Linn) of the Rutaceae family is an evergreen aromatic shrub or small tree, which bears the largest citrus fruit, native to Southeast Asia, and has been reported to have various ethnopharmacological uses in traditional herbal remedies for the treatment of fever, cough, asthma, gastrointestinal disorders, with antioxidant, antimicrobial, anti-inflammatory, and antidiabetic properties (Vijaylakshmi & Radha, 2015). It is locally called Robab tenga in Assam and Robab tasing in Arunachal Pradesh.

Pomelo, or *Citrus maxima*, is a citrus fruit that is well known for having a rich phytochemical composition that includes antioxidants, flavonoids, essential oils, and vitamin C (Mendake et al., 2024). Due to the presence of the various secondary metabolites, *Citrus maxima* is a useful component in cosmetic formulations because of these components' antibacterial, anti-inflammatory, and skin-rejuvenating qualities. The fruit's peel and pulp extracts are very helpful for eliminating acne, enhancing skin texture, and guarding against oxidative damage. This project focuses on the preparation and evaluation of herbal soap incorporating Citrus maxima extract, with an emphasis on its physicochemical properties, stability, and skin benefit.

2. Materials and Methods

2.1 Chemicals and reagents

Plant material (Citrus maxima peel/pulp), Oils (coconut oil, olive oil, etc.), NaOH (lye), distilled water, Additives (fragrance, color), Glycerin, Vitamin E, Soap base 85gm, Honey extract, aloe vera gel, lavender oil, lemon oil, Hot air Oven, Separating Funnel, Water Bath, Magnetic Stirrer, Analytical Balance, Dessicator, and measuring Cylinder.

2.2 Collection of plant material

The fresh fruits of *Citrus maxima* were collected from the Pasighat East Siang District of Arunachal Pradesh during the favourable season with sustainable harvesting practices in accordance with WHO guidelines on good agricultural practices to reduce ecological impact.

2.3 Formulation of Herbal Soap

2.3.1 Drying and Grinding of the Peels of *Citrus maxima*

Fresh peels of Citrus maxima were collected and thoroughly washed with clean water to remove adhering dirt and other impurities. The cleaned peels were then dried in the shade for

approximately 10–15 days until complete removal of moisture was achieved. After drying, the peels were ground into a coarse powder using a mechanical grinder. A photo image of the dried peel of *Citrus maxima* is shown in Figure 2.1. Finally, the prepared powdered peel material was stored in an airtight container for further use in soap preparation.

Figure 2.1:

A photo image A represents the dried peel, and B represents the powder of *Citrus maxima.*

2.3.2 Preparation of Soap Base

The glycerin soap base was taken and cut into small cubes to facilitate uniform melting. The cubes were transferred into a clean beaker and melted using a double boiler or water bath method. During the melting process, the temperature was maintained at approximately 60–70°C to prevent degradation of the soap base. The mixture was stirred gently and continuously until the soap base melted completely and formed a clear, homogeneous liquid.

2.3.3 Development of *Citrus maxima* Peel-loaded Herbal Soap

The ingredients were mixed slowly to ensure uniform distribution throughout the formulation. A measured quantity of *Citrus maxima* powder was then added to the melted soap base under continuous stirring. Subsequently, coconut oil was incorporated to provide a moisturizing effect, while castor oil was added to enhance foam formation and improve lathering properties. A small amount of stearic acid was also included in the formulation to increase the hardness and stability of the prepared soap. The melted soap base was stirred slowly to ensure uniform distribution of all ingredients throughout the formulation. A measured quantity of *Citrus maxima* powder was gradually added to the melted base under continuous stirring. Coconut oil was incorporated to provide moisturizing properties, while castor oil was added to enhance foam formation and improve lathering characteristics. A small amount of stearic acid was also included to increase the

hardness and stability of the soap formulation. Subsequently, essential oil, preferably citrus-based, was added to impart fragrance to the soap. Natural colorant was incorporated, if required, to improve the appearance of the formulation. Vitamin E was also added as an optional antioxidant to enhance the stability of the product. The mixture was stirred gently to avoid the formation of air bubbles. The prepared soap mixture was then poured carefully into clean and dry soap moulds. The moulds were gently tapped to remove any trapped air bubbles and to ensure uniform settling of the mixture. The soap was allowed to cool and solidify at room temperature for approximately 2–3 hours without disturbing the moulds during the solidification process. After complete hardening, the soap bars were carefully removed from the moulds and cut into desired shapes when necessary. The prepared final *C. maxima* peel-loaded herbal soap is shown in the figure 2.2. Finally, the prepared herbal soap was stored in a cool and dry place or wrapped in butter paper for further use and evaluation. The required ingredient for the prepared formulation is shown in Table 2.1.

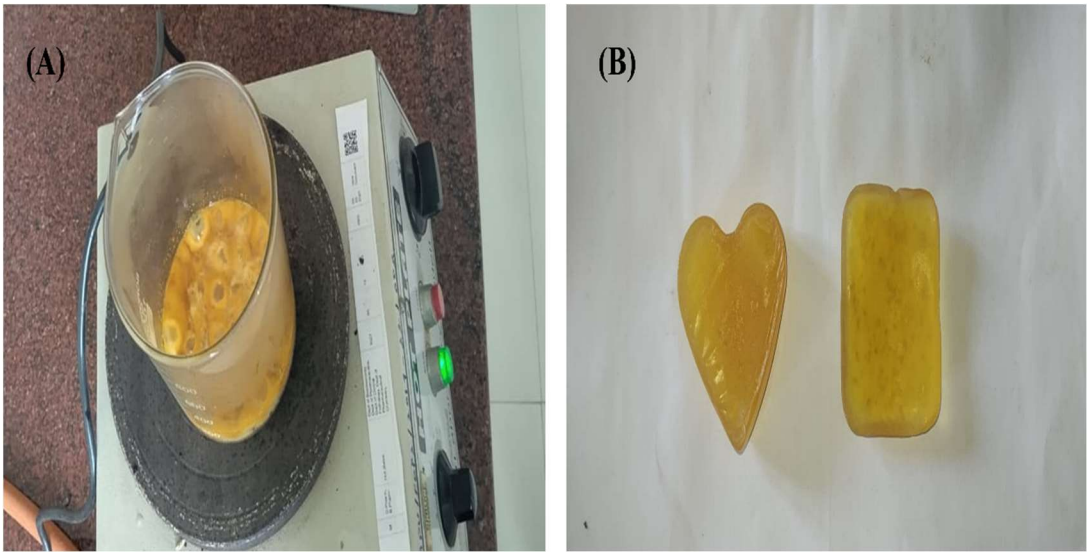

Figure 2.2:

The photo image A represents the preparation and B represents the final *maxima* peel-loaded herbal soap.

Table 2.1:

The required ingredients for the prepared formulation.

Ingredient	**Quantity (g)**	**Function**
Glycerin soap base	85.0 g	Base material

Citrus maxima powder	5.0 g	Active herbal ingredient
Coconut oil	5.0 g	Moisturizer improves lather
Distilled water	2.0 g	Solvent helps mixing
Essential oil (lemon/lavender)	1.0 g	Fragrance, mild antimicrobial
Natural colorant (optional)	0.5 g	Appearance
Vitamin E	1.0 g	Antioxidant, skin nourishment

2.4 Evaluation of *Citrus maxima* Peel-loaded Herbal Soap

The formulated *Citrus maxima* Peel-loaded Herbal Soap was evaluated for the various physicochemical and biological parameters, such as organoleptic parameters, pH determination, foam height, foam retention, moisture content, percentage free alkali, alcohol insoluble matter, total fatty matter, hardness test, skin irritation test, washability test, and stability study.

2.4.1 Organoleptic Evaluation

The formulated herbal soap was evaluated visually and manually for various organoleptic parameters such as color, odor, appearance, texture, and consistency. The soap was carefully observed for uniformity, smoothness, and any visible defects or irregularities. The fragrance and overall aesthetic acceptability of the formulation were also noted.

2.4.2 pH determination

About 1 g of the prepared herbal soap was accurately weighed and dissolved in 10 mL of distilled water to obtain a uniform soap solution. The solution was stirred properly until complete dissolution of the soap. The pH of the resulting solution was then measured using a calibrated digital pH meter at room temperature. The electrode of the pH meter was washed with distilled water before and after each measurement to avoid contamination. The observed pH value was recorded

2.4.3 Foam Height Determination

About 1 g of the prepared herbal soap was accurately weighed and dissolved in 50 mL of distilled water to prepare a soap solution. The solution was transferred into a clean measuring cylinder and

shaken vigorously for 1 minute to produce foam. After shaking, the measuring cylinder was allowed to stand undisturbed for 10 minutes. The height of the foam formed was then measured and recorded to evaluate the foaming ability of the formulation. Foam Height was calculated by using the Formula:

$$\text{Foam Height} = \text{Total Volume} - \text{Liquid Volume}$$

Foam Retention

The foam retention capacity of the formulated herbal soap was evaluated using the prepared soap solution. After vigorous shaking of the soap solution in a measuring cylinder, the foam volume was recorded after 1 minute and again after 5 minutes. The stability and persistence of the foam during the observation period were carefully noted. The ability of the foam to remain stable without rapid collapse was considered an indicator of good foam retention capacity.

2.4.4 Moisture Content

A known quantity of the formulated herbal soap was accurately weighed and transferred into a clean, dry dish. The sample was then dried in a hot air oven maintained at 105°C until a constant weight was obtained. After drying, the sample was cooled in a desiccator and reweighed. The loss in weight after drying was considered as the moisture content of the soap formulation. The Moisture Content was determined by using the Formula:

$$\text{Moisture Content (\%)} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

2.4.5 % Free Alkali

To determine the amount of excess alkali present in the herbal soap formulation, which may cause skin irritation if present in high concentration. A known quantity of the prepared herbal soap was accurately weighed and dissolved in neutralized alcohol with gentle heating to obtain a clear solution. A few drops of phenolphthalein indicator were added to the solution, and the mixture was titrated against standard hydrochloric acid (HCl) until the pink color disappeared, indicating the endpoint. The volume of hydrochloric acid consumed during titration was noted and used for the calculation of free alkali content. The % Free Alkali was determined by using the Formula:

$$\text{Free Alkali (\%)} = \frac{V \times N \times 3.1}{W}$$

Where:

- V = Volume of HCl used
- N = Normality of HCl
- W = Weight of soap sample

2.4.6 The Alcohol Insoluble Matter

A known quantity of the formulated herbal soap was accurately weighed and dissolved in warm alcohol with continuous stirring. The resulting solution was filtered to separate the insoluble matter present in the soap. The residue obtained on the filter paper was dried to a constant weight and weighed accurately. The percentage of alcohol insoluble matter was then calculated using the following formula. The Alcohol Insoluble Matter was determined by using the Formula:

$$\text{Alcohol Insoluble Matter (\%)} = \frac{\text{Weight of Residue}}{\text{Weight of Sample}} \times 100$$

2.4.7 Total Fatty Matter

To evaluate the quality of the formulated herbal soap by determining its total fatty matter content. Total Fatty Matter (TFM) is an important quality parameter for soaps. A higher TFM value generally indicates better quality soap with improved cleansing ability, moisturizing properties, and reduced harshness on the skin. The total fatty matter content was determined using the Formula:

$$\text{TFM (\%)} = \frac{\text{Weight of Fatty Matter}}{\text{Weight of Sample}} \times 100$$

2.4.8 Hardness Test:

The hardness of the formulated herbal soap was evaluated manually by applying gentle pressure to determine its firmness and resistance to breakage. In some cases, a hardness tester may also be used for accurate measurement of mechanical strength. The ability of the soap to maintain its shape without cracking or softening was observed and recorded.

2.4.9 Skin Irritation Test

A small quantity of the prepared herbal soap solution was applied to a limited area of the skin and allowed to remain for observation. The test area was monitored for 24 hours to detect any signs of redness, itching, swelling, or irritation. The absence or presence of any skin reaction was carefully recorded to evaluate the safety of the formulation for topical application.

3. Results and Discussion

3.1 Formulation of *Citrus maxima* Peel-loaded Herbal Soap

The herbal soap formulation containing Citrus maxima peel was successfully developed with satisfactory physical appearance and consistency. The incorporation of the peel extract into the melted soap base resulted in a uniform distribution of herbal constituents throughout the formulation. Coconut oil and castor oil improved the moisturizing and foaming properties of the soap, while stearic acid enhanced the hardness and structural stability of the final product. The addition of citrus-based essential oil imparted a pleasant fragrance to the soap, improving its aesthetic and consumer acceptability. The prepared soap exhibited good texture, smooth surface, and acceptable hardness after solidification. No visible cracks, phase separation, or air bubble formation were observed in the final formulation. The soap showed an attractive appearance with a characteristic citrus aroma, indicating successful incorporation of the herbal ingredients.

3.2 Evaluation of *Citrus maxima* Peel-loaded Herbal Soap

The formulated herbal soap containing *Citrus maxima* peel extract was evaluated for various physicochemical parameters to determine its quality, stability, safety, and suitability for topical application. The obtained results demonstrated that the prepared formulation possessed acceptable characteristics comparable to standard herbal soap preparations. The various parameters evaluated for the formulated *Citrus maxima* Peel-loaded Herbal Soap are shown in Table 3.2.

3.2.1 Organoleptic Evaluation

The organoleptic evaluation of the formulated herbal soap was carried out to assess its physical appearance and sensory characteristics. The results obtained indicated that the soap possessed acceptable aesthetic and physical properties suitable for topical application, as shown in Table 3.1.

3.2.2 pH Determination

The pH of the formulated soap was determined using a calibrated digital pH meter (Systonic, model no. S-901), found to be 8.5 ± 0.2, which falls within the acceptable range of 8–10 for toilet and herbal soaps. This slightly alkaline nature is considered suitable for cleansing action while remaining mild enough to avoid excessive skin irritation. The result suggests that the formulation can maintain effective cleaning properties without causing significant damage to the skin barrier.

3.2.3 Foam Height Determination

The foam height of the soap was observed to be 7.2 cm, indicating good foam-forming ability. Adequate foamability is an important characteristic of soaps as it improves consumer acceptability

and cleansing efficiency. The presence of natural constituents in the formulation may have contributed to satisfactory lather formation.

3.2.4 Foam Retention

Foam retention studies revealed that the foam remained stable for 5 minutes, indicating good foam stability. Stable foam enhances the washing performance of soap and reflects the presence of suitable surfactant properties within the formulation.

3.2.5 Moisture Content

The moisture content of the prepared soap was found to be 10.40%, which lies within the acceptable range of 10–15%. Appropriate moisture content is essential to maintain the hardness, stability, and shelf life of the soap. Excess moisture may lead to softening and microbial contamination, whereas very low moisture can result in brittle soap. Therefore, the obtained value indicates good formulation stability.

3.2.6 % Free Alkali

The percentage of free alkali was determined to be 0.18%, which is well below the permissible limit of 2%. Lower free alkali content indicates complete saponification and suggests that the soap is safe for skin application. Excess alkali in soap may cause skin dryness, irritation, or itching; therefore, the low free alkali value obtained in this study confirms the mild nature of the formulation.

3.2.7 The Alcohol Insoluble Matter

The alcohol insoluble matter was recorded as 14.20%, which was found to be within acceptable limits for herbal soap formulations. Alcohol insoluble matter generally represents the presence of inorganic substances and other insoluble materials. The obtained value indicates acceptable purity and quality of the prepared soap.

3.2.8 Total Fatty Matter

The Total Fatty Matter (TFM) of the soap was found to be 72%, indicating good quality soap according to standard specifications. Higher TFM values are generally associated with better moisturizing properties, improved cleansing efficiency, and reduced harshness on the skin. The result suggests that the formulated herbal soap possesses desirable emollient and skin-friendly properties.

3.2.9 Hardness Test

The hardness of the prepared soap was observed to be moderate, indicating that the soap possessed suitable consistency and mechanical strength. Proper hardness is important to prevent easy breakage and to improve the durability of the soap during use.

3.2.10 Washability Test

The washability test showed that the soap was easily washable, demonstrating efficient cleansing ability without leaving excessive residue on the skin. This characteristic improves user convenience and acceptability.

3.2.11 Skin Irritation Test

The skin irritation test revealed no signs of irritation, redness, or itching after application, indicating that the formulated herbal soap is safe for topical use. The absence of irritation may be attributed to the natural bioactive constituents present in *Citrus maxima* peel extract and the low free alkali content of the formulation.

Overall, the evaluated physicochemical parameters suggest that the formulated herbal soap possesses good quality, stability, cleansing efficiency, and safety for skin application. The findings indicate that *Citrus maxima* peel extract can be effectively incorporated into herbal soap formulations for potential cosmetic and skin care applications.

Table 3.2: The various parameters evaluated for the formulated *Citrus maxima* Peel-loaded Herbal Soap.

Sl. no.	Parameter	Result Obtained	Standard/Acceptable Range
1.	pH	8.5 ± 0.2	8–10
2.	Foam height	7.2 cm	Good foamability
3.	Foam retention	Stable for 5 min	Stable
4.	Moisture content	10.40%	10–15%
5.	Free alkali	0.18%	< 2%
6.	Alcohol insoluble matter	14.20%	Acceptable
7.	Total fatty matter (TFM)	72%	Good quality
8.	Hardness	Moderate	Acceptable
9.	Washability	Easily washable	Good
10.	Skin irritation test	No irritation	Safe

4. Conclusion:

The present study successfully formulated and evaluated a herbal soap containing *Citrus maxima* peel extract. The physicochemical evaluation demonstrated that the prepared soap possessed satisfactory quality parameters, including acceptable pH, good foamability and foam stability, suitable moisture content, low free alkali content, and high total fatty matter (TFM). The formulation also exhibited good hardness, easy washability, and no signs of skin irritation, indicating its safety and suitability for topical application. The findings suggest that *Citrus maxima* peel extract can be effectively utilized in herbal soap formulations due to its skin-friendly nature and potential beneficial properties. The use of natural plant-based ingredients may provide a safer and more eco-friendly alternative to synthetic chemical-based soaps. Overall, the formulated herbal soap showed promising characteristics for cosmetic and personal care applications and may serve as a potential natural cleansing product for maintaining healthy skin.

Credit authorship contribution statement

Dai Moki: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft, Writing – review and editing. **Angshuman Sonowal:** Supervision, Investigation, Methodology, Data curation, Resources, and Writing – review and editing. **Aditya Narayan Barman:** Data curation, Investigation, Methodology. **Amal Bawri:** Supervision, Investigation, and Methodology. **Nazim Hussain:** Investigation and Methodology. **Ahiya Noor:** Supervision, Writing – review and editing. Safiqul Islam: Investigation and Methodology. **Devojit Kuli:** Methodology and Formal analysis. **Dubom Tayeng:** Methodology, Visualization, Conceptualization, Data Curation, Formal analysis, Writing – review and editing.

Declaration of competing interest

The authors declare no competing interests and no known conflicts of interest or personal relationships that could influence the outcome of the study. The authors also hereby declare that the submitted manuscript is our original work and has not been published previously nor submitted to any other journal for publication consideration.

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List of abbreviations

TFM Total Fatty Matter **pH** Potential of Hydrogen

HCl Hydrochloric Acid

°C Degree Celsius

g Gram

mL Millilitre

% Percentage

C. maxima Citrus maxima

WHO World Health Organization

References

Das, S., Agarwal, S., Samanta, S., Kumari, M., & Das, R. (2024). Formulation and evaluation of herbal soap. *Journal of Pharmacognosy and Phytochemistry*, *13*(4), 14–19. https://doi.org/10.22271/phyto.2024.v13.i4a.14990

Doron, S., & Gorbach, S. L. (2008). Bacterial Infections: Overview. *International Encyclopedia of Public Health*, 273–282. https://doi.org/10.1016/B978-012373960-5.00596-7

Gnaneshwari, V., Raveena, R., Akhila, R., Anusha, R., Nayak, S. H., & Aishwarya, S. (2025). Herbal Soaps: A Comprehensive Review of Composition, Benefits, and Future Directions. *International Journal of Pharmacy and Industrial Research*, *15*(1), 10–20. https://doi.org/10.61096/ijpir.v15.iss1.2025.10-20

Mendake, R. A., Amalkar, S. V., Hatwar, P. R., & Bakal, R. L. (2024). Formulation and Evaluation of Polyherbal Soap. *Journal of Drug Delivery and Therapeutics*, *14*(11), 99–104. https://doi.org/10.22270/jddt.v14.i11.6892

Ochate, M. L. B. E., Castro, K. J. C., Arellano, J. M. M., Balagonsa, V. A. O., Saldo, I. J. P., & Dandoy, M. J. P. (2023). Evaluation of the Antibacterial Potential of the Pomelo (*Citrus maxima*) Peel Extract Liquid Hand Soap. *American Journal of Microbiological Research*, *11*(2), 47–51. https://doi.org/10.12691/ajmr-11-2-3

Salam, Md. A., Al-Amin, Md. Y., Salam, M. T., Pawar, J. S., Akhter, N., Rabaan, A. A., & Alqumber, M. A. A. (2023). Antimicrobial Resistance: A Growing Serious Threat for Global Public Health. *Healthcare*, *11*(13), 1946. https://doi.org/10.3390/healthcare11131946

Vijaylakshmi, P., & Radha, R. (2015). An overview: Citrus maxima. *The Journal of Phytopharmacology*, *4*(5), 263–267. https://doi.org/10.31254/phyto.2015.4505