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Anti-Inflammatory Therapeutic Potential of Papaya Root Waste Extract with an Innovative Dermatological Approach

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Abstract: Papaya (*Carica papaya L.*) is a tropical plant known for its various health benefits. Almost all parts of this plant, including its roots, contain phytochemical compounds such as flavonoids, alkaloids, saponins, and papain enzymes with potential anti-inflammatory properties. This study aimed to develop an anti-inflammatory cream based on papaya root waste extract, providing a natural therapeutic solution for skin inflammation. Papaya roots were obtained from Laweung, Pidie Regency, and processed using maceration with 96% ethanol solvent, yielding an extract with a 26% recovery rate. Phytochemical analysis revealed the presence of flavonoids, phenolics, tannins, alkaloids, terpenoids, and saponins.The cream formulation was developed with varying extract concentrations: F0 (control), F1 (1.2 g), F2 (1.6 g), and F3 (2.0 g). Based on organoleptic testing, the cream formulations showed good stability in terms of color, aroma, and texture during storage. The added rose oil provided a pleasant fragrance that meets the SNI cosmetic standards. The pH test results indicated that all formulations (F0 to F3) were within the safe range for skin application, between 5.2 and 6.4. Formula F3 had the lowest pH (5.2), but it still complied with the SNI standard. The spreadability test showed varying results, with F0 having the highest spreadability (8.1 cm), while formulas with papaya extract (F1 to F3) showed spreadability ranging from 6.06 to 7.1 cm. The viscosity of the cream increased with higher extract concentrations, with F0 having the lowest viscosity (10,000-10,800 cPs) and F3 the highest (19,000 cPs). Homogeneity testing confirmed that all formulations had uniform distributions without phase separation. In conclusion, the cream based on papaya root waste extract has potential as a natural anti-inflammatory product with physicochemical stability suitable for topical use and adds value to plant waste.

Keywords: Anti-inflammatory; Cream; Papaya (Carica papaya L.); Phytochemicals; Topical application

Introduction

Papaya (*Carica papaya L.*) is a tropical plant that is widely found in various parts of the world (Kamilla et al., 2021; Romasi et al., 2013), especially in warm climates (Of & Leaf, 2023). Over the years, papaya has been recognized not only as a nutritious fruit (Hernani et al., 2022), but also as a plant with a wide array of health benefits (Santana et al., 2019). Almost all parts of the papaya plant, including roots, leaves, fruits, and seeds (Nair & Mook, 1933), contain phytochemical compounds that have the potential to be used as nutrients and medicine (Gaikwad et al., 2023; Ugbogu et al., 2023).

Phytochemical compounds in papaya, such as flavonoids, alkaloids (Gaikwad et al., 2023), saponins, and the enzyme papain (Damayanti et al., 2021), have

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various bioactivities that have attracted scientific attention (Breijyeh & Karaman, 2024). Flavonoids, for example, are known to have significant anti-inflammatory effects (Ahmed et al., 2024), capable of reducing inflammation that can trigger various health disorders (Hernani et al., 2022), including inflammatory skin diseases such as dermatitis (Kamilla et al., 2021). These skin diseases can negatively impact an individual's quality of life and often require effective treatment (Aulianshah et al., 2021). However, the use of conventional anti-inflammatory drugs is often accompanied by side effects and risk of resistance (Breijyeh & Karaman, 2024), prompting the search for safer and more effective alternatives (Das et al., 2024). Papaya root waste, which is often considered useless, actually has great potential as a source of natural anti-inflammatory agents (Alfarabi et al., 2022). With its beneficial active compound content, papaya root can be further explored to develop innovative dermatological products (Ahmed et al., 2024). Therefore, this study aims to explore the potential of papaya root waste extract in developing a safe and effective anti-inflammatory cream formulation (Aminah & Juliana, 2024), as a first step in utilizing natural resources (Munir et al., 2022) that are sustainable and environmentally friendly (Yuniarti et al., 2021). Through this research, it is hoped that it can contribute to the development of alternative therapies for skin inflammation problems, as well as increase the added value of papaya root waste which is often neglected (Molnar et al., 2024).

The difference between this study and previous studies is the focus on the utilization of papaya root waste, which is rarely used as an active ingredient in pharmaceutical or cosmetic formulations. Previously, many studies have examined the potential of papaya leaves or fruit, but papaya roots, which contain rich active compounds, have not been widely explored. In addition, this research also emphasizes the development of effective and safe dermatological product formulations, and focuses on more optimal extraction techniques to obtain bioactive compounds in high enough quantities, with the aim of producing products that can be widely used in the community. With this approach, it is hoped to create natural solutions that are not only beneficial for skin health but also reduce dependence on synthetic chemicals that often have adverse effects on health and the environment.

Method

This research activity was carried out for one year at the Pharmacology Laboratory of Jabal Ghafur STIKes, Pharmaceutics Laboratory at the Banda Aceh Academy of Pharmaceutical and Food Analysts, Agricultural Products Analysis Laboratory at Serambi Mekkah University, with additional analysis carried out at the Faculty of Mathematics and Natural Sciences, Syiah Kuala University. The research consisted of several stages. The first stage was a preliminary study, which involved a literature review regarding the use of papaya root waste as anti-inflammatory therapy in dermatology. This review included previous studies on the extraction of active compounds from papaya root waste, the anti-inflammatory potential of those compounds, as well as relevant formulation technologies for dermatological product development. The research flow chart can be seen in the chart below:

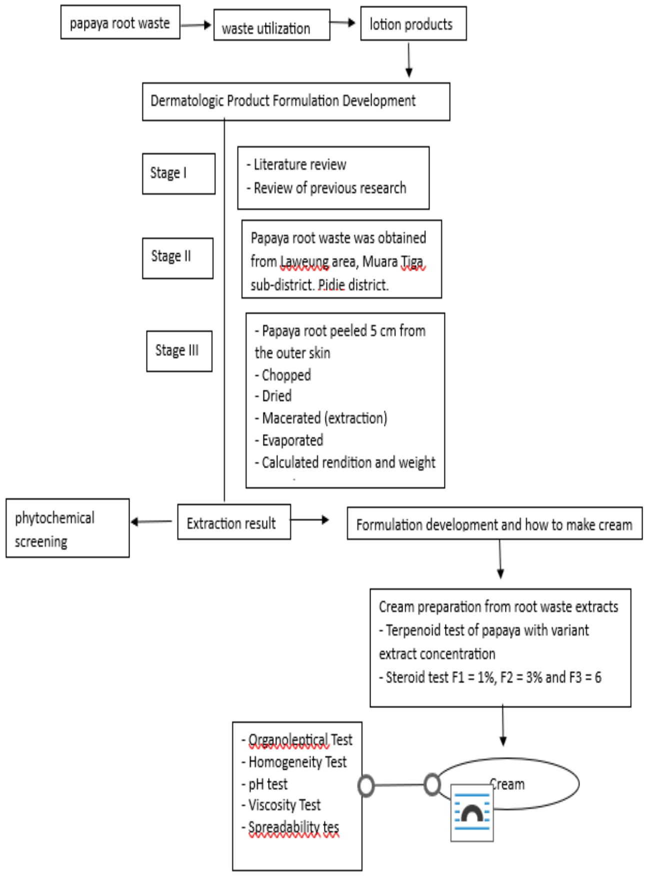

Figure 1. Research flow chart

The second stage involved the preparation of raw materials, namely papaya root waste peeled 3 cm from the outer skin, which was collected from Laweung area, Muara Tiga District, Pidie Regency. The prepared papaya roots were then cut and dried for 1 x 24 hours. In the third stage, papaya root waste extract was made with the following steps: papaya roots that have been cleaned are chopped into small pieces, then macerated in a dark container bottle. Extraction was carried out using 96% ethanol for six hours, stirring occasionally in a ratio of 1:10, with 300 grams of simplisia dissolved in 3 liters of ethanol. After 18 hours, the solution was filtered and evaporated to obtain a thick extract. From this process, the yield was calculated and the weight percentage (w/b) of extract to simplisia was recorded according to the method developed by Watung et al. (2020). With this approach, it is expected to obtain an optimal extract for application as an anti-inflammatory agent in dermatological products.

Result and Discussion

Preparation of Raw Materials

In the raw material preparation stage of papaya root waste (Carica papaya L.), samples were taken from the Laweung area, Muara Tiga sub-district, Pidie district. The collected papaya roots were then peeled about 3 cm from the outer skin to remove contaminants and unwanted materials. It is important that the peeling process is done carefully to ensure that the inside of the root, which contains bioactive compounds, is preserved. This initial processing aims to maximize the content of active compounds that will be extracted in the next stage. After stripping, papaya roots are cleaned and cut into small parts to facilitate the extraction process.

The reduction in particle size serves to increase the contact surface area between the roots and the solvent, thus allowing bioactive compounds such as alkaloids, flavonoids and saponins to be extracted efficiently (Sharma et al., 2022). According to the results of Adeoye et al. (2024) research these prepared root samples are then stored under proper conditions before the extraction process begins, to maintain the stability and composition of the active compounds contained therein.

Preparation of Papaya Root Waste Extract

In the preparation stage of papaya (Carica papaya L.) root waste extract, the roots that have been peeled 3 cm from the outer skin are cleaned of dirt to ensure there is no contamination that can affect the quality of the extract. The roots were then chopped into small pieces and aerated for 24 hours to reduce the water content, which aims to increase the extraction efficiency.

The maceration process was carried out in a dark container bottle to protect the bioactive compounds from exposure to light (Jovanović et al., 2017), which can damage important components such as flavonoids and alkaloids (Singh et al., 2020). Ethanol 96% was used as a solvent due to its good ability to extract polar and semi-polar compounds from papaya roots (Hasrawati et al., 2020). Simplisia as much as 300 grams was soaked in 3 liters of ethanol in a ratio of 1:10, while stirring occasionally for the first 6 hours to accelerate the release of active compounds. After the initial maceration process, the mixture was allowed to stand for 18 hours to ensure optimal extraction of papaya root active compounds. Filtration was carried out to separate the residue from the extract liquid, which was then evaporated using an evaporator until a thick extract was obtained.

According to the results of Aulianshah et al. (2021) reseach to the evaporation process aims to remove the solvent, leaving bioactive compounds in concentrated form. The extract yield is calculated by comparing the weight of the extract obtained with the weight of the initial simplisia (Setyani et al., 2024). In this study, a yield of 26% was obtained. This yield will be used as a parameter of extraction efficiency, where the higher the yield, the more optimal the extraction process. Percent yield of papaya root extract is calculated to evaluate the efficiency of the extraction process (Sipos et al., 2022). This process begins with the preparation of simplisia, namely papaya roots that have been peeled, cut, and dried. The simplisia is then extracted using a specific method, for example maceration with a special solvent. The resulting extract is then evaporated to remove the remaining solvent, and the residue left behind is weighed to obtain the weight of the extract. Papaya root extraction using 96% ethanol solvent and maceration method aims to obtain ethanol-soluble active compounds.

Ethanol 96% was chosen because it has properties as an effective polar solvent, which can extract polar compounds and some nonpolar compounds from natural materials. According to the Fakhruzy et al. (2020) Ethanol is also known as an environmentally friendly and safe solvent for bioactive compounds, so it is often used in phytochemical research and herbal extract production (Fitriyana et al., 2023). In this process, papaya roots are soaked in 96% ethanol for a certain period of time Ethanol will penetrate into the root cell matrix and dissolve the bioactive compounds contained, such as flavonoids, alkaloids, saponins, or phenolic compounds. The use of 96% ethanol allows for optimal extraction due to the very little water content in the solvent. This low water content helps prevent the extraction of highly water-soluble but possibly undesirable compounds, resulting in a purer extract. The results of the phytochemical test can be seen in Table 1 below:

Table 1. Phytochemical Test

Flavanoid	+
Terpenoid	+
Steroid	-
Fenolik	+
Tannin	+
Alkaloid	+
DD	+
Mayer	+
Wagner	+

Phytochemical test results of papaya root extract showed that this extract contains various bioactive compounds that have anti-inflammatory potential (Syah et al., 2022). The flavonoid, phenolic and tannin compounds detected are known to have antioxidant and anti-inflammatory activities, which can help reduce inflammation and protect cells from free radical damage (Fitrianti et al., 2022). In addition, the presence of terpenoids and saponins in the extract strengthens its anti-inflammatory potential, where these compounds support the body's immune response and are able to inhibit the inflammatory process. According to the alkaloid test results were also positive, which contributes additionally to the anti-inflammatory activity of this extract. Thus, the composition of bioactive compounds in papaya root extract demonstrates its potential as a natural agent to relieve inflammation and support overall body health. according to research results Romasi et al. (2013) that papaya fruit seeds contain phytochemical compounds.

Formulation Development and Cream Making Method

Cream formulation with papaya root waste extract, the main difference between each formula lies in the amount of papaya extract and methyl paraben can be seen in Table 2.

Table 2. Observation of Cream Formulation with Papaya Root Waste Extract

Ingredients	F0	F1	F2	F3
Papaya extract	0	1.2	1.6	2
Stereat acid	12	12	12	12
Acetyl alcohol	4	4	4	4
TEA	3	3	3	3
Glycerin	6	6	6	6
Methyl paraben	0.4	0.4	0.4	1.6
Aquadest	174.6	173.4	173.0	172.6
Rose oil	3	3	3	3

Based on Table 2, it can be seen that formula F0, as the control, does not contain papaya extract, while F1, F2, and F3 have increasing extract concentrations, namely 1.2 g, 1.6 g, and 2.0 g, respectively. The increase in extract was intended to see its effect on the physical properties and bioactive benefits of the cream. Stearic acid and cetyl alcohol were used in equal amounts in all formulas, namely 12 g and 4 g, functioning as thickeners and emollients to maintain emulsion stability. Similarly, TEA (3 g) was used to adjust the pH and glycerin (6 g) as a humectant to keep the skin moisturized. Methyl paraben, as a preservative, was added at a fixed concentration of 0.4 g in F0 to F2, but in F3 it was increased to 1.6 g to match the higher amount of extract, which may be more susceptible to microorganism growth. Aquadest was added to reach a volume of 100 ml, with the amount decreasing slightly in each formula as the content of extracts and other ingredients increased, from 174.6 ml in F0 to 172.6 ml in F3. In addition, rose oil as much as 3 drops was added in each formula to provide aroma and soothing benefits. According to the use of these ingredients aims to produce a cream that is homogeneous, stable, and has an anti-inflammatory effect from papaya extract (Dominica et al., 2019).

Physical Quality Testing

The observation results of organoleptical testing, homogeneity, pH, and spreadability on cream formulations with papaya root waste extract can be explained in more detail as follows:

Organoleptical Test

In the organoleptical test, the focus is on physical changes, aroma, and color in each formula during storage. Formula F0 as a control does not contain papaya extract, so it has a more neutral color than F1 to F3. The gradual addition of papaya extract in F1, F2, and F3 caused the color of the cream to become more intense, which can be attributed to the natural pigment content of papaya root. The aroma of the cream resulted from the addition of rose oil, which gave a light floral aroma, there was no noticeable difference in aroma between all formulas. According to physically, all formulas remain stable without any change in consistency during storage, indicating that the ingredients that make up the cream are well arranged and stable (Molnar et al., 2024). The results of the organoleptic test can be seen in Table 3.

Table 3. Organoleptic Test

Formula	Shape	Color	Aroma
F0	Semi Solid	White	Rose
F1	Semi Solid	Light Beige	Rose
F2	Semi Solid	Light Yellow	Rose
F3	Semi Solid	Light Yellow	Rose

Based on the Table, it can be seen that the cream composition has a distinctive shape, color and aroma. Cream products should have a good appearance, not experiencing changes in color, odor, or texture during storage. Based on organoleptic testing, the cream formulation with papaya extract showed stability in terms of color, odor, and shape. F0 to F3 remained physically consistent with no significant changes during storage. The aroma of rose oil added provides an appropriate and non-pungent odor, which is in accordance with the standard of cosmetic products under SNI, where the cream should have a pleasant and unchanging aroma.

Homogeneity Test

Homogeneity test is one of the important parameters in the preparation (Marlina et al., 2021), because it is to determine whether the active substance has been homogeneously distributed in the base or not (Taebenu et al., 2023). This homogeneity test aims to see the ingredients used in the preparation of body cream preparations have been mixed evenly (Weigmann et al., 2012).

The results of observations on homogeneity. The homogeneity test showed that all formulas (F0 to F3) succeeded in producing a homogeneous cream. The test was conducted by applying the cream on a glass plate, then palpated and observed visually. No coarse particles or inhomogeneity were detected, indicating that the oil phase (such as stearic acid, cetyl alcohol, and liquid paraffin) and water phase (aquadest, glycerin, TEA, and papaya extract) were well mixed. The homogeneity test results showed that all formulas (F0 to F3) had a smooth and uniform structure, with no coarse particles or inhomogeneity when applied to the glass plate. This is in accordance with the results of research (Weigmann et al., 2012). This homogeneity standard is important because it ensures that active ingredients such as papaya extract are evenly distributed, so that the effectiveness and safety of the product is maintained during use. Thus, the cream formulation has met the homogeneity criteria required by SNI.

Homogeneity is important to ensure that all active ingredients, especially papaya extract (Setyani et al., 2024), are evenly distributed in the cream preparation so that each application provides a consistent (Sapiun et al., 2022). SNI also requires that the cream must be homogeneous, meaning that each component in the cream formula must be evenly mixed without any coarse grains or phase segregation.

pH test

The pH measurement aims to ensure the formulation is compatible with the pH of human skin, which ideally falls within the range of 5.2 to 6.4 (Blaak et al., 2020). The pH test on papaya root extract can be seen in Table 4.

Table 4. Cream pH Test

Formula	pH 1	pH 2	pH 3
F0	6.3	6.3	6.3
F1	6.4	6.4	6.4
F2	6.3	6.3	6.3
F3	5.2	5.2	5.2

SNI stipulates that cosmetic products applied to the skin, including creams, must have a pH that is in accordance with the physiological pH of the skin, which is in the range of 4.5-8. This is to ensure the product does not cause irritation or damage to the skin. From the pH test results, formulas F0 to F2 had a pH between 6.3 to 6.4, which is in accordance with SNI standards and safe for the skin. However, F3 has a pH of 5.2, which is still at the lower limit but still within the range accepted by SNI. Although slightly more acidic, F3 is still considered safe. This is in accordance with the results of research Hasrawati et al. (2020) but may need extra attention if used by individuals with very sensitive skin.

Spreadability Test

Spreadability testing is done to assess how widely the cream can be spread on the skin (Setyani et al., 2024). Formula F0, which does not contain papaya extract, has the highest spreadability with an average of 8.1 cm, which indicates a lighter cream texture and is easier to spread. The data about the spreadability test can be seen in Table 5.

Table 5. Spreadability Test of Papaya Root Extract Crea

Formula	P1	P2	P3
F0	8	8.1	8.2
F1	6	6.2	6
F2	7	7.4	7.5
F3	7	7.1	7.2

According to cosmetic quality standards, especially creams, spreadability is an important indicator that shows the product's ability to spread evenly on the skin without leaving residue or a sticky feeling. Although SNI does not explicitly set a numerical value for spreadability, generally a good cream should have a wide enough spreadability to guarantee effective use (Saechan et al., 2021).

Based on the test results, formula F0 (without papaya extract) had the highest spreadability with an average of 8.1 cm, indicating a light texture and easy application. Formulas F1 and F2 had lower spreadability (average 6.06 cm), which may be due to the higher concentration of papaya extract, which affects the viscosity of the cream. F3 had a slightly higher spreadability (7.1 cm), although not as high as F0.

With this spreadability, the cream met expectations for comfortable use on the skin (Yasir et al., 2024). This is in accordance with the results of research Fadli et al. (2024), although the addition of papaya extract slightly affected the spreadability (Mutia et al., 2023). In the context of SNI standards, this formulation can be considered eligible because the spreadability is still within the acceptable category.

Viscosity Test

Viscosity is an important indicator in cream testing because it reflects the thickness and flow of the product

(Purwaningsih et al., 2014) for each formula can be seen in Table 6.

Table 6. Viscosity Test of Papaya Root Extract Cream

Formula	P1	P2	P3
F0	10800	10060	10000
F1	16400	15400	15000
F2	17000	16600	16800
F3	19200	19000	18800

Based on Table 6, it can be seen that there is a significant difference between formulas without papaya extract (F0) and formulas containing papaya extract (F1, F2, F3). Formula F0 had the lowest viscosity, with an average of about 10,000-10,800 cPs. With the addition of papaya extract, the viscosity increased gradually, with F1 at about 15,600 cPs, F2 reaching 16,800 cPs, and F3 the highest, with an average value of about 19,000 cPs.

Conclusion

The conclusion of this study shows that the papaya root waste extract (Carica papaya L.) obtained through the maceration method with 96% ethanol solvent contains various bioactive compounds with potential anti-inflammatory properties. Phytochemical testing revealed the presence of flavonoids, phenolics, tannins, alkaloids, and terpenoids, all known for their anti-inflammatory and antioxidant activities. These properties can help reduce inflammation and protect cells from damage caused by free radicals. In the development of cream formulations, the results of physical testing demonstrated that all formulas (F0 to F3) had good physical quality, including stable color, aroma, and form during storage, in accordance with organoleptic standards. Formula F0, which did not contain papaya extract, had a neutral white color, while F1 to F3 showed a color enhancement with the addition of papaya extract. The aroma of all formulas remained stable with the addition of rose oil. Homogeneity testing indicated that all formulas produced homogeneous cream, with no coarse particles or inhomogeneity, ensuring a uniform distribution of the papaya extract and consistent product quality. pH testing revealed that all formulas, except for F3 which was slightly more acidic, fell within the safe range for human skin pH (6.3–6.4), making them safe for use. Viscosity and spreadability tests showed that Formula F0 (without papaya extract) had the highest spreadability, indicating a lighter texture that was easier to apply. As the concentration of papaya extract increased (in F1 to F3), the cream's viscosity increased, which affected spreadability, though it still met the standard for comfortable application on the skin. Overall, papaya root extract has potential as an active ingredient in anti-inflammatory cream formulations, with good physical and chemical qualities, in line with SNI standards for organoleptic properties, pH, homogeneity, and spreadability.

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Author Contributions

L.S., Y., R.S., R.A., contributed to the conceptualization, data collection process, data processing, and article writing.

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Conflicts of Interests

Conflict of Interest the researchers affirm that there is no conflict of interest associated with this study. Although this research was funded by Kemenristek DIKTI, it did not influence the results or integrity of the research. The findings and conclusions are based entirely on the analysis and hard work of the author.

References

Adeoye, R. I., Olopade, E. T., Olayemi, I. O., Okaiyeto, K., & Akiibinu, M. O. (2024). Nutritional and therapeutic potentials of Carica papaya Linn. seed: A comprehensive review. *Plant Science Today*, *11*(2), 671–680. https://doi.org/10.14719/pst.2843

Ahmed, Z., Aslam Channa, N., Parveen Solangi, S., Farooque, S., Hussain Soomro, Z., H. Quraishi, N., & Ali Dahri, Z. (2024). Immunological And Physiological Responses In Horses And Camels Against Pakistani Viper Venom Immunization For Snake Antivenom Immunoglobulin Production. *SSRN Electronic Journal*, *31*(7), 425–434. https://doi.org/10.2139/ssrn.4919734

Alfarabi, M., Siagian, F. E., Cing, J. M., Suryowati, T., Turhadi, Suyono, M. S., Febriyanti, M. S., & Naibaho, F. B. (2022). Bioactivity and metabolite profile of papaya (Carica papaya) seed extract. *Biodiversitas*, *23*(9), 4589–4600. https://doi.org/10.13057/biodiv/d230926

Aminah, S., & Juliana, I. (2024). Lotion Formulation with Papaya Seed Extract (Carica Papaya L) as a Skin Moisturizer. *Jurnal Farmasimed (JFM), 7*(1), 26-30. Retrieved from https://ejournal.medistra.ac.id/index.php/JFM/article/download/2342/1052

Aulianshah, V., Thaharah, Y. R., Zakiah, N., & Handayani, R. (2024). Anti-Inflammatory Effect Of Carica Papaya Leaves Extract In Male Wistar Rats Based On Variation Of Concentration. *International Journal of Health and Pharmaceutical (IJHP)*, *4*(3), 503-507. https://doi.org/10.51601/ijhp.v4i3.279

Blaak, J., Theiss, C., Schleißinger, M., Simon, I., Schürer, N. Y., & Staib, P. (2020). A Commercially Available Skin Care Lotion with a pH of 4.5 and 10% Urea Improves Skin Surface pH, Stratum Corneum Hydration and Epidermal Barrier Function in Subjects with Dry Skin and Atopic Diathesis. *Journal of Cosmetics, Dermatological Sciences and Applications*, *10*(03), 116–133. https://doi.org/10.4236/jcdsa.2020.103014

Breijyeh, Z., & Karaman, R. (2024). Antibacterial activity of medicinal plants and their role in wound healing. *Future Journal of Pharmaceutical Sciences*, *10*(1). https://doi.org/10.1186/s43094-024-00634-0

Damayanti, K. W., Lara, S. P., & Setyawati, T. (2021). Aktivitas antibakteri ekstrak etanol biji pepeya(Carica papaya L.): Narative Review. *Journal of Current Pharmaceutical Sciences*, *4*(2), 2598–2095.

Das, J. N., Basak, S., Sablania, V., Negi, R., Yadav, N., Rustagi, S., Singh, S., Rai, A. K., Shreaz, S., & Yadav, A. N. (2024). Food waste as potential bioresources for extraction of carotenoid of nutraceutical importance: Current research and future challenges. *Journal of Applied Biology & Biotechnology*, *12*(6), 1–15. https://doi.org/10.7324/jabb.2024.162743

Dominica, D., & Handayani, D. (2019). Formulasi dan Evaluasi Sediaan Lotion dari Ekstrak Daun Lengkeng (Dimocarpus Longan) sebagai Antioksidan. *Jurnal Farmasi dan Ilmu Kefarmasian Indonesia,* *6*(1), 1-50. http://dx.doi.org/10.20473/jfiki.v6i12019.1-7

Fadli, J. C., & Lasanudin, R. I. (2024). Formulation of lotion ethanolic extract of rosella flower petals (Hibiscus sabrariffa L.) and antioxidant activity. *Journal of Halal Science and Research*, *5*(1), 23–29. https://doi.org/10.12928/jhsr.v5i1.7151

Fakhruzy, Kasim, A., Asben, A., & Anwar, A. (2020). Review: Optimalisasi Metode Maserasi Untuk Ekstraksi Tanin Rendemen Tinggi. *Menara Ilmu*, *XIV*(2), 38–41. https://doi.org/10.31869/mi.v14i2.1739

Fitrianti, L., & Oktavilantika, D. M. (2022). Formulasi dan Uji Aktivitas Antibakteri Sediaan Krim Ekstrak Daun Kopasanda (Chromolaena Odorata L.) terhadap Bakteri Propionibacterium acnes. *PharmaCine: Journal of Pharmacy, Medical and Health Science*, *3*(1), 47-62. https://doi.org/10.35706/pc.v3i1.7242

Fitriyana, L., Supardan, M. D., Aisyah, Y., & Irfan. (2023). Analisis of Nyamplung (Callophylum inophyllum) Seed Extract as Antioxidants Through Various Methode. *Rasayan Journal of Chemistry*, *16*(4), 2119–2125. https://doi.org/10.31788/RJC.2023.1648364

Gaikwad, A. B., Tiwari, R. K., Choudhary, P., & Kaur, N. (2023). A comprehensive review on papaya seed oil extraction and recent applications in food industry. *The Pharma Innovation*, *12*(5), 1520–1527. https://doi.org/10.22271/tpi.2023.v12.i5s.20106

Hasrawati, A., Hardianti, H., Qama, A., & Wais, M. (2020). Pengembangan Ekstrak Etanol Limbah Biji Pepaya (Carica papaya L.) Sebagai Serum Antijerawat. *Jurnal Fitofarmaka Indonesia*, *7*(1), 1–8. https://doi.org/10.33096/jffi.v7i1.458

Hernani, Halimatussa'diyah, & Supiati, S. (2022). The Quality of Cream Formulated From Gambier Leaf Extract. *IOP Conference Series: Earth and Environmental Science*, *1024*(1). https://doi.org/10.1088/1755-1315/1024/1/012010

Jovanović, A. A., Đorđević, V. B., Zdunić, G. M., Pljevljakušić, D. S., Šavikin, K. P., Gođevac, D. M., & Bugarski, B. M. (2017). Optimization of the extraction process of polyphenols from Thymus serpyllum L. herb using maceration, heat- and ultrasound-assisted techniques. *Separation and Purification Technology*, *179*, 369–380. https://doi.org/10.1016/j.seppur.2017.01.055

Kamilla, L., Tumpuk, S., & Salim, M. (2021). Anti-Inflammatory of Papaya Leaf Extract (Carica Papaya L) Towards Membrane Stabilization of Red Blood Cells. *Jurnal Kesehatan Prima*, *15*(1), 1. https://doi.org/10.32807/jkp.v15i1.399

Marlina, D., Widyani, R. T., Febrihaq, D., & Karunia, T. J. (2021). Formulation of Foot Lotion Containing Papaya Leaf Extract (Carica Papaya L.) With Tri Ethanol Amine Concentration Variation as Emulgator and Its Physical Stability. *Proceedings of the First International Conference on Health, Social Sciences and Technology (ICoHSST 2020)*, 58–61. https://doi.org/10.2991/assehr.k.210415.014

Molnar, M., Gašo-Sokač, D., Komar, M., Jakovljević Kovač, M., & Bušić, V. (2024). Potential of Deep Eutectic Solvents in the Extraction of Organic Compounds from Food Industry By-Products and Agro-Industrial Waste. *Separations*, *11*(1). https://doi.org/10.3390/separations11010035

Munir, S., Liu, Z. W., Tariq, T., Rabail, R., Kowalczewski, P. Ł., Lewandowicz, J., Blecharczyk, A., Abid, M., Inam-Ur-raheem, M., & Aadil, R. M. (2022).

Delving into the Therapeutic Potential of Carica papaya Leaf against Thrombocytopenia. *Molecules*, *27*(9), 1–22. https://doi.org/10.3390/molecules27092760

Mutia, A. S., Jumain, J., & Arisanty, A. (2023). Formulation and Stability Test of Physical Quality of Lotion Preparations from Moringa Oleifera L. Leaf Extract with Various Concentrations of Emulsifier TEA. *Indonesian Health Journal*, *2*(1), 8–15. https://doi.org/10.58344/ihj.v2i1.24

Nair, J. H., & Mook, D. E. (1933). Viscosity Studies of Fluid Cream. *Journal of Dairy Science*, *16*(1), 1–9. https://doi.org/10.3168/jds.S0022-0302(33)93311-1

Of, A. P., & Leaf, C. P. (2023). Comparative Evaluation of Anti-Inflammatory and Antioxidant Property Of Carica Papaya Leaf And Seed Extract - An Invitro Study. *Journal of Population Therapeutics and Clinical Pharmacology*, *30*(14), 11–18. https://doi.org/10.47750/jptcp.2023.30.14.002

Purwaningsih, S., Salamah, E., & Budiarti, T. (2014). Formulasi Skin Lotion Dengan Penambahan Karagenan Dan Antioksidan Alami Dari Rhizophora Mucronata Lamk. *Jurnal Akuatika Indonesia*, *5*(1), 245758. Retrieved from https://jurnal.unpad.ac.id/akuatika/article/view/3705

Romasi, E., Karina, J. K., & Parhusip, A. J. (2013). Antibacterial Activity of Papaya Leaf Extracts Against Pathogenic Bacteria. *Makara Journal of Technology*, *15*(2), 173. https://doi.org/10.7454/mst.v15i2.936

Saechan, C., Kaewsrichan, J., Leelakanok, N., & Petchsomrit, A. (2021). Antioxidant in cosmeceutical products containing Calophyllum inophyllum oil. *OCL - Oilseeds and Fats, Crops and Lipids*, *28*, 28. https://doi.org/10.1051/ocl/2021015

Santana, L. F., Inada, A. C., Santo, B. L. S. do E., Filiú, W. F. O., Pott, A., Alves, F. M., Guimarães, R. de C. A., Freitas, K. de C., & Hiane, P. A. (2019). Nutraceutical potential of carica papaya in metabolic syndrome. *Nutrients*, *11*(7). https://doi.org/10.3390/nu11071608

Sapiun, Z., Achmadi, N., Imran, A. K., Muindar, M., Buana, W. A. A., Nur, M. U., Hartati, H., Kamba, V., Slamet, N. S., Ysrafil, Y., & Rifai, Y. (2022). Determination of Sun Protection Factor Lotion of Pulai Stem Extract (Alstonia scholaris (L.) R.Br). *Open Access Macedonian Journal of Medical Sciences*, *10*(A), 833–840. https://doi.org/10.3889/oamjms.2022.9131

Setyani, E. D., Daskar, A., & Wijayanto, W. P. (2024). Formulasi Sediaan Krim Ekstrak Daun Pepaya (Carica Papaya L) sebagai Krim Pelembab Kulit. *Ners Akademika*, *2*(2), 57–78. https://doi.org/10.35912/nersakademika.v2i2.3413

Sharma, A., Sharma, R., Sharma, M., Kumar, M., Barbhai, M. D., Lorenzo, J. M., Sharma, S., Samota, M. K., Atanassova, M., Caruso, G., Naushad, M., Radha, Chandran, D., Prakash, P., Hasan, M., Rais, N., Dey, A., Mahato, D. K., Dhumal, S., … Mekhemar, M. (2022). Carica papaya L. Leaves: Deciphering Its Antioxidant Bioactives, Biological Activities, Innovative Products, and Safety Aspects. *Oxidative Medicine and Cellular Longevity*, *2022*(April). https://doi.org/10.1155/2022/2451733

Singh, S. P., Kumar, S., Mathan, S. V., Tomar, M. S., Singh, R. K., Verma, P. K., Kumar, A., Kumar, S., Singh, R. P., & Acharya, A. (2020). Therapeutic application of Carica papaya leaf extract in the management of human diseases. *DARU, Journal of Pharmaceutical Sciences*, *28*(2), 735–744. https://doi.org/10.1007/s40199-020-00348-7

Sipos, L., Nyitrai, Á., Szabó, D., Urbin, Á., & Nagy, B. V. (2021). Former and potential developments in sensory color masking–Review. *Trends in Food Science & Technology*, *111*, 1-11. https://doi.org/10.1016/j.tifs.2021.02.05

Syah, A., Dianita, P. S., & Agusta, H. F. (2022). Efektivitas Tanaman Pepaya (Carica papaya L.) Terhadap Penyembuhan Luka : A Narrative Review. *Jurnal Farmagazine*, *9*(1), 1. https://doi.org/10.47653/farm.v9i1.540

Taebenu, D. A. N. T., Arpiwi, N. L., & Sudatri, N. W. (2023). Formulation Of Sunscreen Body Lotion From Moringa (Moringa oleifera L.) Leaf Extract. *Jurnal Biosains Pascasarjana*, *25*(2), 137–145. https://doi.org/10.20473/jbp.v25i2.2023.137-145

Ugbogu, E. A., Dike, E. D., Uche, M. E., Etumnu, L. R., Okoro, B. C., Ugbogu, O. C., Adurosakin, O. E., Chinma, C. E., Ohaeri, E., & Iweala, E. J. (2023). Ethnomedicinal uses, nutritional composition, phytochemistry and potential health benefits of Carica papaya. *Pharmacological Research - Modern Chinese Medicine*, *7*(May), 100266. https://doi.org/10.1016/j.prmcm.2023.100266

Weigmann, H. J., de Sainte Claire, M. S., Schanzer, S., Patzelt, A., Meinke, M., Antoniou, C., Sterry, W., & Lademann, J. (2012). Determination of the protection efficacy and homogeneity of the distribution of sunscreens applied onto skin pre-treated with cosmetic products. *Skin Research and Technology*, *18*(2), 245–250. https://doi.org/10.1111/j.1600-0846.2011.00563.x

Yasir, A. S., Saputra, I. S., & Handayani, K. Y. (2024).

Optimization of For mula and In Vitro Activity Testing of O / W Lotion Cosmetic Formulations Containing Ethanol Extract of Cat ' s Whiskers Leaves (Orthosiphon aristatus) as Sunscreen. *Indonesian Journal of Cosmetic*, *2*(1), 10–25. Retrieved from https://journal.itera.ac.id/index.php/ijcos/article/view/1809

Yuniarti, I., Sapatra, E. F., Novia, S. F., Hovivah, Paramita, V., & Yulianto, M. E. (2021). Efficacy of a Natural Papain-Induced Enzyme on Virgin Coconut Oil-Based Hand and Body Lotions with Added Orange Peel Extract. *International Journal of Technology*, *12*(3), 661–670. https://doi.org/10.14716/ijtech.v12i3.4070