

**ANTIBACTERIAL ACTIVITY TEST OF THE COMBINATION OF MANGOSTEEN (*Garcinia mangostana* L.) PERICARP EXTRACT AND CIPLUKAN (*Physalis angulata* L.) LEAF EXTRACT AGAINST *Propionibacterium acnes* AS A POSTER DESIGN FOR BIOLOGICAL TECHNOLOGY INNOVATION MATERIALS FOR GRADE X SMA**

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**ABSTRACT**

*The problem of acne (*Acne vulgaris*) is a common skin condition among adolescents and is generally triggered by the growth of *Propionibacterium acnes*. Various natural-based treatment alternatives have been developed to minimize the side effects associated with chemical agents. Mangosteen (*Garcinia mangostana* L.) pericarp and ciplukan (*Physalis angulata* L.) leaves are known to contain diverse secondary metabolites such as xanthenes, flavonoids, tannins, saponins, alkaloids, and triterpenoids, which have potential antibacterial properties. This study aims to determine the antibacterial activity of the combined extracts of mangosteen pericarp and ciplukan leaves against *Propionibacterium acnes*, as well as to develop the research findings into a poster design for the Innovation in Biological Technology learning material for Grade X SMA. The research employed an experimental method using 15 treatment variations of extract combinations. Antibacterial activity was tested using the disk diffusion method on Nutrient Agar medium. Observed parameters included extract yield, phytochemical screening, inhibition zone diameter, and macroscopic and microscopic observations of the test bacteria. The results revealed that both extracts tested positive for active antibacterial metabolites. The antibacterial activity of the extract combinations showed varying inhibition strengths, with several treatments categorized as weak to moderate. The best treatment, P9 (35% mangosteen extract + 35% ciplukan extract), produced a strong inhibition zone measuring 14.14 mm. These findings indicate that the combination of extracts exhibits a synergistic effect in inhibiting the growth of *Propionibacterium acnes*. The research findings were further developed into a poster design for the Innovation in Biological Technology material for Grade X SMA. Expert evaluations from media and material specialists indicated that the poster is feasible to use as an innovative, informative, and contextual learning medium. The combination of mangosteen pericarp and ciplukan leaf extracts has potential as a natural antibacterial agent for acne control.*

*Keywords: *Garcinia mangostana* L.; *Physalis angulata* L.; *Propionibacterium acnes*; Antibacterial; Learning poster.*

## INTRODUCTION

Acne or *Acne vulgaris* is one of the most common skin problems experienced by adolescents. In Indonesia, the prevalence of acne among teenagers reaches 80–85% (Pariury et al., 2021), making it a skin health issue that requires special attention. Physiologically, acne is triggered by the activity of *Propionibacterium acnes*, an anaerobic gram-positive bacterium that normally lives in hair follicles and sebaceous glands (Antika, 2020). Excessive bacterial growth occurs when sebum production increases, pores become clogged, and lipase enzyme activity induces skin inflammation (Putri et al., 2022). Chemical anti-acne therapies often cause side effects and resistance, thus natural-based treatment alternatives are needed.

Indonesia is known as the country with the second-highest level of biodiversity in the world (National Geographic Indonesia, 2019). Of the 15,000 medicinal plant species, only about 7,000 have been utilized (Setiawan, 2021). Two local plants with antibacterial potential are mangosteen (*Garcinia mangostana* L.) pericarp and ciplukan (*Physalis angulata* L.) leaves. Mangosteen pericarp is known to be rich in xanthenes, flavonoids, tannins, saponins, alkaloids, and triterpenoids (Wijaya & Azti, 2021). Xanthenes possess strong antioxidant capacity and can damage bacterial cell membranes (Miryanti et al., 2011). Meanwhile, ciplukan leaves contain flavonoids, alkaloids, tannins, triterpenoids, polyphenols, and saponins that exhibit antibacterial activity (Fuad, 2021).

Previous studies have demonstrated the potential of each plant. Fitriana and Raharjo (2024) reported that ethanol extract of mangosteen pericarp produced the best inhibition zone of 12.2 mm at a 25% concentration. However, they suggested combining mangosteen extract with other plants to enhance inhibitory power (Fitriana & Raharjo, 2024). On the other hand, Aldafi et al. (2023) found that ciplukan leaves produced an inhibition zone of 11.62 mm against *Staphylococcus epidermidis* at a 25% concentration, but had not reached the minimum bactericidal concentration, leading to a recommendation for testing concentrations above 25%. To date, no studies have examined the combination of mangosteen pericarp extract and ciplukan leaf extract against *Propionibacterium acnes*, indicating a research gap that needs to be addressed.

Beyond the biopharmaceutical aspect, the findings of this study have potential for integration into high school biology learning. Based on interviews at SMA Negeri 12 Pekanbaru, it was found that posters have not been used in the Innovation in Biological Technology material for Grade X. In fact, posters are effective visual media that facilitate conceptual understanding (Tarigan, 2019). Therefore, the antibacterial findings of this study can be developed as learning materials based on local wisdom to enrich learning resources.

Based on the explanation above, this study aims to (1) determine the antibacterial activity of the combined extracts of mangosteen pericarp and ciplukan leaves against *Propionibacterium acnes*, and (2) develop the research findings into a poster design for the Innovation in Biological Technology material for Grade X SMA.

## RESEARCH METHODS

This study employed a quantitative approach with a laboratory experimental design to examine the antibacterial activity of the combined extracts of mangosteen (*Garcinia mangostana* L.) pericarp and ciplukan (*Physalis angulata* L.) leaves against *Propionibacterium acnes*. The research consisted of two stages: the first stage involved testing the antibacterial activity against *Propionibacterium acnes*, and the second stage involved designing a poster as a learning medium for Grade X SMA.

The antibacterial activity test used the disk diffusion method, as it is a standard technique widely applied in natural product antibacterial research to measure microbial inhibition zones (Aldafi et al., 2023). The research began with the preparation of mangosteen pericarp and ciplukan leaf *simplicia*, which were then extracted using the maceration method. Maceration with 96% ethanol was selected because ethanol is effective in extracting flavonoids, alkaloids, tannins, and xanthenes, as noted in the extraction study by Fitriana & Raharjo (2024). The obtained filtrate was evaporated using a rotary evaporator to produce a thick extract, and the yield was calculated to determine extraction efficiency.

Before being used for the antibacterial test, phytochemical screening was conducted to confirm the presence of secondary metabolites. Phytochemical screening was performed qualitatively on the ethanol extracts of mangosteen pericarp and ciplukan leaves to identify groups of secondary metabolites such as alkaloids, flavonoids, tannins/polyphenols, saponins, triterpenoids/steroids,

and xanthenes. The screening procedures followed commonly used methods in previous plant extract studies (Puspitasari et al., 2013; Oktavia & Sutoyo, 2021). Each metabolite group was tested using specific reagents: Dragendorff reagent for alkaloids, Shinoda reaction for flavonoids, FeCl<sub>3</sub> for tannins/polyphenols, the foam test for saponins, and the Liebermann–Burchard reaction for triterpenoids/steroids. Specifically for xanthenes in mangosteen pericarp, detection was carried out using concentrated KOH solution, which produces a color change from red to green as a positive indicator, consistent with phytochemical studies on mangosteen extract (Puspitasari et al., 2013). Observations of color changes or precipitates were used to determine the presence (+) or absence (–) of each compound. All screening steps were conducted in the Microbiology Laboratory of STIFAR Riau, as documented in the research records.

The extract combinations were prepared in fifteen treatment variations (P1–P15), each with three replications to enhance data reliability. Antibacterial activity was tested using the disk diffusion method on Nutrient Agar. The culture of *P. acnes* was evenly inoculated onto the media surface following the technique applied in acne-causing bacteria research by Putri et al. (2022). Paper disks soaked in each extract combination were placed on the media surface. The plates were incubated under anaerobic conditions to support optimal growth of *P. acnes* (Antika, 2020). After incubation, the diameter of the inhibition zone was measured using a digital caliper in millimeters as an indicator of antibacterial activity. Measurements were taken by determining the horizontal and vertical diameters of the zone. These two diameter values were then used to calculate the average inhibition zone area using the following formula.

$$\text{Inhibition Zone Diameter} = \frac{(D_v - D_c) + (D_H - D_c)}{2}$$

Description:

DV : Vertical diameter

DH : Horizontal diameter

DC : Disc diameter

**Table 1. Antibacterial Activity Criteria**

Inhibition Strength Category	Inhibition Zone Diameter (mm)
Weak	≤ 5
Moderate	6-10
Strong	11-20
Very strong	≥ 21

(Source: Widiani et al., 2020)

In addition to laboratory testing, this study also included validation of the learning media in the form of a research-based poster by media experts and material experts. Validation was carried out using assessment sheets that covered aspects such as content feasibility, accuracy of biological concepts, alignment with research results, aesthetics, and readability. Expert validation was used to ensure that the poster met the eligibility standards for instructional media, as recommended in studies on the effectiveness of visual media by Tarigan (2019). The research data included extract yield, phytochemical screening results, and inhibition zone diameters. The analysis was conducted using a descriptive quantitative approach by categorizing antibacterial activity into no inhibition, weak, moderate, and strong inhibition. Validation data were calculated in the form of eligibility percentages and compared with the established criteria for learning media feasibility.

## RESULTS AND DISCUSSION

A series of research findings were obtained through extraction, phytochemical identification, and antibacterial activity testing against *Propionibacterium acnes*. All resulting data were analyzed systematically to describe the chemical characteristics of the extracts, the potential of each secondary metabolite group, and the effectiveness of the extract combinations in inhibiting bacterial growth.

### Extract Characteristics and Extract Yield




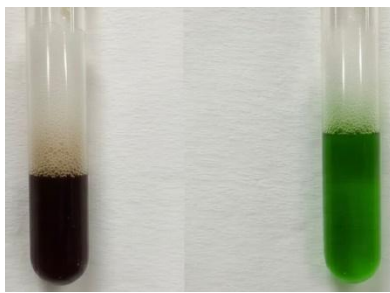
**Figure 1. Extract results**





Visual observations showed that the two extracts possessed different physical characteristics. The ciplukan leaf extract appeared dark green to blackish with a more fluid consistency, whereas the mangosteen pericarp extract displayed a reddish-brown color and a thicker texture. These differences indicate variations in the composition of secondary metabolites contained in each material (Fitriana et al., 2020). The extract yield of mangosteen pericarp reached 18.50%, while the yield of ciplukan leaf extract was 14.09%, demonstrating the efficiency of 96% ethanol in extracting active metabolites. The higher yield in mangosteen is associated with its abundant content of xanthenes, triterpenoids, flavonoids, tannins, and alkaloids (Muthmainnah, 2019). This aligns with the findings of Nasihin et al. (2024), who stated that the moisture content of simplicia and tissue structure influence extraction efficiency.

**Phytochemical Screening**

Phytochemical screening was conducted to identify the groups of secondary metabolites present in the mangosteen pericarp and ciplukan leaf extracts. The results of the phytochemical screening test are presented in the following table.

**Table 2. Phytochemical Screening Results**

Test	Research Findings	Description	Note
Alkaloids		Image (a) Mangosteen: Formation of an orange-brown precipitate	+
		Image (b) Ciplukan: Formation of an orange precipitate	+
Saponins		Image (a) Mangosteen: Foam formed with a height of 3 cm	+
		Image (b) Ciplukan: Foam formed with a height of 2 cm	+

Test	Research Findings	Description	Note
Tannins		Image (a) Mangosteen: Formation of a dark greenish-black color	+
		Image (b) Ciplukan: Formation of a dark green color	+
Flavonoids		Image (a) Mangosteen: Formation of a brick-red color	+
		Image (b) Ciplukan: Formation of a reddish-orange color	+
Triterpenoids/ Steroids		Image (a) Mangosteen: + Triterpenoids Formation of light brown to dark brown coloration	+
		Image (b) Ciplukan: + Steroids Formation of pale green to greenish-brown coloration	+
Xanthones		Image (a) Mangosteen: Formation of an orange color	+
		Image (b) Ciplukan: Formation of a yellowish-green color	-

Note : Image (a): Left position  
Image (b): Right position

The results of the phytochemical screening showed that the mangosteen pericarp extract and ciplukan leaf extract contained various important secondary metabolites, such as alkaloids, flavonoids, tannins, saponins, triterpenoids, steroids, and xanthones (specifically in mangosteen). The presence of these compounds provides strong indications that both extracts possess significant antibacterial potential. Alkaloids function by disrupting bacterial cell walls, tannins are capable of precipitating proteins and inhibiting bacterial adhesion, while flavonoids and saponins act by increasing membrane permeability and interfering with cell synthesis. Xanthones in mangosteen, such as  $\alpha$ -mangostin, are known to damage the lipid layer of bacterial membranes, making them highly effective against Gram-positive bacteria such as *Propionibacterium acnes*. Thus, the rich and varied phytochemical profile of both extracts explains why they especially when combined exhibited strong antibacterial activity in the inhibition zone test.

### Antibacterial Activity

The antibacterial activity test of the combined extracts of mangosteen pericarp (EKM) and ciplukan leaves (EDC) against *Propionibacterium acnes* showed variations in the diameter of inhibition zones across treatments. These inhibition zones represent the ability of bioactive compounds to

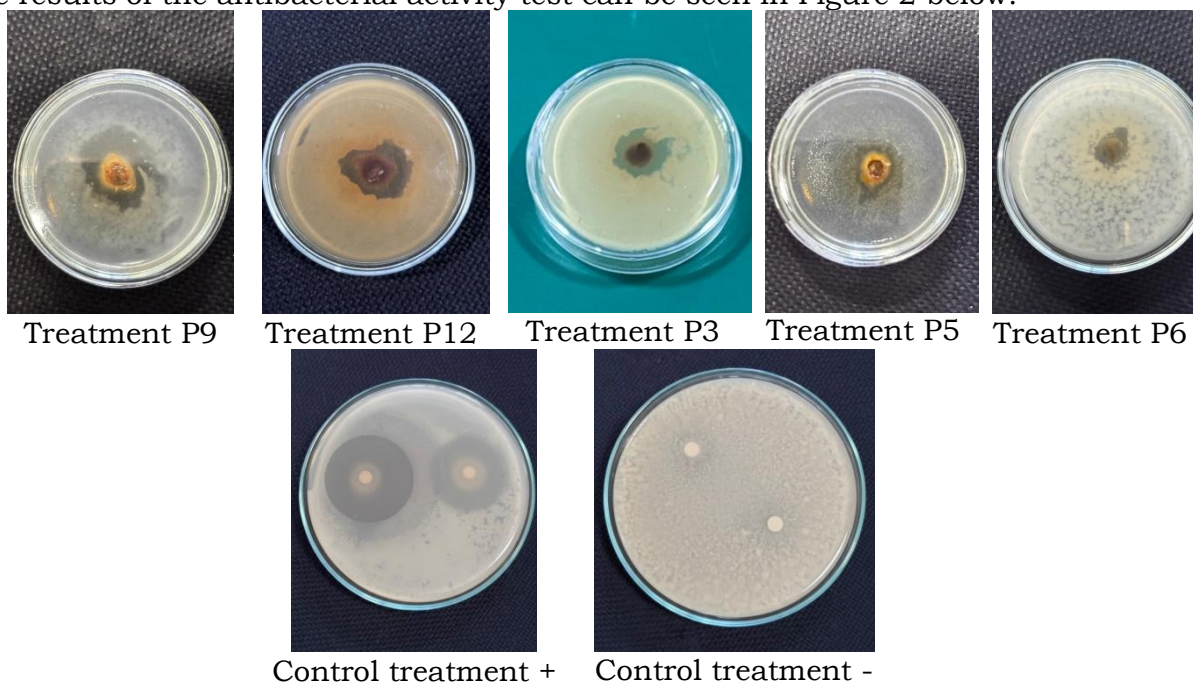
suppress bacterial growth, where larger clear zones indicate stronger antibacterial activity (Dwidjoseputro, 2005). The variations in inhibition zone diameters are presented in detail in Table 3 below.

**Table 3. Antibacterial Activity Test Results**

	<b>Treatment</b>	<b>Average±(mm)</b>	<b>Category</b>
P1	25 % EKM + 25 % EDC	2.50	Weak
P2	25 % EKM + 30 % EDC	2.57	Weak
P3	25 % EKM + 35 % EDC	11.15	Strong
P4	30 % EKM + 25 % EDC	1,00	Weak
P5	30 % EKM + 30 % EDC	8.9	Moderate
P6	30 % EKM + 35 % EDC	0.57	Weak
P7	35 % EKM + 25 % EDC	2.93	Weak
P8	35 % EKM + 30 % EDC	1.35	Weak
P9	35 % EKM + 35 % EDC	14.14	Strong
P10	25 % EKM + 0 % EDC	8.10	Moderate
P11	30 % EKM + 0 % EDC	5.50	Moderate
P12	35 % EKM + 0 % EDC	12.10	Strong
P13	0 % EKM + 25 % EDC	2.50	Weak
P14	0 % EKM + 30 % EDC	1.50	Weak
P15	0 % EKM + 35 % EDC	5.28	Moderate

Description : EKM : Mangosteen Peel Extract  
EDC : Ciplukan Leaf Extract

The results of the antibacterial activity test can be seen in Figure 2 below.



**Figure 2. Results of Antibacterial Activity Test**



The results of the antibacterial activity test showed that treatment P9 produced the largest inhibition zone, measuring 14.14 mm, indicating the strongest antibacterial activity. This effect suggests the presence of synergism between the bioactive metabolites of mangosteen peel and ciplukan leaves at high concentrations (35%:35%). Fitriana & Raharjo (2024) explained that  $\alpha$ -mangostin plays an important role in damaging bacterial membranes. In contrast, treatment P6 produced the smallest inhibition zone (0.57 mm), categorized as weak, likely due to a non-optimal

ratio of active compounds, causing the interaction between the two extracts to be antagonistic (Saputro, 2014). This is consistent with the findings of Prabowo and Rahmatillah (2015), who stated that combining several plant extracts can produce varying combined effects depending on the types and concentrations of the compounds contained. Antibacterial combinations do not always enhance inhibitory effects, because interactions between active compounds may be additive, synergistic, or even antagonistic depending on their proportions and stability. Antagonistic effects occur when the combination of two compounds results in lower antibacterial activity than the sum of the activity produced by each compound individually.

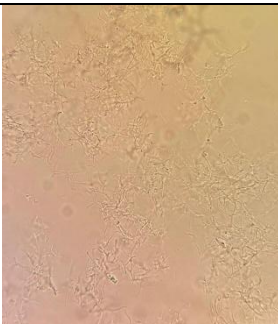
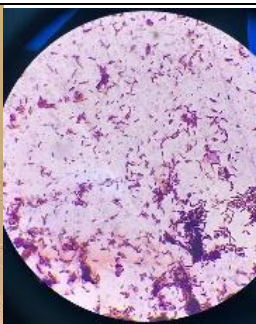
### Macroscopic and Microscopic Observation of Test Bacteria

Macroscopic and microscopic observations were carried out to confirm the morphological characteristics of *Propionibacterium acnes* as the test bacterium, ensuring that the results of the antibacterial activity test could be validated accurately. These two observations complement each other in accurately identifying the bacterial isolate. The results of the macroscopic and microscopic observations of the test bacterium are presented in Tables 4 and 5 below.

**Table 4. Macroscopic observation of *Propionibacterium acnes***

Characteristics	Description	Figure	
Colony shape	Circular		
Colony margin	Irregular undulate		
Colony elevation	Raised		
Colony texture	Granular		
Colony color	Grayish white		

**Table 5. Microscopic observation of *Propionibacterium acnes***

Cell shape	Cell arrangement	Gram reaction	Figure	
Bacil-Irregular Rods	Irregular	(+) Positive (purple)		

The macroscopic observation showed that the colonies of *Propionibacterium acnes* had a circular shape, irregular undulate margins, raised elevation, granular texture, and a grayish-white color, consistent with the characteristics described by Agustina (2025), who reported that *P. acnes* forms small, white, compact colonies on agar media. Microscopically, the bacteria appeared as irregular rod-shaped cells and stained purple after Gram staining, indicating a Gram-positive reaction, which is typical of *Propionibacterium acnes*, a member of the Gram-positive anaerobic bacilli group (Liling et al., 2020). The consistency between the macroscopic and microscopic observations is also aligned with literature stating that *P. acnes* is a normal skin flora characterized as Gram-positive rods (Zahara et al., 2022). Thus, it can be confirmed that the isolate used in this study is indeed *Propionibacterium acnes*.

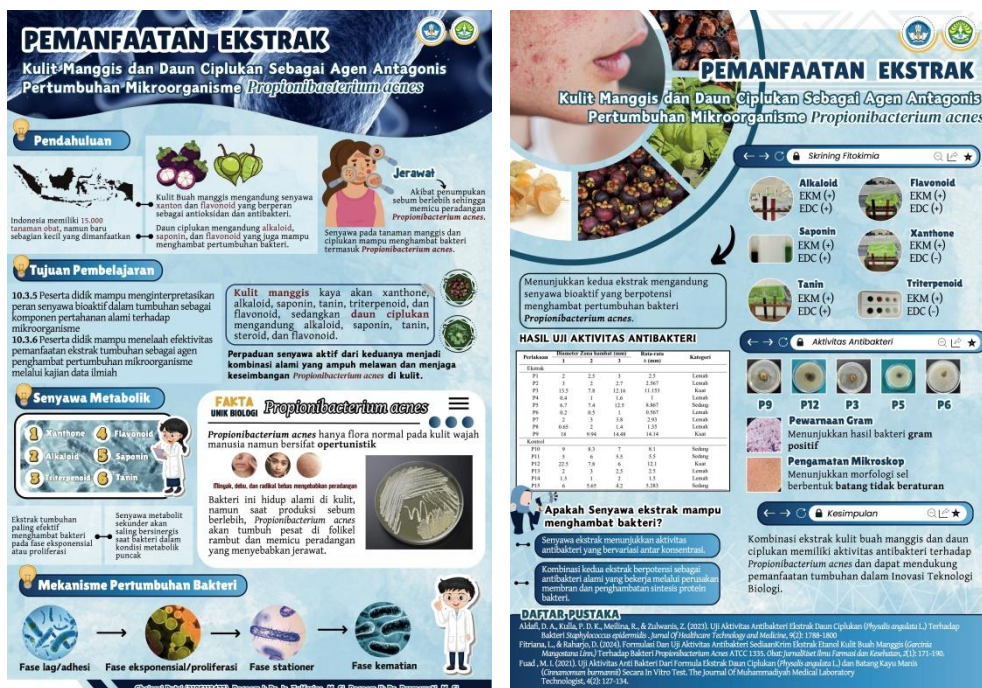
**Learning Media Poster Design**

Based on the results obtained regarding the antibacterial activity test of mangosteen peel extract and ciplukan leaf extract against *Propionibacterium acnes*, these findings can be used as primary data for designing a poster as a learning medium in the Innovation in Biological Technology topic for Grade X senior high school. The relevant learning material associated with this research is presented in Table 6 below.

**Table 6. Analysis of Material Potential for Poster Development Based on Research Findings**

Analysis of Learning Material	Subtopic	Learning Objectives	Grade
The Role of Microorganisms and Plant Potential in Biotechnology	Antagonism in Microorganism Growth	10.3.5 Students are able to interpret the role of bioactive compounds in plants as natural defense components against microorganisms. 10.3.6 Students are able to examine the effectiveness of plant extracts as microbial growth-inhibiting agents through the analysis of scientific data.	X/1

The next stage is the design or planning phase of the poster media to be developed. The design process for this poster was carried out using the Canva application. The final product of the developed poster-based learning media can be seen in the following figure.



**Figure 3. Poster Design**

The poster that was developed was validated by both material experts and media experts. The validation results show that the poster received an average score of 3.85 for the aspects of model size, cover design, and content design, categorized as *highly valid*. Meanwhile, the material expert validation showed an average score of 3.7–4.0 for content feasibility, presentation feasibility, and language feasibility, indicating that the poster was also *highly valid*. The material expert’s assessment is supported by Maiyena (2016), who emphasizes that posters must present material concretely and in a way that is easy for students to visualize so they can understand concepts correctly. In addition, the media expert noted that the structure of the poster was coherent and well-organized, aligning with Nursalim & Putra (2025), who state that logical presentation strengthens students’ conceptual understanding. As a visual medium, the poster was considered effective because its layout, color, illustrations, and graphics supported reader comprehension, consistent with Wahidin (2025), who explains that well-organized visuals enhance student focus and understanding. Overall, the average validation score from media and material experts was 3.8, indicating that the developed learning

poster is feasible for use as a Biology learning medium for the topic of Biological Technology Innovation, consistent with the analysis results in this study.

## CONCLUSIONS

Phytochemical screening analysis indicated that both extracts qualitatively contain various secondary metabolites with potential antibacterial activity. The combination of mangosteen peel extract (*Garcinia mangostana* L.) and ciplukan leaf extract (*Physalis angulata* L.) was proven to inhibit the growth of *Propionibacterium acnes*, with the highest inhibitory activity observed in treatment P9 (35% : 35%), producing a zone of inhibition of 14.14 mm. In contrast, the lowest concentration was found in treatment P6 (30% : 35%), with an average inhibition zone of 0.56 mm. The antibacterial activity of ciplukan leaf extract as a single extract was relatively lower; however, when combined with mangosteen peel extract, its antibacterial effectiveness increased significantly due to synergistic interactions among bioactive compounds. These findings also support the potential of the research as a basis for developing a learning poster relevant to the Class X Biology Innovation Technology material.

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