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Active Compounds and Antibacterial Activity of Banana (*Musa paradisiaca*) var. Agung Bunches and Combs Extracts Against *Escherichia coli* Analysis

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Abstract

Background: *Escherichia coli cause diarrhea. E. coli infections can be treated using synthetic antibiotics. Natural antibiotics are an alternative for prevent E. coli infections as synthetyc antibiotic substitute. Natural antibiotics are come from plants part such as agung banana's (Musa paradisiaca) bunch and combs. This bananas are used as a dessert fruits. The waste of this friut, such as bunches and fruit comb. This banana plant is potentially as antibacterial substance. The aims of this research are, 1) to examine the antibacterial effect of banana bunch and comb extracts; 2) to determine the effective concentration of the extract against the E. coli growth; and 3) to analysis of the active compounds content of banana bunch and comb extracts.* **Methodology:** *The antibacterial effect was examine using the agar well diffusion. Total active compound levels was examine using the UV-Vis spectrophotometry method and the derivative compounds uses the LCMS method.* **Findings:** *The research results showed the bunches had antibacterial effect against E. coli and the effective concentration is 90% with the highest inhibitory zone size diameter is 6.98 ± 0,00 mm, while the combs effective concentration is 80% is 6.55 ± 0.81 mm. The antibacterial effect of both extracts is moderate categorize. The highest content of active compounds in the bunches is phenol, with content: 70.70 mg/g and in the comb is 45.82 mg/g.* **Contribution:** *This research contributes to the utilisation of organic waste as an alternative source of environmentally friendly natural antibacterial agents and supports innovation in phytopharmaceuticals based on local plants.*

Keywords: *Active compounds; Antibacterial; Bunches; Comb*

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INTRODUCTION

Diarrhea is one of the people common digestive diseases. *Escherichia coli* caused of the digestive tract disorder. Besides that, diarrhea is usually followed by fever and loss of a lot of fluids from the body or dehydration (Muttaqin et al., 2016). Poor sanitation

causes a lot of *E. coli* bacterial contamination in clean water that people consume for drinking and cooking needs (Utami & Luthfiana, 2016).

E. coli will enter the body throught the food consumtion and then infect the mucosa by enterotoxin produced by this bacteria. *Enterotoxigenic Escherichia coli* (ETEC) produces toxins and causes the intestines infection. Then the colon produce water to cleanse the intestines from the toxins produced by these bacteria (Muttaqin *et al.*, 2016). This causes the body to lack of fluids and requires control to reduce the impact of *E. coli* infection by taking antibiotics. The synthetic antibiotic usually used is chloramphenicol. The mechanism of chloramphenicol for treating diarrhea is by inhibiting bacterial growth (Ernawati & Kumala, 2015). Long-term use of synthetic antibiotics can cause bacteria to become resistant to these antibiotics. Therefore, people are trying to switch to natural antibiotics as a substitution for thr synthetic antibiotics, for example plants that have the potential to inhibit bacterial growth.

Antibiotics derived from potential antibacterial plants have relatively fewer side effects than synthetic antibiotics. The use of plants that have antibacterial potential to treat diarrhea is considered more effective because they contain flavonoid, tannins, phenolic acids, tocopherols and polyphenols compounds (Fatimah *et al.*, 2016). The banana plant is a sort of plant that can produce several antibacterial compounds (Hasma & Winda, 2019).

Bananas are a commodity that is widely produced, for example is the agung bananas (Nurhayati et al., 2016). Banana plants contains various useful compounds, i.e: water, carbohydrates, reducing sugars, fat, sucrose, pectin, starch, protein, fiber, vitamins, and ash (Hasma & Winda, 2019). The total production of bananas in East Java in 2021 is 2,048,948 tons, while in 2022 was increase to 2,626,582 tons (Badan Pusat Statistik, 2023). The people choice for Agung banana in fresh and processed form has contributed to increasing banana production (Pratama et al., 2022).

In general, the waste product from Agung bananas is in the form of bunches, comb s and banana peels. Nurhayati et al. (2016) stated through her research that the most of banana production causes a lot of bunch and peel waste in post-production. Agung bananas are often processed into various types of processed foods such as chips and fried bananas. This causes an abundance of banana comb fruit bunches and combs (Yulis & Sari, 2020). Therefore, it is necessary to conduct research on the use of bunches and combs of Agung bananas in order to reduce the waste.

The results of banana peels and fruit show that this banana parts contain active compounds (Hasma & Winda, 2019). Research using Raja banana peels shows that there is an antibacterial activity against *Staphylococcus aureus* because it contains antibacterial compounds such as flavonoids, phenols, tannins, and alkaloids. (Rofiyana et al., 2024). The results of phytochemical screening through previous research show that the comb of the agung banana (*Musa paradisiaca*) contains some antibacterial compounds such as: flavonoids, phenols, terpenoids, tannins, and alkaloids (Pratama et al., 2022). The antibacterial compounds content can inhibit *E. coli* growth (Sari et al., 2020). Further studies on the antibacterial effect of agung banana bunches and comb extracts against bacteria need to be carried out.

This research was carried out with the aim to examine the antibacterial effect agung bananas bunches and comb extracts to inhibit *E. coli* growth. Besides that, this

research also aims to analyze the active compounds content in of agung banana bunches and comb extracts. The active compound content the agung banana bunches and comb extracts analyzed consist of: flavonoids, terpenoids, phenols, tannins, and alkaloids. This research proved that the bunches and comb of the agung banana extracts contain antibacterial active compounds. This fact can increase the public knowledge about the benefits of agung banana waste in the health field, besides consumed in fresh and processed form.

METHOD

This research is a type of experimental research. The research aims to determine the levels of active compounds and the effective concentration of extracts from the bunches and combs of agung bananas in inhibiting the growth of *E. coli* bacteria. Concentration treatments for agung bananas bunches and comb extracts are; 10%, 20%, 30% 40%, 50%, 60%, 70%, 80%, 90%, 100%, and positive control using 0.05% chloramphenicol, and negative control using sterile distilled water.

Time and Research Place

This research was carried out in July - October 2024. The antibacterial effect test was carried out in the Microbiology laboratory of the Biology department, FMIPA, Universitas Negeri Malang. Extraction was carried out at the Batu Medika Material Center and analysis of the content of several types of active compounds was carried out at the Chemistry Laboratory, Muhammadiyah University of Malang.

Tools and Materials

The tools used in this research are: measuring cup, blender, knife, digital balance glass funnel, spatula, glass stirrer, Erlenmeyer flask, shaker, refrigerator, rotary evaporator, Laminar Air Flow (LAF), UV-Vis Spectrophotometry, Shimadzu LCMS, analytical balance 0,001g, measuring pipette, vernier calipers, glass funnel, test tube, cuvette, water bath, oven, beaker, measuring flask, vortex, centrifuge, vacuum filter, autoclave, stirrer glass tube rack, micropipette, pippette tip 10 – 100 µL, inoculation needle, petri dish 9cm, spiritus lamp, incubator. The materials used in this research are: bunches and combs of agung bananas, pure culture of *E. coli*, methanol 96% p.a., alcohol 70%, chloramphenicol, aluminum foil, cotton, distilled water, peptone, cover paper, filter paper, mattress thread, cotton bud, plastic wrap, gloves, Nutrient Agar (NA) medium and instant Nutrient Broth (NB) brand MERCK, Beef extract, standard solution Mc Farland 0.5%. Wickerham paper, $NaNO_2$ 5%, Al_2Cl_3 10%, quercetin standard, gallic acid standard, atropine standard, linalool standard, tannic acid standard, ethanol 90%, diethyl ether, NaCl 5%, filter paper, anhydrous $FeCl_3$ 0.1 M, $K_3Fe(CN)_6$ 0.008 M, concentrated H2SO4 p.a, acetonitrile, and formic acid 0.2%.

Reasearch Procedures

Sample Preparation And Masseration

100 grams of agung bananas bunches and comb obtained from farmers at Lumajang, then cleaned with running water, drained, and air-dried. The sample cutted

into several pieces and placed in a container. Samples grounded with a blender until smooth. 100g sampels was put into a maceration container and added 500 ml of 96% p.a. methanol with a ratio of 1 : 5 (Pratama et al., 2022). The maceration container is closed and stored for 2 x 24 hours. The sample is filtered to take the filtrate, while the residue is dissolved again, then all filtrate was evaporated. The evaporation process uses a rotary evaporator at a temperature of 60 °C until a thick extract is obtained.

Tools and Materials Sterilization

Sterilization of tools and materials is used to prevent bacterial contamination. The equipment to be sterilized is: petri dish with diameter 9 cm, beaker glass, measuring cup, sample bottle, drill cork, sample bottle and inoculation needle, the equipment to be sterilized is wrapped in aluminum foil, then sterilized in a dry oven at a temperature of 150 ˚C for 2 hours, while the materials used are Nutrient Agar (NA) and Nutrien Broth (NB) medium using an autoclave at a temperature of 121 ˚C with a pressure of 15 LBS for 15 minute (Hastuti et al., 2024).

Antibacterial Test with Well Diffution

Testing the effect of each banana bunch and comb extract at concentrations of 10%, 20%, 30% 40%, 50%, 60%, 70%, 80%, 90% and 100% was carried out on *Escherichia coli. E. coli* were cultured again in slanted NA medium. Next, the incubation age of *E. coli* was determined using Mc. Farland 0.5. *E. coli* cultures were inoculated into NB medium and incubated for 18 hours then the *E. coli* culture is predicted contain 1.5×108 CFU/ml bacterial cells and is ready for use. *E. coli* in NB medium were inoculated aseptically using sterile cutton buds on the surface of the NA plate medium. Then a well was made in NA plate medium using a sterile cork drill. Next, 20 µL of the extract solution was put into the well and then incubated for 1 x 24 hours at 37°C (Amalia, 2021), then the growth inhibition zone of the test bacteria was measured with vernier calipers.

Analysis of Active Compound Content

The levels of active compounds in banana bunches and comb were measured using the UV-Vis spectrophotometric method. The compounds whose contents were measured included flavonoids, terpenoids, phenols, tannins and alkaloids. Further testing used the LCMS (*Liquid Chromatography Mass Spectrometry*) method to determine the derivative compounds from each bunch extract and comb extract.

Flavonoids

The standard solution for testing flavonoid levels uses 100 mg/L quercetin. Next, several concentrations of quercetin stock solution were made: 0; 0.5; 1; 10; 25 and 50mg/L standard solution or sample solution of 0.1 ml plus 0.1 ml 2% AL_2CL_3, homogenize and let stand for 60 minutes. Then distilled water is added to a volume of 1ml. Absorption measurements were carried out at λ = 420 nm. Determination of flavonoid content using standard regression equations (Hastuti et al., 2023).

Terpenoids

Linalool standard solution 0.5 mg/100 mL. Several concentrations were prepared: 0; 0.01; 0.05; 0.1; 0.25 and 0.5 mg/L. 5 ml of the standard solution or sample solution is taken and 3 ml of concentrated sulfuric acid (H_2SO_4) is added, homogenized, and left for a few moments.The solution was diluted with chloroform to a volume of ten milliliters. Absorption measurements were carried out at λ=538 nm (Hastuti et al., 2024).

Fenols

Standard solution of 100 mg/L gallic acid. A standard phenol solution is prepared by dissolving ten milligrams of gallic acid in distilled water to make 100 milliliters. Several concentrations were prepared: 0; 1; 5; 10; 25; and 50mg/L. The sample solution was then diluted with distilled water to a volume of 10 ml. At λ 470 nm, absorbance was measured (Pratama et al., 2022).

Tanin

The standard tannic acid solution is 50 mg/L. A standard tannic solution was prepared by dissolving five milligrams of tannic acid in ten milliliters of 20% ethanol. There are several concentrations prepared: 0, 1, 5, 10, 25, and 50 mg/L. Take 5ml of the standard solution or sample solution and add 0.1 ml of ferric chloride ($FeCl_3$) and 0.008 ml of $K_3Fe(CN)_6$, homogenize, and let stand for 30 minutes. distilled water is used to dilute the solution to a volume of 10 ml. At λ 620 nm, absorbance was measured (Hastuti et al., 2024).

Alkaloid

Atropine 100 mg/L solution was used as a standard solution. Ten milligrams of atropine solution was dissolved in 100 mL of chloroform. Several concentrations, including 0, 1, 5, 10, 25, and 50 mg/L, were prepared. Samples of banana bunch and comb extract were each weighed at 0.1 g, then dissolved in 10 mL of Dimethyl Sulfoxide (DMSO) plus 1 ml 2N HCl, and 5 ml phosphate buffer and 5 ml green bromine cresol solution, homogenized, and left for 60 minutes. 10 ml chloroform added to the solution in a separatory funnel, then shaken until a layer forms. The upper phase of the solution is removed. 11 ml of standar solution dissolved with chloroform. Absorption measurements were carried out at λ = 470 nm (Hastuti *et al*., 2019).

LCMS Method

0.1 g of the extract was taken and dissolved in methanol to 100 ml and vortexed for 10 minutes then left for 60 minutes. The solution is filtered with a vacuum filter and the filtrate is taken. The filtrate was centrifuged at 8000 rpm for 10 minutes and the supernatant was taken. 2 ml of extract supernatant was added with 3 ml of acetonitrile acidified with 0.2 % formic acid then centrifuged at 8000 rpm for 5 minutes. Next, purification is carried out with SPE (Solid Phase Extraction) until the solution is ready for use. The solution is injected into the

LCMS device to initiate the LCMS procedure on the device until results are obtained.

Data Analysis

Bacterial growth inhibition data was obtained by measuring the diameter of the growth inhibition zone againts *E coli*. Calculation of the growth inhibition zone uses the following formula (Rijal & Asri, 2024):

Diameter of the inhibition zone of Escherichia coli bacteria = (b - a) …… (1)

Description:
a = diameter of the well in the medium filled with banana bunch and comb extract,
b = diameter of the clear zone where bacteria do not grow

The data obtained showed that it was not normally distributed or homogeneous so it was analyzed using non-parametric statistics via the Kruskal-Wallis test, if the results were significant, the Mann-Whitney test was continued.

RESULTS AND DISCUSSION

Agung Banana *(Musa paradisiaca)* Bunches Antibacterial to Inhibit *E. coli* Growth

The data obtained from the diameter zone of antibacterial effect of agung banana (*Musa paradisiaca*) bunches extract measurement againts *Escherichia coli* after 1×24 hours incubation period. The measurement results of the agung banana bunch extract inhibitory zone diameter are shown in Fig 1. The inhibition zone diameter is increased sequentially from 10% to 100% concentration is: 0.45 mm; 0.60mm; 1.2mm; 1.63mm; 1.68 mm; 2.65 mm; 5.58 mm; 6.58 mm; 6.98 mm; and 3.18 mm.

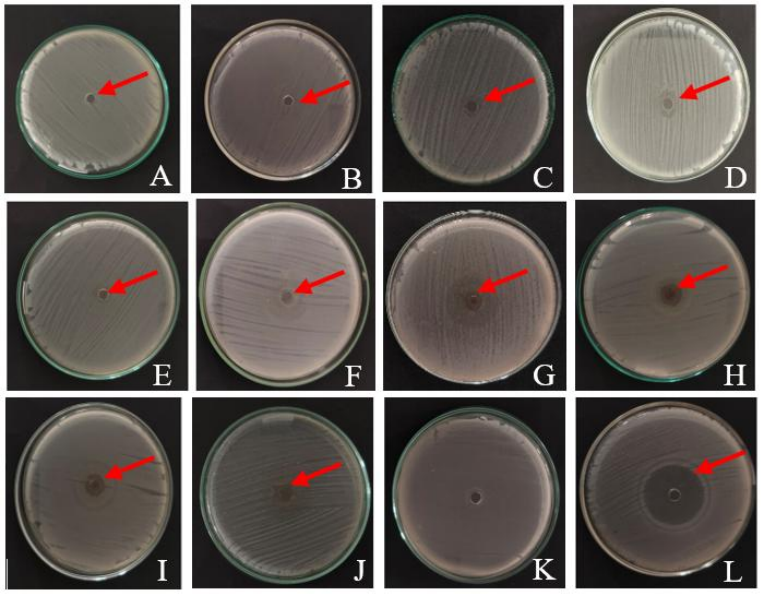

Figure 1. Agung Banana Bunch Extract (*Musa paradisiaca*) againts *E. coli* growth
Description: →: Inhibition Zone, A-J: Agung Banana Bunch Extract concentrations 10%, 20%, 30% 40%, 50%, 60%, 70%, 80%, 90%, and 100%; K: negative control; L: positive control.

The antibacterial effect of agung banana bunch extract againts *E. coli* growth is shown in Fig 2. The 90% concentration of bunch extract have the greatest effect to *E. coli* inhibition growth: 6.98 mm was the moderate category, because it is in the range between 6-10 mm. Based on Davis & Stout (1971) of antibacterial effect categories, namely: <5mm (weak), 6-10 mm (moderate), and 11-20 mm (strong), >20 mm (very strong). Chloramphenicol as a positive control treatment against *E. coli* showed the high antibacterial activity 24.81 mm. The distilled water as a negative control showed that there is no inhibition zone. This fact shown that the distilled water have no inhibition effect to *E. coli*. growth, as the negative control.

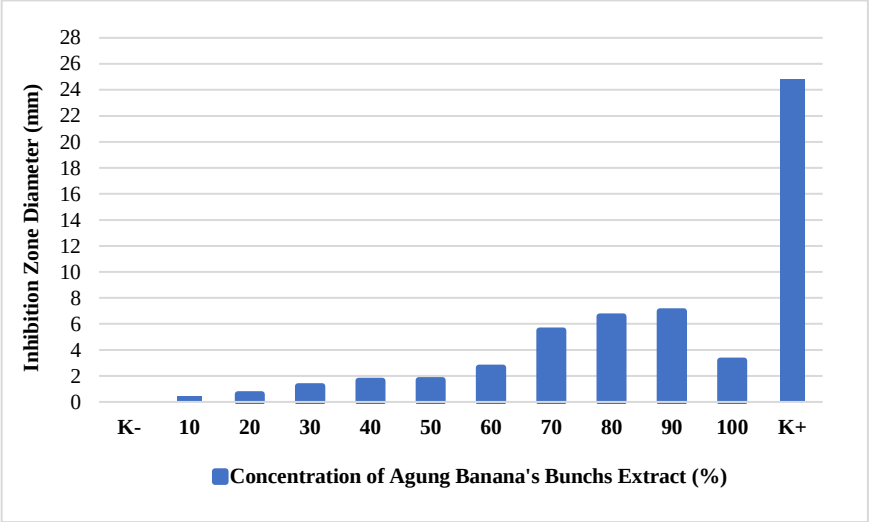

Figure 2. The effect of Agung banana bunchs extract concentration on the diameter of the *E. coli* growth inhibition zone
Note: K- = Distilled water as negative control
K+= Chloramphenicol 0.05 as positive control

The antibacterial effect of various concentrations of agung banana bunch extract (Fig 1) show that there is an effect of the extract against *E. coli* growth. Antibacterial effect was shown by the clear zone around the wells in the NA as the growth media. The diameter of inhibition zone varies depending on the concentration of the extract treated on the *E. coli*. The extract concentration affects the inhibition zone size. The higher extract concentration, the higher antibacterial compound content in the extract. (Magvirah et al., 2019).

The effect of bunch extract concentration on inhibiting the *E. coli* growth showed a tendency to increase as well as extract concentration increased (Fig 2). The antibacterial effect at 100 % concentration decreased because the extract is too viscous, so it is unable to diffuse completely into the NA medium around the well (Purwanitiningsih & Lintang, 2021). So, it is difficult make laeger inhibition zone diameter. This fact is mutual accord with Rahmadeni et al., (2019), based ony research that the concentration of the extract, the number of bacteria, the type of bacteria, and the diffusion effect of the extract are factors that can influence the diameter of the clear zone formed.

Agung Banana *(Musa paradisiaca)* Combs Antibacterial to Inhibit *E. coli* Growth

The antibacterial data obtained from measurement result on the inhibition zone diameter of agung banana combs extract againts *E. coli* after 1×24 hours incubation period. The inhibitory zones result of agung bananas combs extracts are shown in Fig.3. The inhibitory zones result are increase sequencelly from 10 % to 100 % concentration i.e: 0.32 mm; 0.33 mm; 0.60 mm; 0.96 mm; 1.63 mm; 3.55 mm; 3.97 mm; 6.55 mm; 6.03 mm; and 1.25 mm. The antibacterial effect of agung banana combs extracts shown the inhibited zone diameter of *E. coli* growth and shown in Fig 4. The inhibited zone data result of *E. coli* growth carried out with the agung banana comb extract in 10 % concentration is 0.32 mm, this is the smallest inhibitation zone diameter. The 80% concentration produce the highest inhibition zone againts *E. coli* growth i.e: 6.55 mm, at the moderate category.

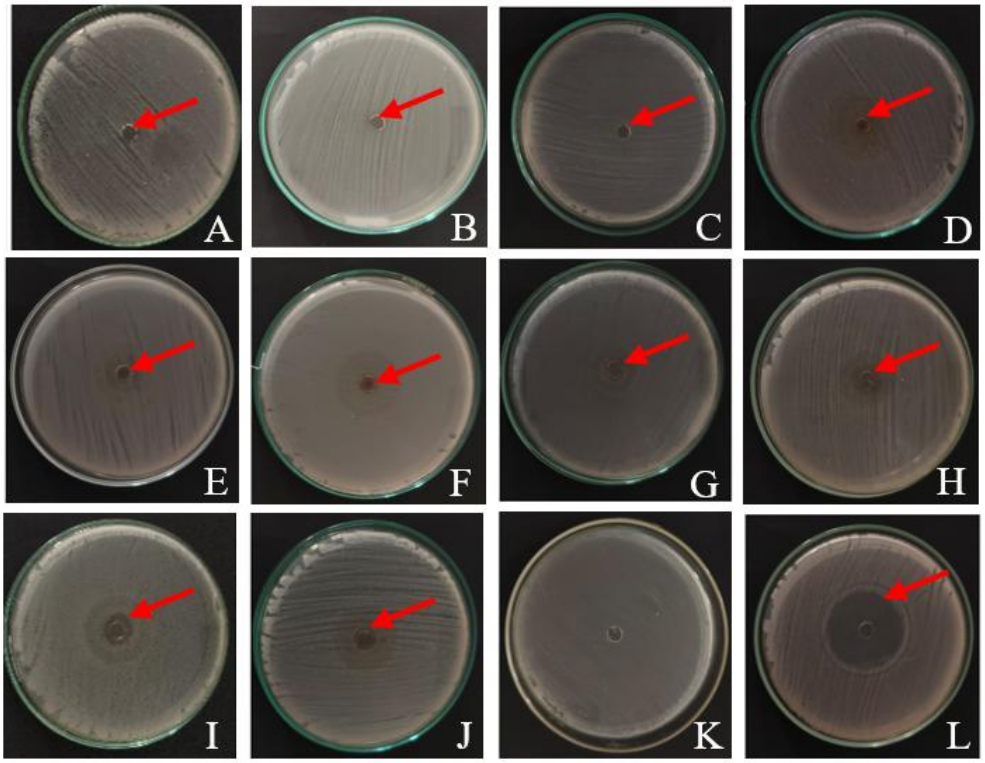

Figure 3. Agung Banana Combs Extract (*Musa paradisiaca*) againts *E. coli* growth
Description: →: Inhibition Zone, A-J: Agung Banana Bunch Extract concentrations: 10%, 20%, 30% 40%, 50%, 60%, 70%, 80%, 90%, and 100%; K as the negative control; L as the positive control.

Fig. 3 shown The antibacterial effect each agung bananas comb extracts against *E. coli* growth. The effect of comb extract concentration on inhibiting *E. coli* growth showed a tendency increase as well as the extract concentration (Fig 4). According research of raja bananas produced an inhibition zone diameter of 10.4 mm, which is a larger zone than that of agung bananas (Rofiyana *et al.*, 2024). These results are match with the research of Purwanitiningsih & Lintang (2021) about the antibacterial effect of Salam Koja (*Murraya koenigii* L.) leaves againts *E. coli* and *S. aureus,* that the higher the concentration of the extract are match with the higher of the extract ability

to inhibit the bacteria growth. The ability of the extract to inhibit the bacteria growth increases as well as the increase the concentration extract and then decreases because of several factors such as concentration and diffusion ability of the extract in the media (Triyani *et al*., 2021).

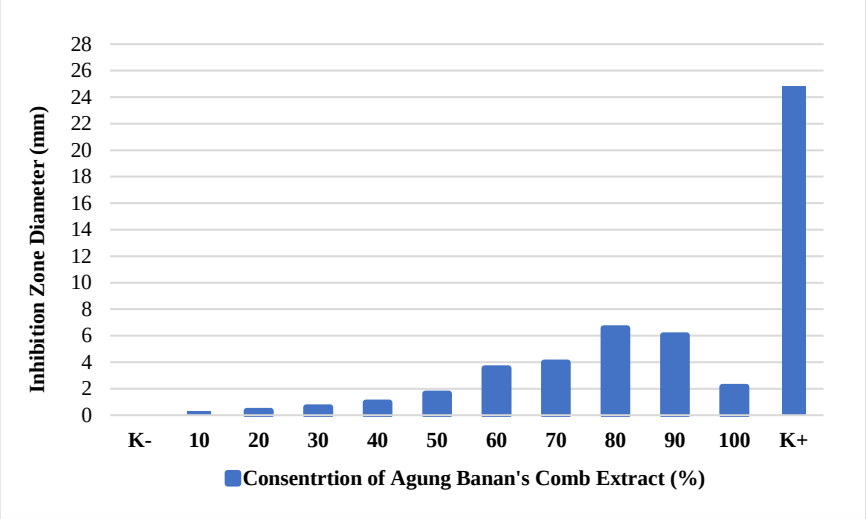

Figure 4. Effect of concentration of Agung banana combs extract on the diameter of the growth inhibition zone of *E. coli*
Note: K- = Distilled water as the negative control
K+= Chloramphenicol 0.05 as the positive control

Banana combs extract produced a smaller inhibition zone diameter compared with the bunches. This may be caused by the fact that the distribution of the active compounds is not the same as in the two parts of agung banana. According to Amalia (2021), the differences of the antibacterial effect of papaya plant parts against bacteria which shows that the leaves extract have the highest antibacterial effect compare within the fruits and stem. Therefore, if we are going to use extracts from agung banana plant parts as a natural antibiotic, it is better to use agung banana bunches extract which have been proved have higher antibacterial compounds content compared to the combs.

The Active Compounds Content Analysis in Banana Bunches and Combs

Table 1 shows active compound analysis result. This table shown that the agung banana bunches and combs extracts contain active compounds such as, flavonoids, terpenoids, phenols, tannins and alkaloids. The active compounds content in the bunches is higher than in the combs. Differences in compound content in each part of the plant can be caused by differences in the biosynthesis of active compounds used for biological processes (Kharismanda & Yuliani, 2021).

Further analysis used the LCMS method to determine derivative compounds from 5 main groups of compounds that have antibacterial effect from agung bananas plants parts. The analysis results is: flavonoid, terpenoid, phenol, alkaloid and tannin derivative compounds showed that there were 18 active compounds with antibacterial effect. The analysis results showed that flavonoid have 6 antibacterial derivative

compounds. Terpenoid have 3 antibacterial derivatives compounds. Phenol have 6 antibacterial derivatives compounds. Tannins have 2 antibacterial derivatives compounds and alkaloid have 1 antibacterial derivatives compounds compounds.

Table 1. The Active compounds content in Agung bananas (*Musa paradisiaca*) bunches and combs extracts of

Plant Parts	Active Compounds (mg/g)				
	Flavonoids	**Terpenoids**	**Fenols**	**Tannins**	**Alkaloids**
Bunchs	39,52	4,49	70,70	13,93	1,45
Combs	34,21	3,91	45,82	12,60	1,29

The antibacterial compounds produced by plants could defend plants from pathogenic bacteria infection. The flavonoids, terpenoids, phenols, tannins, and alkaloids have antibacterial effect (Rofiyana et al., 2024). Based on the results of the research analysis done by the researcher, it was proved that flavonoid compounds content in the bunches was 39.52 mg/g, it is higher than the comb (34.21 mg/g). Flavonoid compounds inhibitte protein synthesis and inhibite the energy metabolism process that occurs in bacteria (Nomer et al., 2019). The metabolism process inhibition will caused the decrease of ATP production and finally cause the bacteri cell death.

Table 2. The Antibacterial Compound Derivatives Content of Flavonoids, Terpenoids, Phenols, Tannins and Alkaloids in Agung Banana Bunches (*Musa Paradisiaca*)

No.	Compound	Composition (%)	Compound class
1.	Quercetin	1,60	Flavonoid
2.	Luteolin	1,34	Flavonoid
3.	Kaempferol	1,33	Flavonoid
4.	Isoquercetin	1,28	Flavonoid
5.	Rutin	0,82	Flavonoid
6.	Hyperoside	0,51	Flavonoid
7.	Stigmasterol	0,72	Terpenoid
8.	Cycloeucalenol	0,61	Terpenoid
9.	β-amyrin	0,55	Terpenoid
10.	4-hydroxybenzaldehyde	1,39	Fenol
11.	Ferulic acid	1,31	Fenol
12.	p-coumaric acid	1,11	Fenol
13.	Caffeic acid	0,90	Fenol
14.	Chlorogenic acid	0,88	Fenol
15.	Vanillic acid	0,66	Fenol
16.	Gallic acid	1,89	Tannin
17.	Apigenin	1,09	Tannin
18.	Piperidine-1-carbaldehyde	0,24	Alaloid

Based on research analysis results carried out by researcher, it was proved that terpenoid compounds content in the bunches was 4.49 mg/g and in the comb was 3.91 mg/g. Terpenoid compounds will bind to transmembrane proteins and cause structural changes because there is a strong bond between terpenes and these proteins. The binding of terpenes and trans membrane proteins causes protein can not work and cell wall permeability will decreases and bacterial growth is inhibited and causes cell

damage (Anuzar *et al*., 2022). The cell wall damage can cause the cell membrane damage and subsequently cause cell death.

Table 3. The Antibacterial Compound Derivatives Content of Flavonoids, Terpenoids, Phenols, Tannins and Alkaloids in Agung Banana Combs (*Musa Paradisiaca*)

No.	Compound	Composition (%)	Compound class
1.	Quercetin	1,54	Flavonoid
2.	Luteolin	1,35	Flavonoid
3.	Kaempferol	1,28	Flavonoid
4.	Isoquercetin	1,24	Flavonoid
5.	Rutin	0,79	Flavonoid
6.	Hyperoside	0,49	Flavonoid
7.	Stigmasterol	0,70	Terpenoid
8.	β-amyrin	0,59	Terpenoid
9.	Cycloeucalenol	0,59	Terpenoid
10.	Ferulic acid	1,27	Fenol
11.	p-coumaric acid	1,07	Fenol
12.	Caffeic acid	0,87	Fenol
13.	Chlorogenic acid	0,85	Fenol
14.	Vanillic acid	0,64	Fenol
15.	4-hydroxybenzaldehyde	0,18	Fenol
16.	Gallic acid	1,82	Tannin
17.	Apigenin	1,05	Tannin
18.	Piperidine-1-carbaldehyde	0,24	Alkaloid

Based on the results of research analysis carried out by researchers, it was proven that phenolic compounds had the highest levels of all compounds analysis with phenol levels in the bunches of 70.70 mg/g and phenol levels in the comb of 45.82 mg/g. Phenolic compounds have antibacterial activity by inhibiting enzyme activity in bacterial cells, thereby cause the cellular metabolic processes inhibition (Khairiah et al., 2020). Furthermore, it can cause obstacles to cellular metabolism and cause cell death.

Based on the research analysis results by researcher, it was proved that the levels of tannin compounds content in the bunches were 13.93 mg/g and the tannin content the comb were 12.60 mg/g. Tannins have antibacterial effect by inhibite the action of enzymes in the bacterial body and inhibiting the formation of polypeptides in cell walls (Khairiah et al., 2020). This fact also causes cellular metabolism and futhermore results in ATP decrease which causes bacteria growth and cell death.

Based on the research analysis results, it was proved that the alkaloid content was the smallest compound content among the others compounds. The content as 1.45 mg/g and the alkaloid content in the comb is 1.29 mg/g. Alkaloids have antibacterial activity because they can inhibite the peptidoglycan formation in bacterial cell walls which causes bacterial cell walls formation inhibition and cause damage (Anuzar et al., 2022).

Prospects of Bunches And Combs of Agung Bananas As Natural Antibiotic Ingredients

This research result proved that there are other benefits from the bunches and comb of the agung banana beside using as dessert fruit. The antibacterial compounds content in banana bunches and comb, besides being used to inhibit *E. coli* bacteria growth. The antibacterial content i.e: flavonoid, terepnoids, phenols, tannins, and alkaloids have potentially as anti-inflammatory, antioxidant and antifungal.

This research has succeeded proved the antibacterial effect of agung banana bunch and comb extract against *E. coli*. Similar further research can be carried out using agung bananas bunches and comb extracts against another bacteria besides *E. coli*. Another research that can also be carried out is by using another part of bananas plant besides the bunches and comb. The bunches and comb of agung bananas can be used as natural antibiotics and also useful for utilizing plant parts, it can also used to overcome this plant parts as pollutant in the enviroment.

CONCLUSION

Based on the research results and discussion, the following conclusions can be formulated: There is a positive influence of bunch extract on the growth inhibition of *E. coli* bacteria from various concentrations tested with the results of measuring the growth inhibition zone ranges from 0.60 ± 0.00 – 6.98 ± 0.00 mm. There was a positive effect of comb extract on the inhibition of the growth of *E. coli* bacteria from various concentrations, with the diameter of the inhibition zone ranging from 0.32 ± 0,78 – 6.55 ± 0.81 mm; The most effective concentration of bunch extract in inhibiting the growth of *E. coli* bacteria is 90% with the growth inhibition zone: 6.98 ± 0.00 mm and the most effective concentration of comb extract 80% with the growth inhibition zone: 6.55 ± 0.81 mm. The largest antibacterial compound content in the bunches is phenol, the content is: 70.70 mg/g and in the comb, namely phenol, the content is: 45.82 mg/g. The conclusion is the banana bunch and comb extract have antibacterial effect against the *E. coli* bacteria growth and and has the potential to be an antibacterial ingredient for health.

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