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Papaya Seed Essential Oil Anti-Acne Cream and Its Effectiveness Against *Staphylococcus epidermidis* and *Cutibacterium acnes*

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Abstract

Acne is a common skin disorder that affects people from all walks of life. One of the causes of acne is the bacteria *Staphylococcus epidermidis* and *Cutibacterium acne*. Papaya seeds are known to have antibacterial properties because they contain active compounds that inhibit bacterial growth. The main objective of this study was to determine the antibacterial activity of acne cream with the addition of papaya seed essential oil (*Carica papaya* L.) against *Staphylococcus epidermidis* and *Cutibacterium acne* bacteria. The method used in the production of essential oil was steam distillation, the antibacterial activity test was conducted using the disc diffusion method with concentrations of 10%, 20%, 30%, 40%, and 50%, and the cream activity test was conducted using the well method. The data analysis results were analyzed using analysis of variance (ANOVA). The results showed that papaya seed essential oil against *Staphylococcus epidermidis* bacteria at concentrations of 10%, 20%, 30%, 40%, and 50% was 7.7 mm, 13.1 mm, 16.3 mm, 18.7 mm, and 21.6 mm, respectively. Meanwhile, against *Cutibacterium acne*, the results were 4.6 mm, 6.4 mm, 9.9 mm, 12.1 mm, and 14.1 mm, respectively. Meanwhile, the inhibition zone results of papaya seed essential oil cream against *Staphylococcus epidermidis* bacteria at concentrations of 40% and 50% were 18.7 mm and 21.7 mm, respectively, while the inhibition zone of the cream against *Cutibacterium acne* bacteria was 12.8 mm and 14.1 mm. It can be concluded that the acne cream made from papaya seed essential oil has the potential to inhibit the growth of *Staphylococcus epidermidis* and *Cutibacterium acne*. A concentration of 50% proved to be the most effective in inhibiting the growth of acne-causing bacteria.

Keywords: Essential oil; papaya seeds; *Staphylococcus epidermidis*; *Cutibacterium acnes*.

INTRODUCTION

Acne is a common skin disorder that affects people of all ages, both men and women, especially during puberty (Sifatullah & Zulkarnain, 2021). This condition is caused by excessive activity of the sebaceous glands, leading to clogged pores by sebum and dead skin cells, followed by colonization of bacteria such as *Staphylococcus epidermidis* and *Cutibacterium acnes* (Pelen et al., 2016). These bacteria are opportunistic pathogens that can cause various clinical problems, including acne (Pariury et al., 2021).

The use of chemical-based acne products often causes side effects such as skin irritation, especially on sensitive skin (Pariury et al., 2021). This has led to the search for safer alternative treatments from natural ingredients. Papaya seeds (Carica papaya L.) are known to have potential as a natural antibacterial agent because they contain active compounds such as alkaloids, steroids, flavonoids, saponins, and triterpenoids (Syarifah, 2015). However, papaya seeds are rarely used because they have a bitter taste, are pungent, and have a distinctive aroma, making them unpopular and ultimately becoming waste. Previous research by Rahayu et al. (2020) showed that papaya seed extract can inhibit the growth of *Staphylococcus epidermidis* with an inhibition zone of 22.33 mm at a concentration of 45%.

Essential oil from papaya seeds has several advantages over other forms of extract, including higher concentrations of active compounds, longer shelf life, and good penetration through the skin (Siswantito et al., 2023). Research by Ahmad et al. (2023) also proved the effectiveness of papaya seed extract in inhibiting Propionibacterium acnes with an inhibition zone of 16.6 mm at a concentration of 10%. However, the use of papaya seed essential oil in the form of anti-acne cream preparations is not widely known. The advantages of cream formulations include easy absorption, non-stickiness, softness on the skin, easy cleansing with water, and aesthetic value for users.

This study aims to develop an acne cream formulation based on papaya seed essential oil and test its effectiveness against acne-causing bacteria. The results of this study are expected to provide a natural solution for treating acne while utilizing papaya seed waste, which has not been optimally utilized.

MATERIALS AND METHODS

The research was conducted from March to June 2025 and carried out at the Microbiology Laboratory of UIN North Sumatra, Jalan Lap. Golf No. 120 Kp.Tengah, Pancur Batu District, Deli Serdang Regency, North Sumatra.

The research materials consisted of ripe papaya seeds (*Carica papaya* L.), *Staphylococcus epidermidis* and *Cutibacterium acne* bacterial isolates, MHA (Mueller Hinton Agar) media, cotton, DMSO, methylene blue, disc paper, stearic acid, Vaseline, cetyl alcohol, triethanolamine, propylene glycol, triethanolamine, and distilled water.

The equipment used in this study consisted of a steam distillation apparatus, analytical balance, autoclave, incubator, inoculating needle, dropper pipette, Bunsen burner, pH meter, microscope, caliper, Petri dishes, test tubes, and vortex mixer.

Research Procedure

Essential Oil Manufacturing

Papaya seeds were identified at the medanense herbarium laboratory to examine the morphological characteristics of the plant. Furthermore, the papaya seeds that will be processed into essential oil are washed and dried and put into a steam distillation device for 3-4 hours. Essential oils are separated using a separator funnel, then oil characteristics are tested which include color, aroma, solubility and density. The essential oils that have been produced are then analyzed gc-ms to identify active compounds. This essential oil will be injected automatically into the column using a helium gas flow at a temperature of 280°c. Then, the essential oil in the form of helium gas will be exposed into the motion phase through a 30-meter-long tg-5ms thermal capillary column in an oven at 330°c. Next, the column will separate the components of the compounds contained in the essential oil. The device is equipped with a mass spectrometer detector that will be recorded by a recorder that will read the composition of the essential oil using a chromatogram.

Antibacterial Activity Test of Papaya Seed Essential Oil

Prepare 15 ml of MHA (Mueller hinton agar) medium, put in a petri dish until it solidifies. A total of 0.1 ml of bacterial culture suspension is placed in a petri dish using a micropipette, flattened using an L rod, let it sit until absorbed. Next, disc paper that has been soaked with various concentrations as well as chloramphenicol and DMSO is placed on a solid medium. It is labeled on a petri dish and then incubated in an incubator for 24 hours at a temperature of 37° in the inverted position.

Cream Formulation

The formulation of the preparation is the dosage that will be used in the manufacture of the cream. This formulation is used as a reference to produce creams that are in accordance with the dosage to form a good and appropriate cream.

Table 1. Papaya Seed Essential Oil Anti-Acne Cream Preparation Formulation.

Material	Formula (%)			Function
	K-	F1	F2	
Papaya Seed Essential Oil	0	K1(x)	K2(x)	Active Substance
Setil Alcohol	2	2	2	Thickener
Stearic Acid	15	15	15	Emulsifier
TEA (Trietanolamin)	1,5	1,5	1,5	Emulsifier
White Vaseline	8	8	8	Base Cream
Propylene Glycol	8	8	8	Humectant
Aquadest	Add 100	Add 100	Add 100	Solvent

Making Anti-Acne Cream from Papaya Seed Essential Oil (Carica papaya L.)

The cream is divided into two phases. The first is done is the oil phase. The method of making it is stearic acid, cetyl alcohol and white petroleum jelly melted at a temperature of 70 degrees Celsius using a water bath. The second phase is the water phase, this phase is carried out by means of Triethanolamine (TEA), propylenicol and aquadest dissolved in a water bath at a temperature of 70 degrees Celsius until it dissolves perfectly. The next stage is to mix the water phase into the dissolved oil phase. Stir until evenly distributed, then put in a hot mortar, then stir again until homogeneous. Next, add papaya seed essential oil, stir again until it produces a good cream

Antibacterial Activity Test Cream

The first step is to pour 5 ml of sterile MHA (Mueller Hinton Agar) into a sterile petri dish, left to solidify. As much as 1 ml of bacterial suspense, inoculated into 5 ml of medium MHA (Mueller Hinton Agar) in a pour plate, then poured evenly as a agar seed layer on top of the agar base layer. Let stand until it is solid. After the agar solidifies, a suction hole is formed. Next, the cream preparation is added. Incubated for 24 hours at a temperature of 37 degrees. After 24 hours, the diameter of the barrier or the barrier zone (clear zone) is measured using a caliper.

Test Cream preparations

- **Organoleptic test**
  Organoleptic tests are performed to assess the quality of products with the help of the five senses or visually. This organoleptic test requires 15 panelists to evaluate the product. Components evaluated include color, aroma, and texture
- **Cream Type Test**
  The cream-type test is carried out by placing 1 drop of cream preparation on a glass object, then mixing it evenly with 1 drop of methylene blue solution, and then observing it under a microscope. Uniform blue discoloration in the outer phase indicates that the emulsion is an oil-in-water type (M/A)
- **Homogeneity test**
  Glass plates are used for homogeneity testing. The preparation is evenly spread on the plate, and its homogeneity is checked under a microscope. This homogeneity test serves to determine that the ingredients used in the cream have been evenly mixed. Homogeneity is considered good if no coarse grains appear.
- **pH Test**
  The pH test is carried out with a cream step of 1 gram diluted with 10 ml of aquades, then measured using a pH meter to show the pH result. The pH requirement for a good cream preparation is 4.5 to 6.5.
- **Dispersion test**
  The dispersion test was carried out with 0.5 grams of cream placed between two glass plates. Then let it sit for 1 minute. Every minute the load is increased by 250 grram for 5 minutes. Measured the diameter of the resulting spread. The good spreadability of the cream is 5 to 7 cm (Hamka & Hardiyanty, 2021).
- **Adhesion test**
  The adhesion test is carried out by placing 0.5 grams of cream on a petri dish. The two petri dishes are glued together until they come together. Then a weight of 250 grams was put for 5 minutes, then released by lifting one of the petri dishes. It is recorded the time until the two petri dishes are detached (Pratasik et al., 2019).
- **Irritation test**
  The irritation test is carried out using the patch test method. There are 15 panelists who will carry out the irritation test. The back of the upper hand of the panelist is cleaned first, then divided into 3 points. Each point will be applied with a cream of various concentrations. It is observed in the first 5 minutes and then continued with 15 minutes after the cream is applied (febriani et al., 2020).

Data Analysis

Data were analyzed using: Descriptive analysis for characterization of one-way ANOVA samples for antibacterial activity test. The Duncan test is used to see the real difference between treatments.

This study also ~~used~~s a disc diffusion method test with some concentration of essential oil from musk orange (Citrus microcarpa bunge) which will be formulated into an edible film to inhibit the growth of bacteria *Streptococcus mutants* and *Candida albicans* fungi are among them with concentrations as explained above which are made 3 times. For negative control use an edible film formulation without the addition of essential oils and for positive control use Gofress xylitol.

This data collection technique can be used with laboratory-based experimental testing. This experimental method was carried out to find out if the product given by the researcher was suitable. In addition, a table was also used to see the results of observations in the inhibition zone using musk orange peel essential oil (*Citrus microcarpa bunge*) which was made in the form of an edible film and tested for physical properties as well as antibacterial and antifungal activity against *Sterptococcus mutans* and *Candida albicans* fungus.

The ingredients used include: musk orange essential oil, corn starch, sorbitol 70%, na. Saccharin, menthol, nipagin, nipasol, orange essence, distilled water (aquades). Bacterial and fungal breeding media, namely mueller hinton agar (mha) and pda (potato dextrose agar media), hydroxypropyl methyl cellulose (hpmc) (phapros), mcfarland standard 1.5 x 108 cfu/ml, dmso solvent, streptococcus mutans bacterial culture and candida albicans fungus.

RESULTS AND DISCUSSION

Manufacture and Identification of Papaya Seed Essential Oil (*Carica papaya* L.)

The identification of papaya plants was carried out at the Medanese Herbarium Laboratory (MEDA) USU Medan with the species results of the plant being *Carica papaya* L. Papaya seed essential oil was obtained through steam distillation using aquades to produce 145 ml from 9 kg of seeds, then identified through characteristic tests, solubility in ethanol, and density measurement, the results of which are presented in a table.

Table 2. Results of Testing the Characteristics of Papaya Seed Essential Oil (*Carica papaya* L.).

No.	Parameter	Results
1.	Scent	Medium and non-stinging papaya
2.	Color	Green-yellowish
3.	Patches	Positive (no stains and stains with filter paper)

Testing the characteristics of papaya seed essential oil (*Carica papaya L.*) is carried out to assess its quality and potential. Essential oils, as a volatile compound with a distinctive flavor, are tested to produce a yellowish-green color with a non-pungent papaya aroma. The test results showed the spots fused on the filter paper without a stain, indicating purity.

Solubility in Ethanol Essential Oil of Papaya Seeds (*Carica papaya* L.)

Solubility testing in ethanol in essential oils is carried out to determine the quality of essential oils, essential oils that are perfectly soluble in ethanol are defined as constituent compounds that have higher polar properties compared to oils that are difficult to dissolve in ethanol. The solubility test in ethanol was carried out by putting 1.0 ml of essential oil samples into a ukut glass tube and then adding 90% ethanol to the tube drop by drop, then shaking and recording the volume when the solution changed to clear. In papaya seed essential oil (*Carica papaya* L.) the solubility in ethanol is obtained, which is a ratio of 1:6, meaning that 1 ml of essential oil will become clear when dissolved using 6 ml of ethanol.

Bulk Essential Oil of Papaya Seeds (*Carica papaya* L.)

The density of essential oils is tested as a comparison between the mass of the substance to its volume. This density testing of essential oils is done to describe the density levels of the substance that have the benefit of identifying the purity as well as the type in the essential oil. The density test was carried out by weighing the weight of the piko meter that had been filled with the sample with an empty piko meter (11.4912 grams) divided by the sample volume. SNI Standard 06-2385-2006 concerning the testing of the density or density of essential oils using temperatures of 95o and 100o, namely 0.9357-0.9603. The test result of the density of papaya seed essential oil is 0.9401 grams/cm3. then it can be said that papaya seed essential oil (*Carica papaya* L.) is close to the SNI standard so it can be declared that papaya seed essential oil (*Carica papaya* L.) is pure.

Uji GC-MS (Gas Chromatography-Mass Spectrometry) Minyak Atsiri Biji Pepaya (*Carica papaya* L.)

GC-MS (Gas Chromatography-Mass Spectrometry) testing is a commonly used analysis to find out the chemical compounds contained in essential oils. GC-MS (Gas Chromatography-Mass Spectrometry) is a combination of two analysis techniques, namely Gas Chromatography (GC) and Mass Spectrometry (MS). GC is a technique for separating the components in a mixture while MS is a technique for identifying each component based on its mass-to-charge ratio. The advantage of the GC-MS technique is that it can detect very small amounts, suitable for both volative and semivolatile compounds, so that the compounds are accurate because the database of the nucleus is very complete (Hotmian *et al*., 2021).

Based on the results of the GC-MS test at the Integrated Research Laboratory of the University of North Sumatra, the following results were obtained

Table 3. GC-MS Test Results of Papaya Seed Essential Oil (*Carica papaya* L.).

RT (minute)	Compound	Area
1.680	4-Penten-2-o1	51017
32.604	Acetic anhydride	2199
32.953	Carbon dioxide	2639
33.680	Acetic anhydride	2616
39.675	Silane, trichloro (chlorometh)	2328
41.536	2H-Phyran, 2,5-diethenyltetra	2086

Based on table 3, the results of the GC-MS (*Gass Cromatography-Mass Spectrofometry*) test analysis on papaya seed essential oil (*Carica papaya* L.) showed that there were 6 components of chemical compounds contained in it. The highest compound found in it is 4-Penten-2-ol (51017). The sequence of other compounds contained includes Carbon dioxide (2639), Acetic Anhydride (2616), Silane, trichloro (chlorometh) (2328) and 2H-Phyran, 2,5-diethenyltetra (2086).

4-Penten-2-ol is a compound of the unsaturated aliphatic alcohol group, this compound has the ability to damage the cell membrane of bacteria resulting in leakage of cell contents. Acetic anhydride compounds are reactive compounds that can react with amine and hydroxyl groups of microbial proteins that will inhibit enzyme function. Silane, trichloro (chlorometh) is the parent compound of organosilicon compounds. This compound can cause disruption of the bacterial membrane so that it can be used as an antibacterial. 2H-Phyran, 2,5-diethenyltetra is an unsaturated heterocyclic compound derived from Flavonoids and coumarins that is known to have antibacterial and antifungal abilities. The mechanism of action of these compounds can interfere with bacterial enzymes, inhibit the synthesis of microbial proteins and bind to DNA or cell membranes from microbes (Tania *et al*., 2021).

Test Results of Antibacterial Activity of Papaya Seed Essential Oil (*Carica papaya* L) against *Staphylococcus epidermidis* and *Cutibacterium acnes* bacteria

The concentration used is 10%, 20%, 30%, 40% and 50%. The positive control used chloramphenicol while the negative control used DMSO. This test was carried out to determine the ability of papaya seed essential oil (*Carica papaya* L.) in inhibiting the growth of *Staphylococcus epidermidis* and *Cutibacterium acnes* bacteria. The data from the antibacterial test can be seen in the table below.

Table 4. Test Data Antibacterial Activity of Papaya Seed Essential Oil (*Carica papaya* L.) against *Staphylococcus epidermidis* and *Cutibacterium acnes bacteria.*

Concentration (%)	Average *Staphylococcus epidermidis* Bacterial Inhibition Zone ± SD (mm)	Average *Cutibacterium acnes* Bacterial Inhibition Z ± SD (mm)
Control (+)	$26,1 \pm 0,31^{g}$	$26,0 \pm 0,31^{g}$
Control (-)	$0 \pm 0,0^{a}$	$0 \pm 0,0^{a}$
10%	$7,7 \pm 0,50^{b}$	$4,6 \pm 0,50^{b}$
20%	$13,1 \pm 0,32^{c}$	$6,4 \pm 0,32^{c}$
30%	$16,3 \pm 0,23^{d}$	$9,9 \pm 0,23^{d}$
40%	$18,7 \pm 0,51^{e}$	$12,1 \pm 0,51^{e}$
50%	$21,6 \pm 0,53^{f}$	$14,1 \pm 0,53^{f}$

Description:
Positive control (+) : Chloramphenicol
Negative control (-) : DMSO
Papaya Seed Essential Oil (Carica papaya L.) : Concentration 10%, 20%,30%, 40% dan 50%.

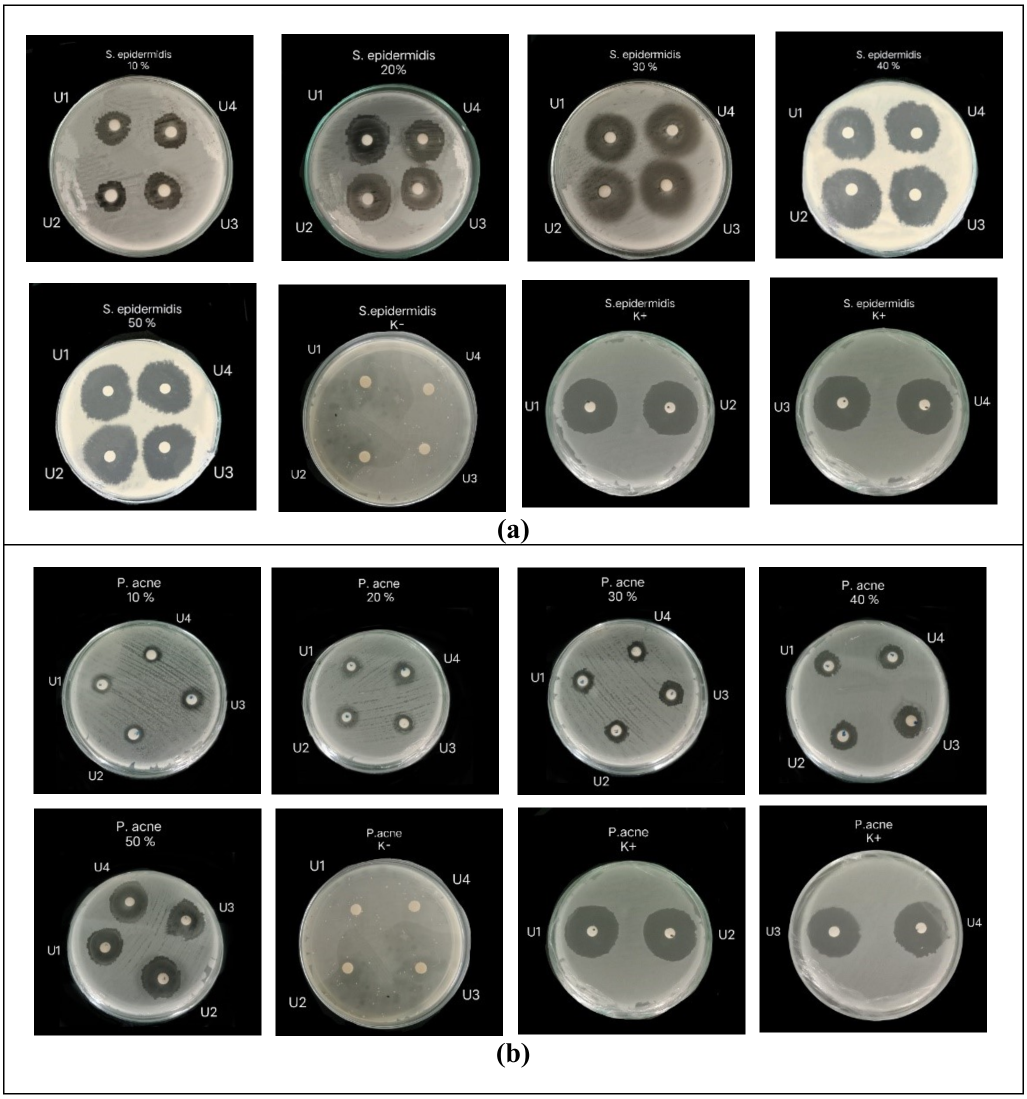

Figure 1. Comparison of Papaya Seed Essential Oil Inhibition Zones Against Bacteria. (a) *Staphylococcus epidermidis* dan (b) *Cutibacterium acnes.*

Based on table 4, the inhibitory zone test of papaya seed essential oil (*Carica papaya* L.) against *Staphylococcus epidermidis* showed an increase in diameter along with an increase in concentration, but it remained lower than the positive control, namely chloramphenicol (26.28 mm). GC-MS analysis identified antibacterial compounds contained in papaya seed essential oil (*Carica papaya* L.) in the form of **4-Penten-2-ol** which can damage cell membranes and **2H-Phyran, 2,5-diethenyltetra** can inhibit microbial protein synthesis (Tania *et al*., 2021). Meanwhile, in the test of the barrier zone of papaya seed essential oil (*Carica papaya* L.) against *Cutibacterium acnes* also showed an increase in diameter along with the increase in concentration with the largest zone at a concentration of 50% which met the effectiveness criteria of Pharmacopoeia IV (1995) which was 14-16 mm. Chloramphenicol positive control against *Cutibacterium acnes* resulted in a zone of 26.05 mm while DMSO (negative control) showed no antibacterial activity (0 mm) due to its nature as a non-toxic polar solvent (Fathanah *et al*., 2022).

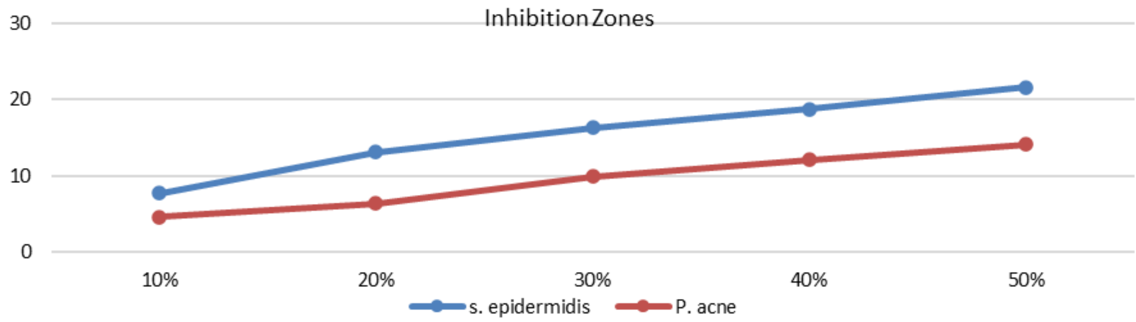

Figure 2. Graph of the bland zone of essential oils against *Staphylococcus epidermidis* and *Cutibacterium acnes.*

Based on the graph the antibacterial test showed that the treatment group had a noticeable difference in values. The negative control had significantly different values compared to the 10%,20%,30%,40% and 50% treatments. The results of the graph show that the negative control (DMSO) has no antibacterial activity, while the positive control (chloramphenicol) shows a significantly higher value due to its antibiotic properties against bacterial infections (Asni & Sianita, 2020). It can be known that the activity test of papaya seed essential oil (*Carica papaya* L.) on *Staphylococcus epidermidis* bacteria produced a larger inhibition zone than in *Cutibacterium acne bacteria.* Treatment with a concentration of 10%-50% showed an increase in the inhibition zone as the concentration increased, allegedly due to the content of the antibacterial compound 4-Penten-2-ol in the essential oil (Tania *et al*., 2021).

Results of Anti-Acne Cream Activity Test of Papaya Seed Essential Oil (*Carica papaya* L.)

Testing of the antibacterial activity of anti-acne creams was carried out using the suction method. The grout method is carried out by making holes in the MHA media that have been inoculated with bacteria. The number of holes is adjusted to the number of repetitions. In this study, 4 repetitions were used. The advantage of the welling method is that it is easier to measure the area of the barrier zone formed because bacteria are not only on the upper surface of the nutrient but also to the bottom (Hainil *et al*., 2022).

Table 5. Test Data of Antibacterial Activity of Papaya Seed Essential Oil Cream (*Carica papaya* L.) against *Staphylococcus epidermidis bacteria.*

Concentration (%)	Average *Staphylococcus epidermidis* Bacterial Inhibition Zone ± SD (mm)	Average *Cutibacterium acnes* Bacterial Inhibition Z ± SD (mm)
K (+)	10,9 ± 0,78[b]	11,33 ± 0,16[b]
K (-)	0,9 ± 0,10[a]	1,17 ± 0,18[a]
40 %	18,7 ± 0,60[c]	12, 8 ± 0,44[c]
50 %	21,7 ± 0,58[d]	14,1 ± 0,13[d]

Description:
Positive control (+) : Commercial anti-acne cream
Negative control (-): basic cream 0% essential oil
Concentration : 40 %, 50% essential oil

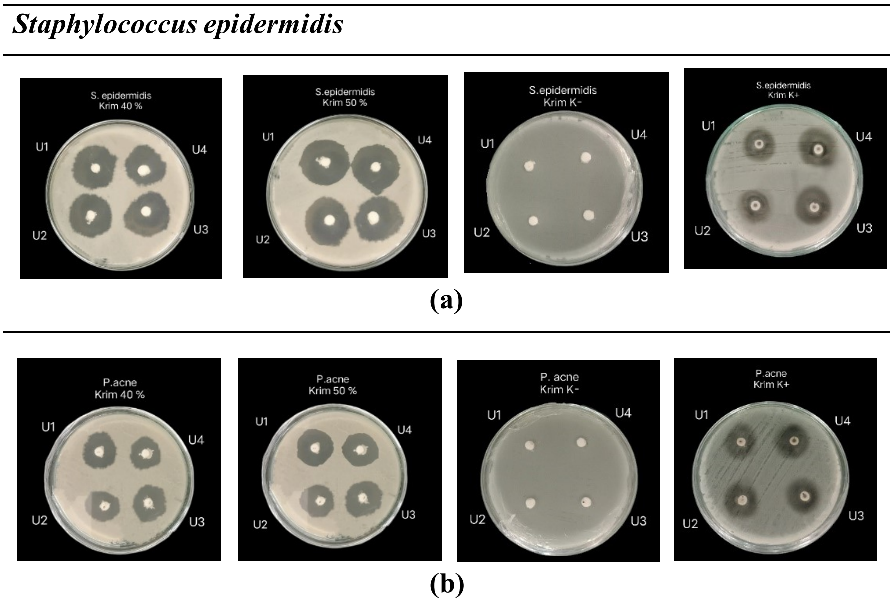

Figure 3. Comparison of Cream Inhibition Zones of Papaya Seed Essential Oil Against bacteria (a) *Staphylococcus epidermidis* and (b) *Cutibacterium acnes.*

Table 5 shows the difference in the inhibition zone of papaya seed essential oil (*Carica papaya* L.) against the bacteria *Staphylococcus epidermidis* and *Propionibacterium acne*. Negative control treatment produces weak inhibition zones because negative control does not contain additional essential oils, while concentrations of 40% and 50% occur antibacterial activity because it contains essential oils, the more essential oil content, the greater the inhibition zone produced. The essential oil activity test against *Staphylococcus epidermidis* bacteria resulted in a larger inhibition zone compared to the essential oil activity test against *Cutibacterium acnes* bacteria. The difference in inhibition zones is caused by several factors, including *Staphylococcus epidermidis* is a gram-positive bacteria that lives on the surface of the skin, so it is more open to compounds from essential oils that have the ability to penetrate and damage cell membranes (Hidayat et al., 2021). While *Cutibacterium acnes* is an anaerobic bacteria that lives in sebaceous follicles, an environment rich in lipids so that the absorption of essential oils is still limited. In addition, *Cutibacterium acnes* has a thick lipid layer and produces lipase enzymes and antioxidant systems, making it more resistant to membrane damage due to natural antibacterial compounds (Kolar et al., 2019).

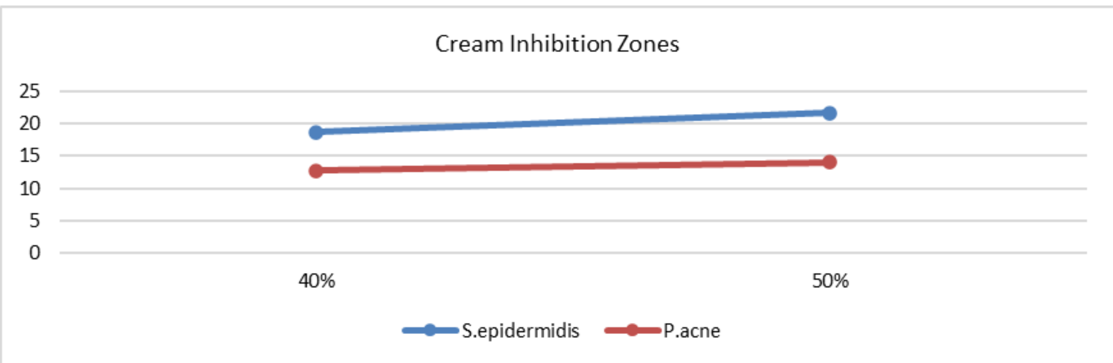

Figure 4. Graph of the inhibition zone of the cream against *Staphylococcus epidermidis* and *Cutibacterium acnes.*

The line in the graph above shows the change from the inhibition zone along with the increase in the concentration of papaya seed essential oils used. The increase in the barrier zone formed from essential oils is due to the content contained in papaya seed essential oil (*Carica papaya* L.). The content contained in papaya seed essential oil such as 4-Penten-2-ol which is a compound that has the ability to damage bacterial cells which will result in leakage of cell contents. The compound 4-penten-2-ol is an unsaturated alcohol group that has amphipathic properties, so it has the potential to have antibacterial activity against gram-positive bacteria such as *Staphylococcus epidermidis* and *Cutibacterium acnes* because it does not have a thick outer lipopolysaccharide layer. The mechanism of action of the compound 4-penten-2-ol is capable of damaging the cell membrane or leaking the cell contents. This compound will penetrate peptidoglycan so that it enters the cell membrane. This will result in changes in membrane permeability, resulting in the leakage of ions and metabolite compounds from within the cell, as a result of which ions are disrupted, cell energy decreases and bacteria eventually experience physiological damage that leads to cell lysis (Tania et *al*., 2021). The difference in the barrier zone formed between the bacteria *Staphylococcus epidermidis* and *Cutibacterium acnes is* also quite significant. *Staphylococcus epidermidis* has a larger inhibition zone than *Cutibacterium acne.*

Test Results of Anti-Acne Cream Preparation Papaya Seed Essential Oil (*Carica papaya* L.)

Figure 5. Papaya Seed Essential Oil Cream (a) Control (b) 40% (c) 50%

Organoleptic Test Results

Organoleptic testing was carried out by 15 panelists to assess the quality of papaya seed essential oil-based anti-acne creams through texture, color, and aroma parameters. The test results can be seen in the following table

Table 6. Organoleptic test data of the cream.

Concentration	Texture	Color	Scent
0%	Semi-compact	White	Unscented
40%	Semi-compact	Yellowish white	The distinctive scent of papaya seeds
50%	Semi-compact	Yellowish white	The distinctive scent of papaya seeds

From organoleptic test data, it was found that the texture of the three concentrations was semi-solid, the color of the cream with a concentration of 0% was white while the color for the cream with a concentration of 40% and 50% was yellowish-white. Creams with a concentration of 0% have no aroma while creams with concentrations of 40% and 50% have a distinctive aroma of papaya seeds.

Cream Type Test Results

Based on the results of the cream type test, it was found that the three concentrations of papaya seed essential oil, namely 0%, 40% and 50%, are all included in the type of oil cream in water (M/A). This is because at the time of administration of methylene blue, there is a blue/purple color change in all creams from all three concentrations. The M/A type cream is suitable for acne-prone skin because it has a light texture, is easy to absorb and is non-sticky (Pratasik *et al.*, 2019).

Homogeneity Test Results

The homogeneity test was performed with a microscope to assess the distribution of particles in the cream preparation (Pratasik *et al.,* 2019). The results showed that the three creams of 0%, 40%, and 50% of papaya seed essential oil (*Carica papaya* L.) did not contain coarse granules and were proven to be evenly mixed, indicating good homogeneity in all formulas

pH Test Results

The pH measurement of the cream aims to ensure the safety of use on the skin, with an ideal range of 4.5-6.5 (Pratasik et al., 2019). The results of pH measurements can be seen in the table below.

Table 7. Cream pH test results.

Concentration	pH
0%	5,55
40%	5,22
50%	5,19

All formulas meet the cream's pH standards. The results showed an inverse relationship between essential oil concentration and pH values. A pH below 4.5 is too acidic (risk of irritation), while a pH above 6.5 is too alkaline (can cause dry and flaky skin) (Ardhany *et al*., 2019).

Dispersion Test Results

A dispersion test was performed to assess the ability of the cream to spread on the surface of the skin with a load of 250 grams for 5 minutes. The results showed that the three concentrations of papaya seed essential oil anti-acne cream (*Carica papaya* L.) (0%, 40%, and 50%) had an optimal spreadability of 5 cm, meeting the standard of good cream (5-7 cm). The optimal spreadability of the cream will have advantages including ease of application, convenience of use, even distribution of active substances and maximum effectiveness when used (Hamka & Hardiyanti, 2021).

Adhesion Test Results

The adhesion test was carried out by placing a load of 250 grams on 0.5 grams of cream between two petri dishes for 5 minutes, then recording the release time. The results showed that **the 0% cream** was sticky for 47.99 seconds, **the 40% cream was sticky for** 59.24 seconds and **the 50% cream** was sticky for 67.17 seconds. The higher the concentration of papaya seed essential oil (*Carica papaya* L.), the greater the adhesion of the cream. Good adhesion (<4 seconds) ensures that the cream lasts longer on the skin, so that the active substance can work optimally (Tungadi *et al*., 2023).

Irritant Test Results

Irritation testing was conducted on 15 panelists to assess the safety of the cream. The results showed that the three creams with different concentrations did not cause symptoms of irritation to the skin. These differences in irritation responses can be influenced by the skin condition of the panelists or incompatibility with the composition of certain ingredients. Overall, all three cream formulas show good safety with minimal irritation levels, indicating that the product is safe for topical use. (Ardhany *et al*., 2019).

CONCLUSIONS

This study successfully proved the effectiveness of papaya seed essential oil (*Carica papaya* l.) As an active ingredient in the formulation of anti-acne creams. The results of the antibacterial activity test showed that papaya seed essential oil was able to inhibit the growth of staphylococcus epidermidis and propionibacterium acnes bacteria, with the highest effectiveness at a concentration of 50%. The formulated cream developed meets all the parameters of the evaluation of topical preparations, including good organoleptic characteristics with semi-solid texture and yellowish-white color, skin ph (5.19-5.55), perfect homogeneity, as well as adequate physicochemical properties including dispersability and optimal adhesion. Irritation tests prove the safety of the product by not causing an irritating effect on the skin. This finding not only provides an alternative solution made from natural ingredients for acne therapy, but also offers sustainable utilization of papaya seed waste that has not been optimally utilized so far.

Competing Interests: The authors declare that there are no competing interests.

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