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Investigating the Phytochemical Composition, GCMS Profile and Antimicrobial Effects of Nursehan Herbal Remedy for Sinusitis in Praya, Central Lombok

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Abstract: Recent studies emphasize the importance of medicinal plants in Indonesia's healthcare systems, where traditional remedies, including herbal formulations, are commonly used for treating ailments such as sinusitis. This research focuses on the Nursehan herbal remedy, a traditional treatment for sinusitis, used in Praya District, Central Lombok Regency. Nursehan is a combination of several plant materials, including *Cinnamomum verum*, *Nauclea orientalis*, and *Nigella sativa*, which are believed to alleviate sinus-related symptoms. However, scientific evidence supporting its efficacy remains limited. This study aims to validate the antimicrobial potential of Nursehan by analyzing its phytochemical profile and antibacterial activity. The Nursehan extract was prepared using a maceration method, and its chemical composition was assessed via GC-MS analysis, which identified key bioactive compounds such as hexadecanoic acid and 8-heptadecenoic acid, known for their antimicrobial and anti-inflammatory properties. Antimicrobial testing using the Kirby-Bauer method revealed significant antibacterial activity, particularly against *Streptococcus pyogenes* and *Staphylococcus aureus*. These findings provide scientific backing for the traditional use of Nursehan and highlight its potential as a therapeutic agent for sinusitis.

Keywords: Antibacterial activity; GC-MS analysis; Nursehan herbal; Phytochemical test; Sinusitis treatment; Traditional medicine

Introduction

Medicinal plants have been used for thousands of years in various traditional medicine systems around the world. (Henri et al., 2022). In Indonesia, the use of medicinal plants not only serves as an alternative form of treatment but also plays a crucial role in preserving biodiversity and local culture (Hasyim et al., 2025). With the enactment of Law No. 17 of 2023 concerning Health and Government Regulation No. 28 of 2024, the Ministry of Health now has a strong legal basis to integrate traditional medicines into the national healthcare system. This policy opens up opportunities for herbal medicine and natural remedies not only to be used individually by the public, but also to be available in hospitals and public health centers (JDIH Setneg, 2023). Recent studies highlight the significant role of medicinal plants in Indonesia's traditional healthcare systems, where indigenous knowledge has been passed down through generations. These plants offer valuable therapeutic properties, and ongoing research is exploring their modern applications. Indonesian medicinal plants are crucial in both preserving biodiversity and addressing contemporary healthcare needs, with various studies emphasizing their cultural importance and therapeutic potential (Sari et al., 2025).

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For example, traditional medicine using herbal ingredients in Indonesia, including treatments for respiratory diseases like sinusitis, is increasingly attracting the attention of scientists. Several recent studies suggest that medicinal plants have significant therapeutic potential, supported by their ability to address various health issues, both preventively and curatively.

Sinusitis, a condition characterized by inflammation of the paranasal sinuses, is typically caused by infections or obstructions that impair sinus drainage, leading to symptoms such as nasal congestion, pain, and mucus accumulation (Husni et al., 2022). While pharmacological treatments like decongestants, antibiotics, and corticosteroids are commonly prescribed, alternative therapies, such as herbal remedies, may offer promising adjuncts to conventional care (Astrid et al., 2023).

Traditional treatment options, such as herbal remedies, offer a complementary approach to managing sinusitis, especially in resource-limited settings. Research suggests that sinusitis may result from a variety of etiological agents, including bacterial, viral, and fungal pathogens.

In traditional medicine, gurah is a technique used to cleanse the nasal passages and respiratory tract with specific liquids. It is commonly applied to treat various health conditions such as sinusitis, colds, and other respiratory issues (Munandar et al., 2025).

Gurah is a traditional treatment widely practiced in Indonesia. The method involves administering an extract of Senggugu root into the nostrils to expel impurities and mucus from the nasal passages and surrounding cavities. The primary purpose of gurah is to treat respiratory conditions, alleviate nasal congestion, and, in some cases, improve vocal clarity and projection (Munandar et al., 2025). Gurah therapy, originating in the 1900s in Giriloyo Hamlet, Yogyakarta, was introduced by a religious leader to improve the voice of the Qori. Traditional treatments using sirgunggu plants, particularly their roots, faced challenges due to their bitter taste and strong odor caused by high saponin content, creating issues for patients undergoing the therapy (Amrih et al., 2025).

In Praya District, Central Lombok Regency, the traditional *Gurah* method, which includes the use of herbal preparations like *Nursehan*, is widely used to treat sinusitis. The *Nursehan* formulation combines various plant materials, including, *Cinnamomum verum* bark, *Nauclea orientalis* bark, *Cuminum cyminum* seeds, *Coriandrum sativum* seeds, *Pimpinella anisum* seeds, *Nigella sativa* seeds, *Syzygium aromaticum, Curcuma longa*, *Trigonella foenum.*

Cinnamomum verum or cinnamon is known to contain the compound cinnamaldehyde, which has antifungal properties (Nisa et al., 2021). *Nauclea orientalis* he bacteria *Staphylococcus aureus* and *Escherichia coli* are susceptible to *Nauclea orientalis* due to its content of indoloquinolizidine alkaloids, saponins, and flavonoids, which can disrupt bacterial cell walls, cell membranes, and metabolic processes (Atmiyanti et al., 2022). The dichloromethane fraction of *Cuminum cyminum L.* was found to contain compounds from the flavonoid, alkaloid, tannin, and terpenoid groups. The antimicrobial activity of this fraction is attributed to its ability to disrupt microbial cell structures, interfere with metabolic pathways, and inhibit the growth of pathogenic microorganisms, particularly by affecting the integrity of cell membranes and cell walls (Ridawati et al., 2024). The extract of *Coriandrum sativum* seeds was found to inhibit the growth of *Streptococcus mutans* bacteria. The antimicrobial mechanism of this extract is likely due to the presence of bioactive compounds such as flavonoids, terpenoids, and phenolic acids, which have been shown to disrupt bacterial cell membranes, interfere with cellular metabolism, and inhibit biofilm formation. These compounds may also inhibit key enzymes involved in bacterial cell wall synthesis, leading to cell death and reduced bacterial proliferation. Additionally, the extract may exhibit antioxidant properties that further contribute to its antibacterial effects by neutralizing reactive oxygen species, which can damage bacterial cells (Kodariah et al., 2024). *Pimpinella anisum*-based herbal medicine and fluticasone nasal spray target the inflammatory processes involved in CRS without polyps, albeit through different mechanisms. While fluticasone works primarily through direct anti-inflammatory action by modulating the immune response, *Pimpinella anisum* may offer a complementary therapeutic effect with its anti-inflammatory, antioxidant, and antimicrobial properties, addressing multiple aspects of CRS pathology (Vazifehkah et al., 2016). *Nigella sativa* seed fixed oil demonstrated therapeutic potential in treating sinusitis through its anti-inflammatory, antioxidant, antihistaminic, immune-modulatory, antimicrobial, and analgesic effects. It helps inhibit sinus and respiratory airway inflammation and microbial infections. The antimicrobial mechanism involves disruption of bacterial cell walls, inhibition of metabolic processes, and damage to cell membranes, leading to bacterial cell death and reduced infection (Mahboubi, 2018). The antimicrobial mechanism of *Syzygium aromaticum* (clove) primarily involves its essential oils damaging the microbial cell membrane, leading to increased permeability and leakage of cellular contents (Maggini et al., 2024). The antimicrobial mechanism of *Trigonella foenum-graecum* (fenugreek) is due to its bioactive compounds, including alkaloids, flavonoids, tannins, and saponins. These compounds disrupt

microbial cell walls and membranes, inhibiting bacterial growth by releasing enzymes such as lactate dehydrogenase (LDH) and alkaline phosphatase (ALP), which signals damage to the cell structure (Sobhy et al., 2013). The antibacterial mechanism of *Curcuma longa* (turmeric) in sinus infections involves curcumin disrupting bacterial cell membranes, inhibiting bacterial enzymes, and reducing inflammation, which collectively help to prevent bacterial growth and alleviate symptoms (Manarin et al., 2019). Despite its long history of use, there is a lack of scientific evidence supporting its efficacy and identifying the specific active compounds responsible for its therapeutic effects. This gap in research hinders the full integration of *Nursehan* into clinical practice and limits the understanding of its potential in modern healthcare.

However, no study has investigated the combined effects of these plants in the *Nursehan* formulation for treating sinusitis. This research aims to fill this gap by evaluating the phytochemical composition and antibacterial activity of the *Nursehan* extract, providing scientific validation for its traditional use and potential therapeutic application in sinusitis treatment. Research on traditional medicines is crucial to scientifically validate their efficacy and safety. Although many traditional remedies have been used for generations, clinical trials and further studies are necessary to confirm their therapeutic benefits and identify potential risks and side effects. This research enhances the understanding of the mechanisms of herbal medicines and aids in the development of safer and more effective natural-based drugs (Rozaliyani et al., 2023).

This study aims to systematically evaluate the pharmacological properties of the *Nursehan* formulation, focusing on its phytochemical profile and antibacterial efficacy. Given the increasing reliance on traditional medicine in Indonesia, there is an urgent need for scientific evidence that supports the safety and effectiveness of these treatments. By bridging the gap between traditional knowledge and modern scientific research, this study seeks to contribute to the development of alternative treatment options for sinusitis, particularly in underserved populations.

Method

The herbal component was purchased from a spice vendor in Praya, Indonesia. It was taxonomically verified by a botanist from the Forest Management Study Program, Faculty of Agriculture Mataram University. The sample was washed with distilled water and left to drain overnight at room temperature. After draining, it was ground using a grinder to a particle size of 25 mesh (Sariwati et al., 2024) . Flowchart of methodology is presented in figure 1.

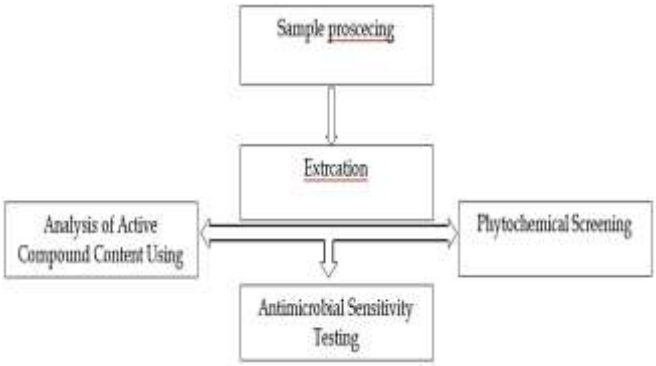

Figure 1. Flowchart of methodology

A total of 250 grams of *Nursehan* herbal powder was subjected to extraction using the maceration method. The powder was placed in a bottle and soaked with 250 mL of 96% ethanol for three consecutive 24-hour periods at room temperature, protected from light, with occasional shaking. Following the extraction, the mixture was filtered to obtain the filtrate, and the residue was remacerated twice more. After completing the extraction, the three filtrates were combined and separated from the residue. The filtrate was then evaporated using a rotary evaporator to obtain the crude *Nursehan* extract. (Wendersteyt et al., 2021).

The final extract was weighed, and the ethanol extract was subsequently used for antimicrobial testing, phytochemical analysis, and compound identification via gas chromatography-mass spectrometry (GC-MS) according to the method (Misrahanum et al., 2022).

Phytochemical Screening

Phytochemical screening was performed using ethanol extract, followed by specific tests for different classes of compounds: Alkaloids: The extract was treated with HCl and then tested with Dragendorff's reagent. Flavonoids: Magnesium (Mg) and HCl were added to the extract, and the formation of a red colour indicated the presence of flavonoids. Saponins: Stable foam formation was observed when the extract was shaken with water. Tannins: A black or blue precipitate formed after the addition of $FeCl_3$ solution, indicating the presence of tannins. Terpenoids: The extract was reacted with acetic anhydride, resulting in a red or purple colour, suggesting the presence of terpenoids. Results Interpretation: After the reactions, the results were visually observed. The formation of color changes or precipitates indicates the presence of specific compounds in the extract (Yadav et al., 2024). Extraction and phytochemical testing were conducted at the Pharmacy Laboratory, Faculty of Medicine, Mataram University.

Analysis of Active Compound Content Using GC-MS

The filtrate was placed in a vial and then analysed using a Shimadzu QP 2010 Ultra GC-MS system. A 1 µL sample was injected into the GC-MS using a column with a length of 25 cm, a diameter of 0.25 mm, and a thickness of 0.25 µm. The oven temperature was programmed from 40°C to 260°C with a heating rate of 10°C per minute. The identification of compounds was based on comparison with the GC-MS library/reference (Khan et al., 2024). The GC-MS test was conducted at the Analytical Laboratory of Mataram University.

Antimicrobial Sensitivity Testing

The instruments and materials used in this study were sterilized to prevent microbial contamination. Media such as Nutrient Agar (NA), Brain Heart Infusion (BHI), and Mueller Hinton Agar (MHA) were sterilized in an autoclave at 121°C for 15 minutes. Petri dishes, test tubes, and other equipment were washed thoroughly before being sterilized in a dry oven at 160°C for two hours. For the preparation of Nutrient Agar (NA), 2.84 g of NA was dissolved in 100 mL of distilled water, poured into test tubes (10 mL per tube), sterilized in an autoclave, and solidified at a 15° angle. Brain Heart Infusion (BHI) media was prepared by dissolving 3.7 g of BHI in 100 mL of distilled water, followed by sterilization in an autoclave. Mueller Hinton Agar (MHA) media was prepared by dissolving 3.8 g of MHA in 100 mL of distilled water, sterilizing in an autoclave, and pouring 20 mL into petri dishes (Wendersteyt et al., 2021). Antimicrobial testing was conducted at the Microbiology Laboratory of the Health Polytechnic, Ministry of Health, Mataram.

The bacterial strains used for testing included *Streptococcus pyogenes* ATCC 19615, *Staphylococcus aureus* ATCC 25923, ATCC 25922, and a local isolate of *Candida albicans*. These strains were obtained from the Health Laboratory Centre for Testing and Calibration of NTB Province with certification from the American Type Culture Collection (ATCC). A loopful of each strain was streaked onto slanted NA media and incubated at 37°C for 24 hours. Following growth, the cultures were transferred to BHI media using a sterilized inoculation loop and incubated for another 24 hours at 37°C.

For antibacterial testing, amoxicillin at 30 µg/mL was used as the positive control, and distilled water was the negative control. The antibacterial activity of the *Nursehan* herbal extract was assessed using the Kirby-Bauer disc diffusion method. The extract was tested at concentrations of 100 mg/mL, 50 mg/mL, and 25 mg/mL, and bacterial suspensions were standardized to a turbidity of 0.5 McFarland. After incubation, 10 µL of each bacterial suspension was transferred onto MHA plates, swabbed evenly, and allowed to stand for 30 minutes for absorption. Sterile 6-mm discs were impregnated with 10 µL of the extract solutions, as well as the control solutions, and placed on the MHA plates. The plates were incubated at 37°C for 24 hours. After incubation, clear zones of inhibition around the discs were measured using a caliper to determine the antibacterial activity of the extracts (Meutia et al., 2025).

Result and Discussion

This study focuses on the characterization of the Nursehan herbal remedy originating from. Praya District, Central Lombok Regency. The objective of this study is to explore the potential of Nursehan herbal remedy as an antimicrobial agent against sinusitis, as the local community uses this remedy for the treatment of sinusitis. The results of the phytochemical test are presented in Table 1.

Table 1. Phytochemical Screening of Nursehan Concoction

Metabolite compounded	Phytochemical
Alkaloid	-
Tannin	+
Flavonoid	+
Terpenoid	-
Steroid	-
Saponin	-

The herbal spice extract was characterized through phytochemical screening, using ethanol as a solvent in the maceration extraction method, the extract was found to Flavonoids, Terpenoids, and Tannins, their antimicrobial and antioxidant properties (Altemimi et al., 2017). The result of the phytocemicalsphytochemicals showing below.

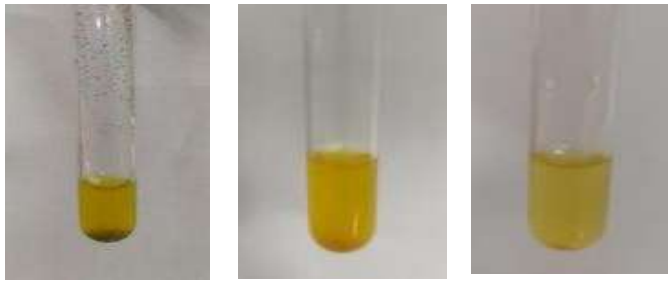

Figure 2. The results of the phytochemical test using the tube method, indicating positive results for Flavonoids, Terpenoids, and Tannins

As a polar solvent, ethanol is highly efficient in extracting various phytochemicals, such as alkaloids, flavonoids, and phenolic acids, which are recognized for their antimicrobial and antioxidant effects (Syafriana et al., 2025). In traditional herbal medicine extractions like tannin and flavonodoid-rich plants and drugs have been proven in the past to affect biofilms of bacteria

(Ghenabzia et al., 2023). The mechanism of tannins involves inhibiting bacteria by binding to bacterial proteins, blocking enzymes, and disrupting bacterial membranes (Nasri et al., 2025). Terpenoids act as antimicrobials by damaging cell membranes, causing leakage of essential components. They also inhibit protein and nucleic acid synthesis, disrupt metabolic pathways, and interfere with biofilm formation and quorum sensing (Dias et al., 2022).

GC-MS Analysis

GC-MS (Gas Chromatography-Mass Spectrometry) is a highly sensitive technique that can identify numerous plant compounds, including volatile, non-ionic, and thermally stable ones, which are not detectable by standard phytochemical screening methods (Khan et al., 2024).

The GC-MS analysis of the methanol extract identified ninth compounds. The details of these compounds, including their retention time (RT), molecular formula, molecular weight, and concentration (peak area %), are summarized in Table 2. The GC-MS chromatogram, showing the chemical structures of the sixteen compounds, is illustrated in Figure 3.

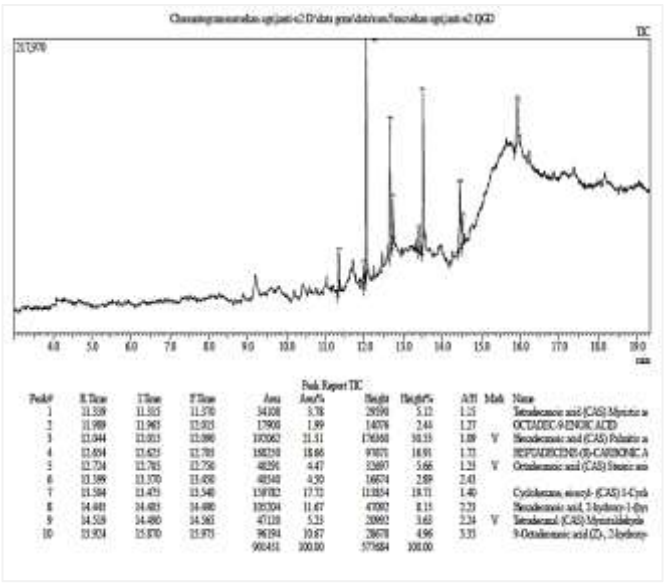

Figure 3. GC-MS chromatogram of ethanol extract of Nursehan herbs

Based on the GCMS analysis (Figure 1), there were 10 main peaks identified. The peak with the highest area percentage (21.31%) corresponds to Hexadecanoic acid (CAS) with a retention time of 12.015 minutes. The second largest area is observed for Heptadec-8-enoic acid, with a retention time of 12.564 minutes and an area percentage of 18.66%. The third peak corresponds to Cyclohexane eicosyl-(CAS) 1-Cyclo, with a retention time of 13.504 minutes and an area percentage of 17.72%. The fourth peak is Hexadecanoic acid 2 (Hydroxyl), with a retention time of 14.445 minutes and an area percentage of 11.67%. The fifth peak corresponds to 9-Octadecanoic Acid-Z-2 Hydroxy, with a retention time of 15.924 minutes and an area percentage of 10.67%. The sixth peak is Tetradecanal (CAS) Myristaldehyde, with a retention time of 14.519 minutes and an area percentage of 5.23%. The seventh peak is unidentified, with a retention time of 13.399 minutes and an area percentage of 4.50%. Unidentified compounds peaks in GC-MS may arise from limitations in the Wiley Library, where compounds not present in the database cannot be accurately identified. This could include newly discovered compounds or contaminants from the analysis equipment, sample preparation, or solvents used. Additionally, operational conditions like incorrect column temperature or solvent issues can lead to poor separation and unidentified peaks (Skoog et al., 2018). The eighth peak is Octadecanoic Acid (CAS) Stearic acid, with a retention time of 12.724 minutes and an area percentage of 4.47%. The ninth peak is Tetradecanoic acid (CAS) Myristic acid, with a retention time of 11.339 minutes and an area percentage of 3.38%. The tenth peak corresponds to Octadec-9-enoic acid, with a retention time of 11.339 minutes and an area percentage of 3.78%. The summary of the active compound content analysis of the Nursehan formulation is presented in Table 2.

Table 2. Summary of the Active Compound Content Analysis of the Nursehan Formulation

Retention Time (mm/minute)	% Area	Chemical component
12.015	21.31	Hexadecanoic acid (CAS) Palmitic acid
12.564	18.66	Heptadence-(8)-Carbonic acid
13.504	17.72	Cyclohexane eicosyl-(CAS) 1- Cyclo
14.445	11.67	Hexadecanoic acid 2 (Hydroxyl)
15.924	10.67	9 Octadecanoic Acid-Z-, 2 Hyroxy
14.519	5.23	(CAS) Myristaldhehyde
13.399	4.50	Not identified
12.724	4.47	Octadecanoic Acid (CAS) Steraic acid
11.339	3.38	Tetradecanoic acid (CAS) Myristic acid
11.339	3.78	Octadec-9- enoic acid

The identified major compounds possess important biological potential for future drug development (Nisar et al., 2022). The chromatogram for each sample and discussion can be seen below. The highest active component is Hexadecenoic acid, the chromatogram is presented in figure 4.

Hexadecenoic acid, also known as palmitic acid (CAS), exhibits notable antimicrobial properties, including strong activity against methicillin-resistant *Staphylococcus aureus* (MRSA). It inhibits

biofilm formation by 79.73%, 38%, and 28% at concentrations of 100, 50, and 25 µg/mL, respectively, compared to its biofilm inhibition activity against methicillin-susceptible *S. aureus* (MRSA) at the same concentrations. In addition to its antimicrobial effects, palmitic acid enhances immune responses by inducing macrophage polarization towards the M1 phenotype and upregulating the expression of TLR-4 and IL-8. However, it does not promote M2 polarization (Garcia et al., 2023). Palmitic acid (hexadecanoic acid), a saturated fatty acid, exhibits antimicrobial properties mainly through membrane disruption, biofilm inhibition, and interference with bacterial enzymes. By integrating into bacterial cell membranes, it destabilizes the membrane structure, leading to leakage of cell contents and bacterial death. Palmitic acid also disrupts biofilm formation, making bacteria more susceptible to other antimicrobial treatments. Furthermore, it may impair bacterial enzyme functions, weakening the bacteria's ability to replicate (Ansari et al., 2021; Sauberan et al., 2018). Unsaturated fatty acids, such as 8-heptadecenoic acid, exhibit significant antibacterial activity against a range of pathogens. This specific activity against gram-positive bacteria aligns with the known ability of many naturally occurring fatty acids to disrupt bacterial cell membranes (KyeongYoon et al., 2018). Unsaturated fatty acids, such as oleic acid (C18:1), exhibit greater inhibitory effects than saturated fatty acids. Furthermore, amine derivatives have demonstrated antimicrobial activity against both Gram-positive and Gram-negative bacteria (Sauberan et al., 2018).

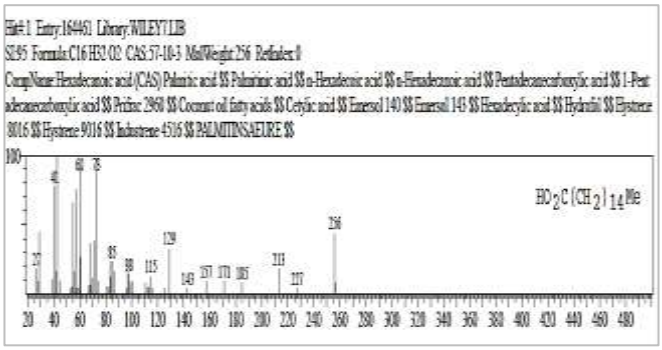

Figure 4. Chromatogram Hexadecenoic acid

The component with the second highest concentration is Heptadec-8-enoic acid. The chromatogram can be seen in Figure 5. The antibacterial mechanism of Heptadec-8-enoic acid exerts its antibacterial effects through several mechanisms: membrane disruption, where unsaturated fatty acids integrate into bacterial cell membranes causing leakage of vital cell contents; biofilm inhibition, preventing the formation of biofilms and reducing bacterial resistance; and alteration of membrane fluidity, impairing bacterial growth and function (Bajerski et al., 2017).

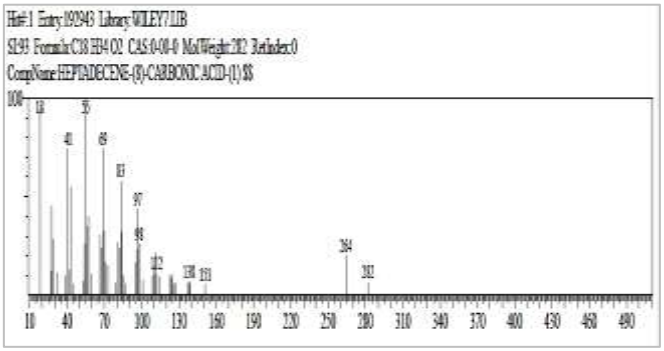

Figure 5. Chromatogram Heptadec-8-enoic acid.

The third most abundant component is Cyclohexane eicosyl. The chromatogram can be seen figure 6.

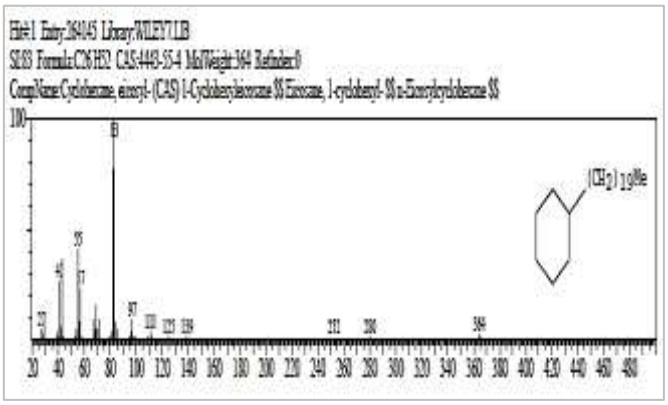

Figure 6. Chromatogram cyclohexane eicosyl

Cyclohexane eicosyl exhibits notable anti-inflammatory properties by inhibiting the induction of COX-2 and iNOS by IL-1β in chondrocytes. Additionally, it enhances the expression of collagen II and aggrecan while downregulating the expression of MMP-13 and ADAMTS-5. These findings suggest that cyclohexane eicosyl may hold therapeutic potential for the treatment of osteoarthritis. Cyclohexane eicosyl, this compound has shown anti-inflammatory effects by inhibiting COX-2 and iNOS induction by IL-1β in chondrocytes. It also increases collagen II and aggrecan expression while reducing MMP-13 and ADAMTS-5 expression. These findings suggest cyclohexane epicotyl may have therapeutic potential in osteoarthritis (Huang et al., 2022). Furthermore, long-chain aliphatic and cyclic compounds, like cyclohexane epicotyl, have potential for use in topical drug delivery systems to enhance skin penetration and therapeutic efficacy (López-Gómez et al., 2020). Synergistic effects of multiple compounds in herbal medicines, which contribute not only to

antimicrobial properties but also to antioxidant and anti-inflammatory activities (Vaou et al., 2022).

The fourth most abundant active component is 2-Hydroxyhexadec-9-enoic acid. The chromatogram can be seen below.

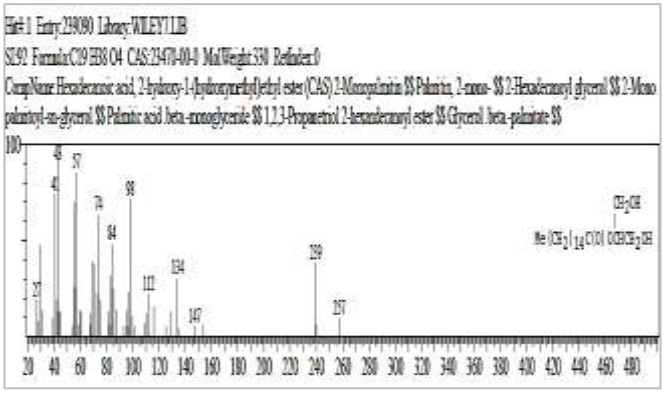

Figure 7. Chromatogram 2-Hydroxyhexadec-9-enoic acid

2- Hydroxyhexadec-9-enoic acid**,** an unsaturated fatty acid with a hydroxyl group offers anti-inflammatory, antimicrobial, and wound-healing properties. It can inhibit inflammatory pathways, contributing to its potential in treating inflammatory diseases (Wang et al., 2023). The therapeutic potential of herbal medicines, highlighting how various bioactive compounds work synergistically to enhance antimicrobial, anti-inflammatory , and other therapeutic effects (El-Saadony et al., 2025). Many plant extracts possess a combination of active compounds that work together to provide enhanced antimicrobial and anti-inflammatory effects, thus making herbal medicines more effective (Saquib et al., 2021).

The fifth most abundant component is 9-Octadecanoic Acid-Z-2-Hydroxy Oleic Acid.

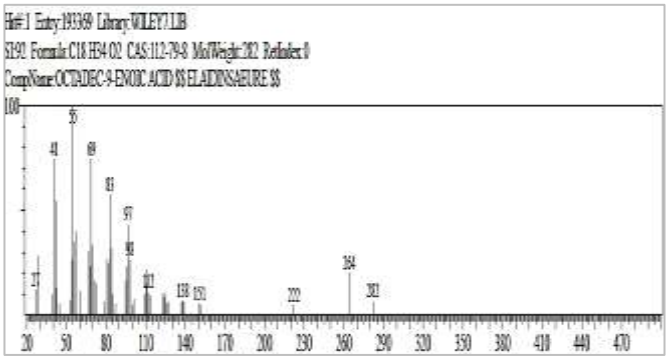

Figure 8. Chromatogram 9 -Octadecanoic Acid-Z-2-Hydroxy Oleic Acid

9 -Octadecanoic Acid-Z-2-Hydroxy Oleic Acid, as a derivative of oleic acid, demonstrates potential antimicrobial activity through several mechanisms as follow Bacterial Cell Membrane Disruption: Oleic acid and its derivatives can integrate into microbial cell membranes, damaging the membrane structure and causing leakage of essential cellular components, leading to microbial death. Biofilm Formation Inhibition: Several studies suggest that oleic acid and its derivatives can prevent biofilm formation by bacteria, making them more susceptible to treatment and reducing resistance. Direct Antimicrobial Activity is Oleic acid capable of inhibiting the growth of various Gram-positive and Gram-negative bacteria, as well as certain types of fungi. For example, oleic acid and its derivatives (including hydroxy forms) have shown activity against *Staphylococcus aureus*, *Escherichia coli*, and other pathogens, as well as several fungal species, a major component in various oils, has anti-inflammatory effects, particularly on human periodontal ligament fibroblasts. It also regulates insulin sensitivity by affecting gene expression in visceral adipocytes, highlighting its role in metabolic diseases like insulin resistance (López-Gómez et al., 2020; Schuldt et al., 2022).

The sixth highest component is (CAS) Myristaldehyde. The chromatogram can be seen below.

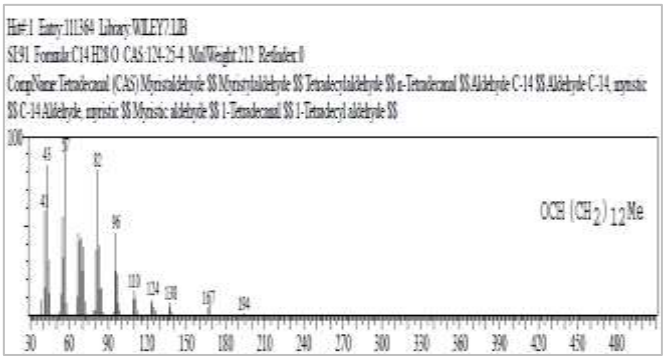

Figure 9. Chromatogram (CAS) Myristaldhehyde

(CAS) Myristaldehyde is an aldehyde compound with potential antimicrobial activity, likely through several mechanisms, membrane DisruptionIt can damage microbial cell membranes, causing leakage of cellular contents and leading to cell death, protein Denaturation: Myristaldehyde may alter protein structure, inhibiting the function of vital enzymes and proteins and enzyme Inhibition It could interfere with key metabolic enzymes, hindering microbial growth; and Nucleic Acid Interaction It may affect DNA replication, reducing the ability of microorganisms to proliferate (Okukawa et al., 2021). Myristic acid (C14H28O2 is involved in regulating lipid profiles, especially in conditions like dyslipidemia. It can also induce apoptosis in cancer cells through mitochondrial pathways and improve chemotherapy effectiveness while reducing side effects (Wang et al., 2023).

Stearic acid (C18H36O2) found in various seed oils, shows significant antimicrobial and cytotoxic properties. Its fatty acid composition, especially with longer chains (C12–C18), contributes to its efficacy against bacteria and fungi, particularly in oils like loofah and pumpkin seed oils (Petropoulos et al., 2021).

The six higest component is 9 -Octadecanoic Acid-Z-2-Hydroxy Oleic Acid the chromatogram figureis shows below.

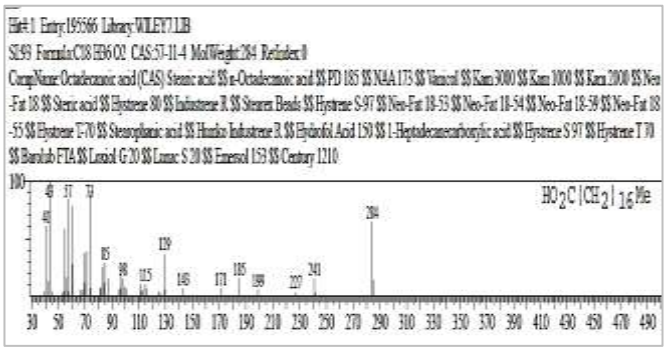

Figure 10. Chromatogram Octadecanoic Acid-Z-2-Hydroxy Oleic Acid

Octadecanoic acid-Z-2-Hydroxy Oleic Acid known for its antimicrobial properties, decanoic acid affects bacterial cell membranes and inhibits growth, making it a potential candidate for antibacterial drug development (Hong et al., 2025).

The ninth higest component is the Tetra decanal (CAS: 112-72-1), figure chromatogram show below.

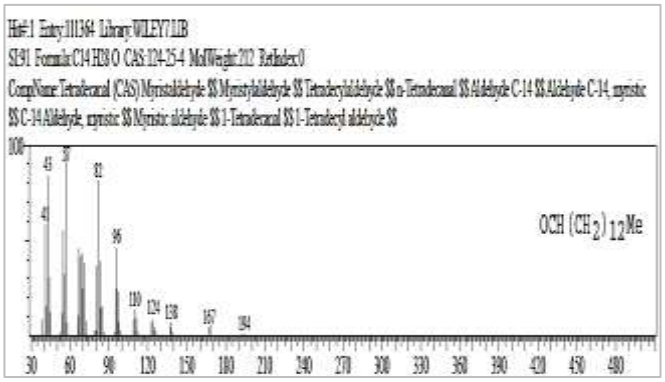

Figure 11. Chromatogram tetra decana

Tetra decanal (CAS: 112-72-1), has shown potential in inhibiting biofilm formation by *Staphylococcus aureus*, *Escherichia coli* O157:H7, and *Candida albicans*. This activity is attributed to lauric acid and myristic acid, which reduce the expression of genes related to biofilm formation in these microbes. The combination of fatty acids and antibiotics also shows synergistic antibacterial effects (Auttajinda et al., 2023).

Antimicrobial Sensitivity Testing

It can be observed that the antibacterial activity of the ethanol extract from the Nursehan plant showed inhibition at a concentration of 100%, with an inhibition zone diameter of 16.00 mm. The largest inhibition zone diameter was observed against *Streptococcus pyogenes* ATCC 19615, while the smallest inhibition zone diameter was 19.30 mm ±0.30, observed against *Staphylococcus aureus* ATCC 25923 at a concentration of 12.5% it can illustrated in figure 12.

The inhibition zone diameters produced by the ethanol extract of the Nursehan plant are illustrated in the graph in Figure 12.

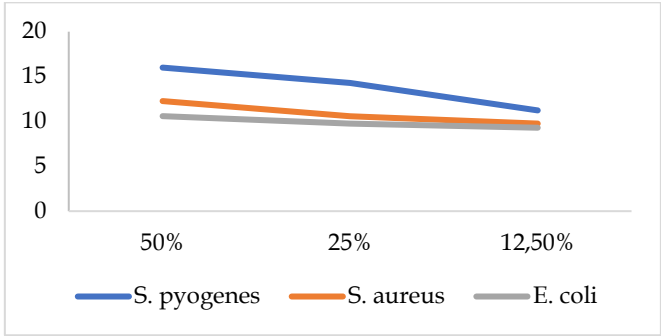

Figure 12. Inhibition zone diagram of Nursehan extract against several types of bacteria

Conclusion

The antibacterial effects of the Nursehan formulation are attributed to its flavonoid-rich plants, which target bacterial biofilms, and tannins, which inhibit bacteria by binding to proteins, blocking enzymes, and disrupting cell membranes. Compounds like hexadecenoic acid (palmitic acid) prevent biofilm formation and enhance immune responses by promoting M1 macrophage polarization and upregulating TLR-4 and IL-8 expression, without inducing M2 polarization. Similarly, 8-heptadecenoic acid disrupts bacterial membranes. Cyclohexane eicosyl exhibits anti-inflammatory effects by inhibiting COX-2 and iNOS induction in chondrocytes, and holds potential for improving skin penetration in topical drug delivery systems. Additionally, 2-hydroxyhexadec-9-enoic acid, an unsaturated fatty acid, offers antimicrobial, anti-inflammatory, and wound-healing properties. Oleic acid, a major component of various oils, also has anti-inflammatory effects. Tetradecanal (CAS: 112-72-1) and decanoic acid, known for their antimicrobial properties, enhance the formulation's antibacterial and antifungal efficacy. The synergistic action of these compounds contributes to the overall antimicrobial, antioxidant, and anti-inflammatory properties of the herbal medicine.

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Conceptualization, methodology, formal analysis, investigation, resources, data curation, and original draftwriting: L.F.; validation, review and editing, and visualization: R.S. All authors have read and approved the published version of the manuscript.

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All authors declared that there is no conflict of interest.

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