Pharmacogn J. 2024; 16(1): 255-262
A Multifaceted Journal in the field of Natural Products and Pharmacognosy
www.phcogj.com

Review Article

Antibacterial Potential of Durian (*Durio zibethinus* murr.) Waste as an Alternative Disinfectant in Raw Drinking Water - A Literature Review

Rahwan Ahmad[1,*], Ridwan Amiruddin[2], A.Arsunan Arsin[2], Stang Stang[3], Hasanuddin Ishak[4], Yahya Thamrin[5], Anwar Mallongi[4]

Rahwan Ahmad[1,*], Ridwan Amiruddin[2], A.Arsunan Arsin[2], Stang Stang[3], Hasanuddin Ishak[4], Yahya Thamrin[5], Anwar Mallongi[4]

[1]Doctoral Program, School of Public Health, Hasanuddin University, Makassar, INDONESIA.

[2]Department of Epidemiology, Faculty of Public Health, Hasanuddin University, Makassar, INDONESIA.

[3]Department of Biostatistics and Demographics, Faculty of Public Health, Hasanuddin University, Makassar, INDONESIA.

[4]Department of Environmental Health, Faculty of Public Health, Hasanuddin University, Makassar, INDONESIA.

[5]Department of Occupational Safety and Health, Faculty of Public Health, Hasanuddin University, INDONESIA.

Correspondence

Rahwan Ahmad

Doctoral Program, School of Public Health, Hasanuddin University, Makassar, INDONESIA.

E-mail: rahwan.ahmad@gmail.com

History

- Submission Date: 06-10-2023;
- Review completed: 12-12-2023;
- Accepted Date: 18-12-2023.

DOI : 10.5530/pj.2024.16.37

Article Available online

http://www.phcogj.com/v16/i1

Copyright

© 2024 Phcogj.Com. This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International license.

ABSTRACT

Efforts continue to be made to eliminate pathogenic bacteria in drinking water by using safer disinfection materials. The use of local plants as disinfection materials is highly desirable. The durian plant (Durio zibethinus) can be a very promising alternative as a natural disinfection agent to destroy pathogenic bacteria in drinking water. This narrative review comes from three online journal databases that provide free journal articles in PDF format, collected over the last ten years. The main keywords in conducting a literature review through online journals are "Durian, Durio Zibethinus, antibacterial, disinfectant, drinking water". Of the 5,693 journals identified in the three databases, 21 studies remained that met the requirements for inclusion in this review. This included study illustrates that fruit rind, seed, and leaf extracts from the durian plant have antimicrobial properties. Durian plants have antibacterial active compounds such as phenolics, alkaloids, steroids, saponins, tannins, flavonoids and triterpenoids. The antimicrobial potential tested using the diffusion and dilution method indicated that the presence of antimicrobial ingredients in the durian plant extraction was in the strong category. Some pathogenic bacteria in water that can be inhibited or killed are Escherichia coli, Pseudomonas aerugenosa, Bacillus subtilis, Bacillus cereus, Enterococcus faecalis, Staphilococcus aureus, Shigella boydii and Salmonella Typhi. This shows that there is an opportunity for the durian plant to provide a solution and great hope as a safe and economical alternative disinfection material as a replacement for current disinfection materials.

Index terms: Durian (Durio zibethinus), antibacterial, disinfectant, drinking water.

INTRODUCTION

Water is a basic need for life and existence, and is something that is essential for sustainable development. If water is handled well, it will become a stepping stone to achieving one of the Sustainable Development Goals (SDGs).[1] Sufficient and safe water is essential for health, achieving food security and eliminating poverty.[2] However, the decline in water quality is starting to take place. in the last few decades due to the development of industrialization and urbanization.[3] More than two billion people do not have the opportunity to get drinking water that is properly managed, and more than 4 billion people or half of the world's population do not have the opportunity to get sanitation that is managed properly.[2]

Diseases that are transmitted through water are a universal problem because more than two million deaths occur every year, including deaths due to diarrhea. Transmission of disease through water is caused, among other things, by consuming water that contains microbes. There are around 800 million people at risk of consuming polluted water and they do not have access to clean, drinkable water. Gram-negative bacteria such as E. coli cause diarrhea in babies, lower urinary tract infections, coleocystis or septicemia. [4]

The use of plant elements, better known as herbs, has been widely used as medicine since ancient times, becoming very popular nowadays because it is very cheap and very easy to obtain and has lower side effects compared to the use of synthetic chemicals.[5,6] Plants have various natural phytochemicals in the form of secondary metabolites which have antibacterial properties and can be used to help overcome health problems.[7] Secondary metabolites are organic compounds that can be produced by plants. Secondary metabolites in plants have several functions, including defense against viruses, bacteria and fungi.[8] The use of plants as disinfection agents in water treatment is very promising. This is because plants, whether leaves, fruit, seeds, fruit skin, stem bark or roots contain anti-bacterial ingredients such as phenols, quinones, flavonols, tannins, coumarins and alkaloids.[7,9] Phenolic compounds in plants have several biological effects, such as anti-bacterial properties. -inflammatory, antibacterial, and antioxidant. [10]

Durian plants have very abundant by-products or waste. In general, what durian lovers consume is the flesh or fruit coating, which is around 20 – 35% of the whole durian fruit. Meanwhile, the remaining 60 – 75% of the fruit skin and 5 – 15% of the seeds are not utilized and become waste.[11] Several studies have revealed that durian skin waste contains active secondary metabolites and is able to inhibit bacterial growth,[12–14] so that the use of durian plants such as fruit skin and seeds as an alternative disinfectant to replace chlorine or chlorine need to be considered.

Considering the fact that until now, the killing power of extracting durian plant waste as an antimicrobial agent in the water disinfection process is still unknown, research in this field is very important. This article reviews the current knowledge about the possibility of using durian plant extracts as raw water disinfection materials for drinking water.

Cite this article: Ahmad R, Amiruddin R, Arsin AA, Stand S, Ishak H, Thamrin Y, Mallongi A. Antibacterial Potential of Durian (*Durio zibethinus* murr.) Waste as an Alternative Disinfectant in Raw Drinking Water - A Literature Review. Pharmacogn J. 2024;16(1): 255-262.

METHOD

In conducting this literature review, the literature sources used were mainly online journal databases that provide free journal articles in PDF format, such as: ProQuest, Elsevier and Google Scholar. However, to keep the information up to date, the information used is mainly from literature collected within the last ten years.

The procedure for conducting a literature review is carried out systematically and coherently, starting with collecting study sources and information based on predetermined topics. The main keywords in conducting a literature review through online journals are "Durian, Durio Zibethinus, antibacterial, disinfectant". Of the 5,693 journals identified in the three databases, there were 380 duplicate journals and 1,695 journals that were not related to the topic at all. Furthermore, of the 3,618 journals remaining after limiting the year of journal publication in the last ten years, a total of 2,520 journals were released leaving 1,098 journals remaining. Of this number relating to durian and antibacterials, 840 journals were excluded that did not have open access status. So the remaining 258 journals. Of the remaining 258 journals, a review of the abstracts was carried out and only journals were taken that were related to the use of durian plants as an anti-bacterial, so that 237 journals were released consisting of review journals and journals related to processed durian food products and durian farming. So there are 21 journals left that will be read in full-text.

RESULTS

Secondary metabolite compounds are active compounds found in plants which have the ability to inhibit or kill bacteria.[15] Table 1 shows the findings of several relevant studies related to durian plant parts such as fruit skin, fruit flesh, seeds and leaves which have secondary metabolite compounds which can used as antibacterial ingredients such as phenolics, alkaloids, steroids, saponins, tannins, flavonoids and triterpenoids. Of the 21 studies highlighted in this paper, there were 15 studies that clearly looked at secondary metabolite content. Of the 15 studies, 13 studies were conducted qualitatively and 2 studies were conducted both qualitatively and quantitatively.

Table 2 shows that of the 21 relevant study findings on several parts of the durian plant, there were 17 studies that clearly observed the effect of several parts of the durian plant on the inhibitory or killing power of pathogenic bacteria and LC50. A total of 14 studies looked at the inhibitory power of durian plant extracts against bacteria, 6 studies looked at the MIC (Minimum Inhibitory Concentration) and MBC (Minimum Bactericidal Concentration), and 2 studies looked at the LC50 (Lethal Concentration 50) of durian plant extracts.

Table 3 shows several relevant studies on several parts of the durian plant which contain antibacterials and can be used as a disinfection agent in water. Of the 21 studies, there were 16 studies that looked at durian skin, 3 studies at durian leaves, one study looked at three components at once, namely skin, seeds and flesh of durian fruit and one study at durian seeds. This research found that several pathogenic bacteria in water that could be inhibited or killed by using extraction of natural ingredients from the durian plant were Escherichia coli, Pseudomonas aerugenosa, Bacillus subtilis, Bacillus cereus, Enterococcus faecalis, Staphilococcus aureus, Shigella boydii and Salmonella Typhi.

DISCUSSION

Secondary metabolites in durian plants

Self-defense mechanisms were developed by plants to protect themselves from predators and various microorganisms that attack them. Around 200,000 secondary metabolites are produced throughout the plant world, and are believed to be used for self-defense from various disorders arising from the surrounding environment.[38] Secondary metabolite compounds are active compounds found in plants that have antibacterial and anti-cancer abilities, making them very valuable for humans.[15,39] Secondary metabolites such as phenolics,

Table 1. Relevant studies regarding parts of the Durian plant (*Durio zibethinus*) containing secondary metabolite compounds that can inhibit and kill pathogenic bacteria in water.

Plant parts	Extraction material	Secondary Metabolite Content	Ref
Durian skin	By boiling/heating	There are phenols, alkaloids, tannins, flavonoids and triterpenoids	16
Durian skin	Heating At temperatures of 380°C and 340°C	At 380 °C, Phenol 1.73 wt.% and acetic acid 8.51wt.%), At 340 °C, phenol 0.79% and acetic acid 3.40% by weight	17
Durian skin	Extraction with 96% ethanol	There are flavonoids, phenolics, alkaloids and tannins	18
durian skin	Extraction using 96% ethanol	There are flavonoids, alkoloids, saponins and tannins, (Terpenoids are negative)	19
Durian skin	Extraction using 96% ethanol,	There are alkaloids, saponins and triterpenoids (flavonoids, phenols and negative tannins)	20
Durian skin	96% ethanol extract	There are flavonoids, alkaloids, saponins, tannins and triterpenoids	21
Durian skin	Rinse with 70% methanol and boil	There are flavonoids, tannins and triterpenoids, as well as lignin, cellulose and pectin	22
Durian skin	The skin is rinsed with 70% methanol, boiled with 200 mL of water	There are polyphenols, tannins, flavonoids	23
durian skin	Macerated with 96% ethanol. 3 x 24 hours	There are alkaloids, flavonoids, saponins, phenols and tannins.	24
durian skin and ore	Extracted using 80% methanol. with a ratio of 1:10	Total phenolics = 205.16 to 3.86 mg GAE/g and Total flavonoids = 375, 93 to 0.28 mg QE/g	25
durian leaf and skin	Using 70% ethanol solvent as much as 2500 ml for 72 hours	There are flavonoids, saponins, steroids and tannins	26
durian skin	Uses 96% ethanol and 96% methanol	There are alkaloids, flavonoids, phenols, saponins and tannins, (negative for steroids and triterpenoids)	27
Durian leaf	Extraction was carried out using a percolation procedure with 70% ethanol solvent.	There are alkaloids, flavonoids, steroids and phenols (negative saponins and tannins)	28
Durian skin	Extraction with 96% ethanol, then successive fractionation with n-hexane, chloroform, ethyl acetate and methanol as solvents.	There are quinones, flavonoids, tannins, alkaloids, steroids and triterpenoids in the extract (alkaloid negative in powder/simplisia)	29
Durian skin	Metanol, etanol, etil asetat	There are terpenoids, steroids, flavonoids, phenolics and tannins (negative alkaloids and saponins)	13
Durian skin	Uses etanol 96%	There are flavonoids, saponins, tannins and alkaloids	30

Tabel 2. Bukti bagian tanaman Durian (*Durio zibethinus*) dengan Aktifitas antimikroba dan LC50 terhadap bakteri pathogen pada air.

Plants Part	Method	Antimicrobial activity and LC 50	Ref
Durian skin	In vitro experimental research with a post-test only experimental design group, using Klebsiella pneumonia bacteria as the study object.	MIC = 0,39% dan 0,20%	16
Durian skin	lab experimental research. Dried durian skin is heated and distilled to separate the liquid smoke.	Konsentrasi 3% selama 42 jam	17
Durian skin	Research Lab experiments. By drying the durian skin, it is crushed and then extracted.	Konsentrasi 5% dengan daya hambat 5 – 10 mm	18
durian skin	lab experimental research. Photochemical tests for secondary metabolites were carried out 3 times, and antibacterial activity was tested using the disc digestion method.	*S.thypi* konsentrasi 35% (14,75 mm) *B.creus* konsentrasi 35% (25 mm)	19
Durian skin	Lab experimental research. Durian culture extract using the maceration method for 24 hours using ethanol solvent. antibacterial activity test using the disc diffusion method.	*E.coli* konsentrasi 5% (12,6 mm) *S.aureus* 5% (11,8 mm)	20
Durian skin	Lab research. Antibacterial activity was tested using Mueller Hinton agar media using the Kirby-Bauer disk diffusion method	*Enterococcus faecalis* 25% (1,69 mm)	21
Durian skin	Lab research. To reduce silver nitrate, an aqueous extract from D.zibethinus skin with 70% methanol was used to become silver nanoparticles.	(*S. typhi* 9 mm), (*E.coli* 10 mm) dan (*S. aureus* 10 mm). MIC *S.hemolitikus, B.subtilis* dn *E.coli* (4 mg/mL) sedang *S.typhimurium* dan *S.typhi* (2 mg/mL)	22
Durian skin	Lab experiments. To obtain ZnO NPs, 5 mL of durian peel extract was placed in a zinc acetate solution at room temperature. Add sufficient 2M NaOH solution.	*E.coli* dan *S.aureus* pada zona hambat 20 dan 21 mm. MIC 500 µg/mL, tabung terlihat jernih tidak ada pertumbuhan bakteri untuk bakteri *E.coli* dan *S.aureus*	23
Durian skin	Lab Test. The durian skin is cleaned of the thorns, then cut into small pieces and dried in the sun until completely dry, and made into powder.	LC 50 = 7,76%	24
Durian seeds	Lab experiments. Durian seeds cut into small pieces. Soaked and rinsed with methanol and dried at room temperature. Boiled, filtered and centrifuged for 15 minutes.	4 mg/mL E. coli 7 ± 0.22 mm, S. typhi 7 ± 0.20 mm, S. aureus 8 ± 0.13 mm LC 50 = 3,03 mg/mL (3030 mg/L)	31
durian leaves	Lab experiments. By extracting durian leaves, the simplicia was weighed 500g, then macerated using 2500 ml of 70% ethanol for 72 hours.	Konsentrasi 40% pelarut aqua destilasi sebesar 8,33 mm, pelarut etil asetat sebesar 6,67 mm	26
durian skin	Lab experiments. By extracting the white inner part of the durian skin, 200 grams of simplicia were dissolved in 800 ml each with 96% ethanol and methanol solvent.	Pelarut etanol 96% dan methanol 96% memiliki MIC sebesar 25%	27
durian leaves	Lab experiments. The samples were cut into small pieces. Endophyte isolation was carried out according to the method with slight modifications. Surface sterilization and followed by immersion in 70% ethanol and continued by immersion in 95% ethanol	250 mg/mL *S.aureus* 10,3 ± 0,58 *E.coli* 8.0±0.58, *P.aerugenosa* 8.6±1.00. MIC dan MBC masing masing tertinggi adalah pada 250 g/mL dan 500 g/mL, sedang untuk *B.subtilis* dan *S.aureus* pada MIC 250 g/mL	32
	Lab experiments. The collected Durio Zibethinus L. was rinsed with running water and dried in the sun for no less than 2 days, to avoid chemical decomposition. After drying, the leaves are ground with a Waring Blender.	0,25 mg/mL *S.aureus* 3.0±1.00, *E.coli* 12.0±1.00 *P.aerugenosa* 11.2±0.76. MIC pada bakteri gram-negatif, tertinggi 0,1 mg/ml dan MBC 0,25 mg/ml sedang pada bakteri *P.aerugenosa* dan *E.coli* MIC 0,1 mg/ml	28
durian leaves	Lab experiments. The extraction process uses the maceration method. Durio zibethinus skin was macerated with ethanol solvent for 24 hours. The filtrate obtained was concentrated using a rotary evaporator.	Pada konsentrasi 1% *S.aureus*, fraksi etil asetat 10.65±0.14 mm, *E.coli* fraksi etil asetat 10.35±0.07 mm	29
Durian skin	Experimental research carried out in the lab. By extracting durian skin with three types of solvents, namely methanol, ethanol and methyl acetate.	Konsentrasi 100%, Methanol, 14,67 ± 1,54 mm, Etanol, 15,08 ± 0,96, Etil asetat, 18,89 ± 1,67	13
Durian skin	Lab experiments. By extracting durian skin, then using concentrations of 5%, 10%, 20%, 30% as well as control (+) using baygon spray and control (-) with distilled water with three repetitions	kematian *kecoa amerika* tertinggi terdapat pada konsentrasi 30%. nilai LC50 sebesar 2,63x105 ppm	30

Table 3. Relevant studies regarding parts of the Durian plant (*Durio zibethinus*) containing antibacterial compounds that can kill various pathogenic bacteria in water.

Authors and year	Plants part	Target Bactery	Findings	Ref
A Amanah et al. (2019)	Durian skin	*klebsiella pneumonia*	By using polysaccharide and ethanol extracts, durian peel can be used as an anti-bacterial agent	16
Faisal Muhammad, et al. (2019)	Durian skin	*Escherichia coli* dan *Stafilococcus aureus*	Grade 1 liquid smoke on durian skin can be used as an antibacterial for the pathogens Escherichia coli and Staphylococcus aureus	17
Fitrianingsih F, et al. (2019)	Durian skin	*Propionibacterium acne*	Dried durian skin extracted with 96% ethanol can be used as an antibacterial with bacteriostatic properties	18
Jamal, Kurnia Putri, et al. (2019)	durian skin	*Salmonella typhi* dan *Bacillus cereus*	Durian skin extracted with 96% ethanol can inhibit the growth of pathogenic bacteria Salmonella typhi and Bacillus cereus	19
Arlofa Nina, et al. (2019)	Durian skin	*Escherichia coli, Salmonella typhosa* dan *Staphylococcus aureus*	Durian skin extracted with 95% ethanol can inhibit the growth of pathogenic bacteria and can be applied as a disinfection agent for the skin/ hands	20
Ghaffar Mufti, et al. (2019)	Durian skin	*Escherichia coli* dan *Staphylococcus aureus*	Durian peel powder extracted with 95% ethanol can be used as an antibacterial agent for Escherichia coli and Staphylococcus aureus pathogens.	33
Rizky, et al. (2020)	Durian skin	*Enterococcus faecalis*	96% ethanol extract of durian peel has antibacterial activity against Enterococcus faecalis namul in the weak category	21
Samuggam Sumitha, et al. (2019)	Durian skin	*Escherichia coli, Salmonella typhi, Stafilokokus aureus,* dan *Bacillus subtilis*	It can be used against human pathogens as a potential therapeutic agent and in wastewater purification.	22
Ravichandran et al. (2020)	Durian skin	*Escherichia coli* dan *stafilococcus aureus*	Durian skin extract with nanoparticles can be used against human pathogens	23
Payus C.M et al. (2021).	Durian skin	*Kesadahan Air*	Durian skin can also be used as an absorbent in water treatment, especially in reducing water hardness.	34
Masturi M, et al. (2019).	Durian skin	Kandungan Flavonoid total	Rough results of all methods shows that local Indonesian durian skin contains flavonoid compounds that can be extracted or even isolated in the future.	35
Arrizqiyani T, et al. (2019),	Durian skin	larva aedes aegypti	The content of secondary metabolite compounds in durian skin can be used as a larvicide for the Aedes aegypti mosquito	24
Chutrakulwon Fueangfahkan g, et al. (2020).	Durian skin	Aktivitas antimikroba	Durian peel extract silver nanoparticles can be applied in various fields such as antimicrobial activity, biosensors, and catalysis. and efficient alternative approaches to waste processing	36
Juarah N. et al. (2020)	durian skin, seeds and flesh	aktivitas antioksidan, kandungan total fenolik dan flavonoid total	Because the phenolic content is found to be higher in the peel, durian peel can be used as an antibacterial ingredient	25
Sumitha Samuggam , et al. (2018).	Durian seeds	*Stapylococcus aureus*, *Bacillus subtilis* dan Gram negatif *Salmonella typhi* dan *Escherichia coli*.	Silver nanoparticles (DSAgNPs) water extract from durian seeds (Durio zibethinus) can be used in the fields of water treatment, pharmaceuticals,	31
Choirul Huda et al. (2019)	Durian leaves	*Escherichia coli ATCC 25922*	Durian leaves have antibacterial activity and show the most optimum inhibitory response with an average inhibitory zone diameter of 8.33 mm against Escherichia coli.	26
R.Calyptranti et al. (2022)	durian skin	*Salmonella typhi*	96% ethanol extract of durian peel can inhibit Salmonella typhi bacteria at a concentration of 25% and 96% methanol extract of durian peel can inhibit Salmonella typhi bacteria at a concentration of 10%.	37
Chigurupati Sridevi, et al. (2018).	Durian leaf	*Bacillus subtilis, Enterococcus faecalis, Pseudomonas aeruginosa dan Escherichia coli*	The antimicrobial activity of endophytes in Durio zibethinus leaves is capable of producing bioactive agents with pharmaceutical potential and may provide new clues in pursuing new biological sources of drug candidates.	32
Chigurupati Sridevi , et al. (2017)	Durian leaf	*Stafilokokus aureus, Pseudomonas aeruginosa,* dan *Escherichia coli*	Durian leaves can be an antibacterial agent for human pathogens.	28
Anggraeni Eka Vany , et al. (2016).	durian skin	bakteri *Escherichia coli,* dan bakteri *Staphylococcus aureus*	Antimicrobial activity test of durian peel ethanol extract with ethyl acetate fraction, can be used as an antibacterial agent for human pathogens	29
Pratiwi M. M. et al. (2019)	Durian skin	*Propiniobacterium acnes*	Ethyl acetate extract of durian peel (D. zibethinus Murr.) is the most effective extract for inhibiting the growth of the test bacteria P. acnes	13

alkaloids, steroids, saponins, tannins, flavonoids and triterpenoids have shown their efficacy in destroying pathogenic microorganisms.[39,40] It is estimated that around 1,260 types of plants have medicinal properties. One of the compounds that acts as a medicine in plants is the secondary metabolite content.[41] The findings in this literature review show that several parts of the durian plant such as leaves, fruit skin and seeds have secondary metabolite compounds such as flavonoids, alkaloids, saponins, triterpenoids, tannins, polyphenols, steroids and phenolics which can very likely be used as alternative disinfectants to kill bacteria. pathogens in water. The content of secondary metabolite compounds in durian plants shows that durian fruit skin has antimicrobial activity.[42] By using several types of solvents, extracts from durian leaves were found to contain several secondary metabolite compounds such as alkaloids, steroids and terpenoids.[43] We have obtained several research results in the last 10 years. The durian plant shown in table 1 shows the phytochemical screening process to determine the secondary metabolite content using several types of solvents and methods in the extraction process. The form of extraction of durian

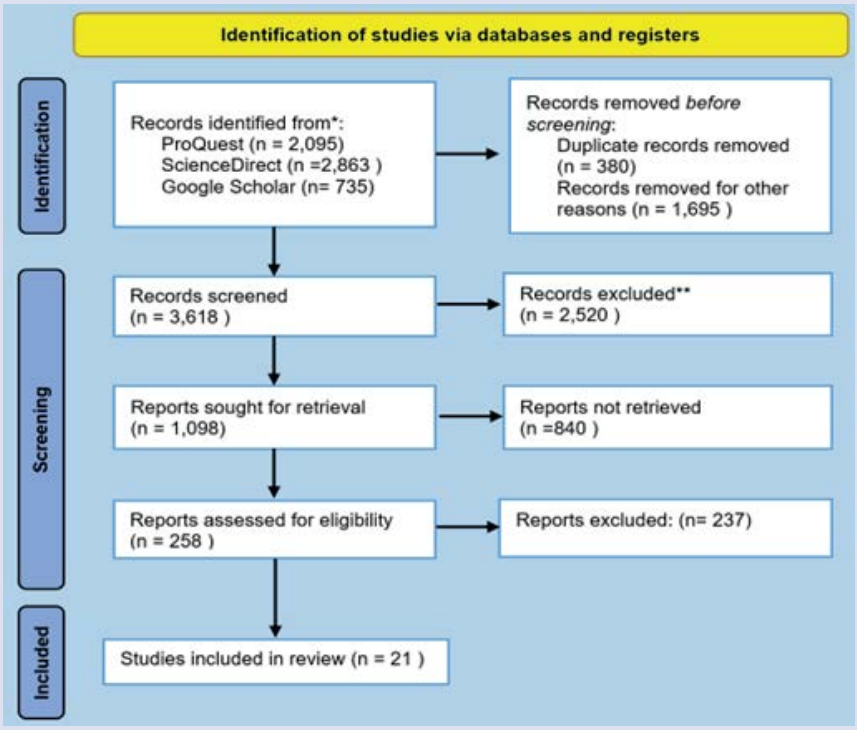

Figure 1. Literature search flow. Antibacterial potential of durian plant waste (*Durio zibethinus* murr.) as an alternative disinfectant in raw water.

skin with cold extraction using solvents such as ethanol, methanol and ethyl acetate with concentrations of 70, 90 and 96%, is most widely used by researchers. Meanwhile, extraction by heating or boiling, as in research conducted by A Amanah et al. (2019) [16] found the presence of secondary metabolites in durian skin such as phenols, alkaloids, tannins, flavonoids and triterpenoids, while research conducted by Faisal Muhammad, et al. (2019) [17] by heating at temperatures of 380°C and 340°C, there is phenol and acetic acid content in durian skin.

Antimicrobial activity and LC50 in durian plants

The purpose of the antimicrobial activity test is to determine the potential of a material or compound to have antimicrobial activity on bacteria. The methods used in each antimicrobial test are the diffusion and dilution methods.[44] The diffusion methods that are often used by researchers are the disc diffusion method, the well method [45] and the antimicrobial gradient method.[46] The disc diffusion method or well diffusion method is the measurement of the clear zone area that appears in the area. around the paper disc or well and is useful for determining the inhibition zone or antimicrobial activity.[47] The inhibition zone is the clear area around the disc or around the well of the bacterial growth medium where no bacterial growth is found. The diameter of the inhibition zone is measured using a measuring instrument such as a vernier caliper.[48] Observations on the media containing the test bacteria are carried out after 24 hours of incubation. The diameter of the inhibition zone or clear zone around the disc paper is the sensitivity of bacteria to the antibacterial material placed on the disc paper, which is used as a test material and is declared as the inhibition zone.[49]

Of the 17 studies that made antimicrobial observations as shown in table 2, there were 14 studies that made observations using the diffusion method. Research conducted by Fitrianingsih F, et al. (2019),[18] found the bacterial inhibitory value of 5% durian skin extract to be 5 to 10 mm. This value is a relatively strong inhibitory value, so it can be said that durian peel extract is very likely to be used as an antimicrobial agent. Likewise, observations made by Anggraeni Eka Vany, et al. (2016),[29] found the bacterial inhibitory value of 1% durian skin extract with the ethyl acetate fraction for S.aureus bacteria, was 10.65 ± 0.14 while the ethyl acetate fraction for E. coli bacteria was 10.35 ± 0.07

Meanwhile, the dilution method used by researchers is the broth dilution method and agar dilution method.[50] The liquid dilution method is used by researchers to measure the minimum inhibitory concentration of bacteria or commonly called Minimum Inhibitory Concentration (MIC) and solid dilution or agar dilution is used to measure bacteria killing power or Minimum Bactericidal Concentration (MBC). Liquid dilution is carried out by making a series of dilutions of antimicrobial agents in a liquid medium containing the test microbes. Meanwhile, solid dilution is carried out by inoculating the test microbes on agar medium containing antimicrobial ingredients.[51]

Of the 17 studies that made antimicrobial observations on durian plants as shown in table 2, there were 6 studies that made observations using the dilution method. Research conducted by Chigurupati Sridevi, et al. (2017)[28] on durian leaf extract, found that the MIC for gram-negative bacteria was the highest at 0.1 mg/ml and the MBC was 0.25 mg/ml while the MIC for P.aerugenosa and E.coli bacteria was 0.1 mg/ml. . as well as research by Chigurupati Sridevi, et al. (2018)32 on durian leaf extract found that the MIC and MBC of several types of pathogenic bacteria were the highest at 250 g/mL and 500 g/mL, while for B.subtilis and S.aureus the MIC was 250 g/mL.

LC50 is a dose or concentration given once or several times in 24 hours to an animal that is statistically expected to kill 50% of the test animals. The use of test animals in the form of Artemia salina Leach shrimp, is the Brine shrimp lethaly test (BSLT) method which can be used as a simple bioassay to examine the acute toxicity of a compound, by determining the LC50 value used from the active components of the plant.[52] Of the 17 studies conducted antimicrobial observations on durian plants as shown in table 2, there were 3 studies that carried out the LC50 test, namely research conducted by D. Wahyuni, R. Muktitama, (2019)[30], using durian skin as an extract material found, the percentage of deaths of American cockroaches The highest concentration was 30% with a death rate of 61.11% with an LC50 value of 2.63x105 ppm. Likewise,

research conducted by Sumitha Samuggam, et al. (2018)[31] using durian seeds found that LC 50 = 3.03 mg/mL (3030 mg/L). as well as research conducted by Arrizqiyani T, et al. (2019)[24] using durian peel extract found that the LC50 of durian peel (Durio zibethinus murr) extract for the death of Aedes aegypti mosquito larvae was 7.76%.

Parts of the durian plant act as antibacterial pathogens

Durian fruit skin

Fruit peels usually become rubbish and are thrown away. However, parts of some plants contain many antibacterial compounds that can be utilized. Like durian (Durio zibethinus), the skin of the fruit contains antibacterial compounds.[53] As can be seen in table 3, the results of research conducted by Arlofa et al., 2019[20] found antibacterial content in durian skin such as alkaloids, saponins and triterpenoids which can inhibit the growth of pathogenic bacteria such as Escherichia coli, Salmonella typhosa and Staphylococcus aureus and as a disinfection agent.[54] Likewise, research conducted by Jamal, 2019[19] contained secondary metabolites such as flavonoids, alkoloids, saponins and tannins which can inhibit pathogenic bacteria such as Salmonella typhi and Bacillus cereus.[55] Samuggam Sumitha et al., 2022[22] conducted antibacterial tests on durian skin and found that it contained flavonoids, tannins and triterpenoids, as well as lignin, cellulose and pectin which can be used against pathogens such as Escherichia coli, Salmonella typhi, Staphylococcus aureus, and in waste water purification. Durian skin antibacterial tests conducted by Anggraeni and Anam, 2016[29] and Ravichandran et al., 2020[23] found that durian skin extract can be used as an antibacterial for human pathogens such as Escherichia coli and Staphylococcus aureus bacteria. There was inhibition of the growth of Eschercia Coli and Stapilococus Aureus bacteria on durian skin according to the results of research conducted by R. Calyptranti et al. (2022)[37,56] and Muawanah, et al., 2019[12].

Durian seeds

Apart from the fruit skin, the antibacterial compounds of the durian plant (Durio zibethinus) are also found in the seeds. With the antibacterial compounds in durian seeds, there is a great opportunity to be used as a disinfection agent to reduce or even eliminate pathogenic bacteria in water. Antibacterial tests using durian seeds carried out by Sumitha et al., 2018[31] found that they contain secondary metabolites such as flavonoids, tannins and polyphenols which can kill pathogenic bacteria in drinking water such as Stapylococcus aureus, Escherichia coli, so they can be used in the water treatment sector, pharmaceuticals, and nanotechnology.[57]

Durian leaves

There are many benefits found in durian leaves for body health. The chlorophyll and fiber content in durian leaves can help you lose weight. If consumed regularly it will help improve the immune system, the body will be less susceptible to disease because adequate nutrition can build the body's immunity. Research conducted by Chigurupati et al, 2018[32] found that the antimicrobial activity of endophytes in Durio zibethinus leaves is capable of producing bioactive agents and contains secondary metabolite compounds in the form of alkaloids, flavonoids and phenols. Likewise, the results of research by Chigurupati et al., 2017[28] which found that durian leaves contain compounds such as alkaloids, flavonoids, saponins, steroids and phenols and can be an antibacterial agent for human pathogens, especially Escherichia coli bacteria. These bacteria are pathogenic bacteria in drinking water.[58]

CONCLUSION

In short, this review shows that the natural ingredients of the durian plant (Durio zibethinus) have antibacterial compounds such as flavonoids, alkaloids, saponins, triterpenoids, tannins, polyphenols, steroids and phenolics, which play an important role in inhibiting and even killing pathogenic bacteria, not only in Escherichia coli bacteria, but also several other pathogenic bacteria such as Pseudomonas aerugenosa, Bacillus cereus, Staphilococcus aureus, and Salmonella Typhi. This type of bacteria is a bacteria that causes health problems which is also always found in water and causes a decrease in water quality. Even though research using natural ingredients from the durian plant in water disinfection is still very rare, the potential antibacterial compounds in the durian plant can provide a solution and great hope as a safe and economical alternative disinfection material to replace current disinfection materials.

REFERENCES

1. Lisa Guppy; kelsey Anderson; Mehta; P.; Nagabhatla; N. and, M. Q. Global Water Crisis : the Facts. Published online 2017:1-3. http://inweh.unu.edu
2. Boyd D. The global water crisis and human rights global water crisis. *United Nations Hum Rights Spec Proced*. Published online 2021.
3. Chen W, Gu Y, Xu H, Liu Z, Lu C, Lin C. Variation of microbial communities and functional genes during the biofilm formation in raw water distribution systems and associated effects on the transformation of nitrogen pollutants. *Environ Sci Pollut Res*. 2017;24(18):15347-15359. doi:10.1007/s11356-017-9125-z
4. Ibrahim Al Ahadeb J. Impact of Cinnamomum verum against different Escherichia coli strains isolated from drinking water sources of rural areas in Riyadh, Saudi Arabia. *J King Saud Univ - Sci*. 2022;34(2):101742. doi:10.1016/j.jksus.2021.101742
5. Mphuthi DD, Husaini DC. Traditional medicinal plants used by hypertensive patients in Belize: a qualitative evaluation of beliefs and practices. *Bull Natl Res Cent*. 2022;46(1). doi:10.1186/s42269-022-00789-x
6. Singh R. Pharmacological screening of heartwood of Tectona grandis Linn.for antibacterial activity by Agar-Well Diffusion method. *IOP Conf Ser Mater Sci Eng*. 2022;1221(1):012019. doi:10.1088/1757-899x/1221/1/012019
7. Yi Xin L, Hui Min T, Nur Liyana Mohd Zin P, Pulingam T, Nelson Appaturi J, Parumasivam T. Antibacterial potential of Malaysian ethnomedicinal plants against methicillin-susceptible Staphylococcus aureus (MSSA) and methicillin-resistant Staphylococcus aureus (MRSA). *Saudi J Biol Sci*. 2021;28(10):5884-5889. doi:10.1016/j.sjbs.2021.06.036
8. Anggraito YU, Susanti R, Iswari RS, et al. *Metabolit Sekunder Dari Tanaman : Aplikasi Dan Produksi.*; 2018.
9. Adeeyo AO, Edokpayi JN, Alabi MA, Msagati TAM, Odiyo JO. Plant active products and emerging interventions in water potabilisation: disinfection and multi-drug resistant pathogen treatment. *Clin Phytoscience*. 2021;7(1). doi:10.1186/s40816-021-00258-4
10. Kadir DH. Statistical evaluation of main extraction parameters in twenty plant extracts for obtaining their optimum total phenolic content and its relation to antioxidant and antibacterial activities. *Food Sci Nutr*. 2021;9(7):3491-3499. doi:10.1002/fsn3.2288
11. Sisanto, Yuwana, Sulistyowati E. Utilization of Durian (Durio zibethinus Murr) Seeds by- Product as a Stabilizer of Dairy Cow Milk Ice Cream. *J Sain Peternak Indones*. 2017;12(1):9-23.
12. Muawanah N, Jaudah H, Ramadhanti TD. Pemanfaatan Limbah Kulit Durian sebagai Anti Bakteri pada Sabun Transparan. *Semin Nas Sains dan Teknol*. Published online 2019:1-10.
13. Pratiwi M., Kawuri R, Ardhana IP. Potensi antibakteri limbah kulit durian (Durio zibethinus Murr .) terhadap Propionibacterium acnes penyebab jerawat Antibacterial potency from the waste of durian rind (Durio zibethinus Murr .) against Propionibacterium a cnes that causing acnes. *J Biol Udayana*. 2019;23(1):8-15.
14. Arlofa N. Uji kandungan senyawa fitokimia kulit durian sebagai bahan aktif pembuatan sabun. *J Chemtech*. 2015;1(1):18-22.

15. Fitriah F, Mappiratu M, Prismawiryanti P. Uji Aktivitas Antibakteri Ekstrak Daun Tanaman Johar (Cassia Siamea Lamk.) Dari Beberapa Tingkat Kepolaran Pelarut. *Kovalen*. 2017;3(3):242. doi:10.22487/j24775398.2017.v3.i3.9333

16. Amanah A, Pratamawati TM, Taslimah M, Primanagara R. Potential polysaccharide gel from Durio zibethinus var.Raja galuh rind extract towards Klebsiella pneumoniae bacteria. *J Phys Conf Ser*. 2019;1146(1):1-8. doi:10.1088/1742-6596/1146/1/012029

17. Faisal M, Gani A, Mulana F. Preliminary assessment of the utilization of durian peel liquid smoke as a natural preservative for mackerel [version 1; peer review: 1 not approved]. *F1000Research*. 2019;8. doi:10.12688/F1000RESEARCH.18095.1

18. Fitrianingsih F, Soyata A, Wigati S. The Antibacterial Activities of Durian Rinds Extract (Durio Zibethinus) Against Propionibacterium acne. *IOP Conf Ser Earth Environ Sci*. 2019;391(1). doi:10.1088/1755-1315/391/1/012013

19. Jamal KP. Antibacterial Activities Of Ethanol Extracts Of Durian Fruit Skin (Durio Zibethinus Murr.) On Salmonella Bacteria In Atcc 14028 And Bacillus Cereus Atcc 11778 Cause Of Diarrhea. *Indones J Pharma Sci*. 2019;1(1):1-6. https://online-journal.unja.ac.id/IJPS/article/view/7287

20. Arlofa N, Ismiyati I, Kosasih M, Fitriyah NH. Effectiveness of Durian Peel Extract as A Natural Anti-Bacterial Agent. *J Rekayasa Kim Lingkung*. 2019;14(2):163-170. doi:10.23955/rkl.v14i2.14275

21. Rizky A, Anastasia D, Merdekawati LE. The Potential Antibacterial Power of Ethanol Extract of Durian Peel (Durio zibethinus murr) Against Enterococcus faecalis. *Sjd*. 2020;1(1):1-12.

22. Samuggam Sumitha SV, , Sivadasan Shalini , Suresh V. Chinni SCBG, Sathasivam Kathiresan PA, Ravichandran V. Durio zibethinus Rind Extract Mediated Green Synthesis of Silver Nanoparticles: Characterization and Biomedical Applications. *Pharmacogn Mag*. 2022;13 (Suppl(62):179-188. doi:10.4103/pm.pm

23. Ravichandran V, Sumitha S, Ning CY, et al. Durian waste mediated green synthesis of zinc oxide nanoparticles and evaluation of their antibacterial, antioxidant, cytotoxicity and photocatalytic activity. *Green Chem Lett Rev*. 2020;13(2):102-116. doi:10.1080/17518253.2020.1738562

24. Arrizqiyani T, Hidana R, Sopian MA, Nurpalah R, Meri. LC 50 of Rind Durian (Durio zibethinus murr) Extract to Mortality of Aedes aegypti Larvae. *J Phys Conf Ser*. 2019;1179(1):1-6. doi:10.1088/1742-6596/1179/1/012174

25. Juarah N, Surugau N, Rusdi NA, Abu-Bakar MF, Suleiman M. Phytochemical content and antioxidant properties of Bornean wild durian from Sabah. *IOP Conf Ser Earth Environ Sci*. 2021;736(1):1-11. doi:10.1088/1755-1315/736/1/012030

26. Huda C, Putri AE, Sari DW. Uji Aktivitas Antibakteri Fraksi Dari Maserat Zibethinus Folium Terhadap Escherichia Coli. *J SainHealth*. 2019;3(1):7. doi:10.51804/jsh.v3i1.333.7-14

27. Sivananthan M, Elamaran M. In vitro evaluation of antibacterial activity of chloroform extract Andrographis paniculata leaves and roots , Durio zibethinus wood bark and Psidium guajava leaves against selected bacterial strains Department of Biomedical Science, Faculty of Biomedici. *Int J Biomol Biomed*. 2013;3(1):12-19.

28. Chigurupati S, Mohammad JI, Vijayabalan S, Vaipuri ND, Selvarajan KK, Nemala AR. Quantitative estimation and antimicrobial potential of ethanol extract of Durio Zibethinus Murr. Leaves. *Asian J Pharm Clin Res*. 2017;10(9):251-254. doi:10.22159/ajpcr.2017.v10i9.19767

29. Anggraeni EV, Anam K. Identifikasi Kandungan Kimia dan Uji Aktivitas Antimikroba Kulit Durian (Durio zibethinus Murr.). *J Kim Sains dan Apl*. 2016;19(3):87-93.

30. Wahyuni D, Muktitama RE. Uji Mortalitas Kecoa Amerika (Periplaneta americana) Menggunakan Ekstrak Kulit Durian (Durio zibethinus Murr). *Phot J Sain dan Kesehat*. 2019;9(2):9-18. doi:10.37859/jp.v9i2.1353

31. Sumitha S, Vasanthi S, Shalini S, et al. Phyto-mediated photo catalysed green synthesis of silver nanoparticles using Durio zibethinus seed extract: Antimicrobial and cytotoxic activity and photocatalytic applications. *Molecules*. 2018;23(12). doi:10.3390/molecules23123311

32. Chigurupati S, Marri MR, kumar A, et al. Bacterial Endo-Symbiont Inhabiting Durio zibethinus leaves and their Antibacterial Potential. *Int J PharmTech Res*. 2018;11(3):198-205. doi:10.20902/ijptr.2018.11301

33. Ghaffar M, Kusumaningrum H, Suyatma N. Extraction of Pectin from Durian Rind and Its Minimum Inhibitory Concentration towards Staphylococcus Aureus and Escherichia Coli. *SEAFASTInternational Semin (2nd*. Published online 2020:72-76. doi:10.5220/0009978600720076

34. Payus CM, Refdin MA, Zahari NZ, et al. Durian husk wastes as low-cost adsorbent for physical pollutants removal: Groundwater supply. *Mater Today Proc*. 2019;42:80-87. doi:10.1016/j.matpr.2020.10.006

35. Masturi M, Alighiri D, Edie SS, et al. Identification of flavonoid compounds and total flavonoid content from biowaste of local durian shell (Durio zibethinus). *J Phys Conf Ser*. 2020;1567(4):1-11. doi:10.1088/1742-6596/1567/4/042084

36. Chutrakulwong F, Thamaphat K, Limsuwan P. Photo-irradiation induced green synthesis of highly stable silver nanoparticles using durian rind biomass: Effects of light intensity, exposure time and ph on silver nanoparticles formation. *J Phys Commun*. 2020;4(9):1-10. doi:10.1088/2399-6528/abb4b5

37. Calyptranti R, Luviriani E, Safitri L. Konsentrasi Hambat Dan Bunuh Minimum Ekstrak Etanol Dan Metanol Kulit Durian (Durio Zibethinus Murr) Terhadap Salmonella Thypi. *HERBAPHARMA J Herb Farmacol*. 2022;4(1):36-45. doi:10.55093/herbapharma.v4i1.285

38. Burton GP, Prescott TAK, Fang R, Lee MA. Regional variation in the antibacterial activity of a wild plant, wild garlic (Allium ursinum L.). *Plant Physiol Biochem*. 2023;202:107959. doi:10.1016/j.plaphy.2023.107959

39. Khafid A, Wiraputra MD, Putra AC, et al. UJi Kualitatif Metabolit Sekunder pada Beberapa Tanaman yang Berkhasiat sebagai Obat Tradisional. *Bul Anat dan Fisiol*. 2023;8(1):61-70. doi:10.14710/baf.8.1.2023.61-70

40. Selwal N, Rahayu F, Herwati A, et al. Enhancing secondary metabolite production in plants: Exploring traditional and modern strategies. *J Agric Food Res*. 2023;14(May):100702. doi:10.1016/j.jafr.2023.100702

41. Nurasia, Pirda. Identification of secondary metabolite compounds and gc-ms test (gas chromatography mass spectroscopy) on purslane plant (Portulaca oleracea L). *J Phys Conf Ser*. 2021;1940(1):012045. doi:10.1088/1742-6596/1940/1/012045

42. Jamal K, … MMIJ of, 2019 undefined. Antibacterial activities of ethanol extracts of durian fruit skin (Durio zibethinus Murr.) on Salmonella Bacteria In Atcc 14028 and Bacillus Cereus Atcc 11778 Cause of. *online-journal.unja.ac.id*. Published online 2019. Accessed June 26, 2022. https://online-journal.unja.ac.id/IJPS/article/view/7287

43. Suteja A, Kardhinata EH, Lubis R. Identifikasi Senyawa Metabolit Sekunder pada Durian (Durio zibethinus Murr). *J Ilm Biol UMA*. 2019;1(1):1-6. doi:10.31289/jibioma.v1i1.138

44. Titisari N. *Potensi Susu Kuda Sumbawa Yang Diinkubasi Terhadap Kemampuan Daya Hambat Pertumbuhan Bakteri Penyebab Enteritis Secara In Vitro.*; 2020.

45. Nurhayati LS, Yahdiyani N, Hidayatulloh A. Perbandingan Pengujian Aktivitas Antibakteri Starter Yogurt dengan Metode Difusi Sumuran dan Metode Difusi Cakram. *J Teknol Has Peternak*. 2020;1(2):41. doi:10.24198/jthp.v1i2.27537

46. Etikasari R, Murharyanti R, Wiguna AS. Evaluasi Pigmen Karotenoid Karang Lunak Sarcophyton Sp. Sebagai Agen Antibakteri Potensial Masa Depan. *Indones J Farm*. 2023;2(1):60. doi:10.26751/ijf.v2i1.414

47. Intan K, Diani A, Nurul ASR. Aktivitas Antibakteri Kayu Manis (Cinnamomum burmanii) terhadap Pertumbuhan Staphylococcus aureus. *J Kesehat PERINTIS (Perintis's Heal Journal)*. 2021;8(2):121-127. doi:10.33653/jkp.v8i2.679

48. Putri VA., Posangi J, Nangoy E, Bara RA. Uji daya hambat jamur endofit rimpang lengkuas (Alpinia galanga l.) terhadap pertumbuhan bakteri Escherichia coli dan Staphylococcus aureus. *J e-Biomedik*. 2016;4(2). doi:10.35790/ebm.4.2.2016.14665

49. Magvirah T, Marwati, Ardhani F. Uji Daya Hambat Bakteri Staphylococcus aureus Menggunakan Ekstrak Daun Tahongai (Kleinhovia hospita L.). *J Peternak Lingkung Trop*. 2019;2(2):41-50.

50. Puspa SR. Antimicrobial effect of catfish (Pangasius sp .) meat extract Efek antimikroba ekstrak daging ikan patin (Pangasius sp). *Makassar Dent J August*. 2023;12(2):242-246. doi:10.35856/mdj.v12i2.775

51. Hadder B, Dexter F, Robinson ADM, Loftus RW. Molecular characterisation and epidemiology of transmission of intraoperative Staphylococcus aureus isolates stratified by vancomycin minimum inhibitory concentration (MIC). *Infect Prev Pract*. 2022;4(4):100249. doi:10.1016/j.infpip.2022.100249

52. Almoudi MM, Hussein AS, Mohd Sarmin NI, Abu Hassan MI. Antibacterial effectiveness of different zinc salts on Streptococcus mutans and Streptococcus sobrinus: An in-vitro study. *Saudi Dent J*. Published online 2023. doi:10.1016/j.sdentj.2023.07.003

53. Azis ASFW, Darmawansyah, Razak A, Arifin A, Syafar M, Mallongi A. Analysis of Policy Implementation of The First 1000 Days of Life Program in Overcoming Stunting in Maros District. *Pharmacogn J*. 2023;15(3):405-410. doi:10.5530/pj.2023.15.92

54. Asrina A, Payapo R, Idris FC, Palutturi S, Mallongi A. Health Behavior and Social Support in Postpartum Mothers Treatment in Ba'ukup Tradition in Maluku. *Pharmacogn J*. 2023;15(3):438-442. doi:10.5530/pj.2023.15.98

55. Syahriani N, Palutturi S, Birawida AB, Hidayanty H. Clean Water Supply as an Indicator for Healthy Island in Makassar City. *Open Access Maced J Med Sci*. 2022;10(34):320-325. doi:10.3889/oamjms.2022.8350

56. Ernyasih, Mallongi A, Daud A, et al. Model Prediction of Potential Disease Effects from PM2.5 Emission Among School Children in Coming 30 years in South Tangerang. *Pharmacogn J*. 2023;15(3):400-404. doi:10.5530/pj.2023.15.91

57. Hilda, Supriadi, Widiastuty HP, Arsyawina, Mallongi A. Development of Patient Safety Management Learning Model Based on Problem Based Learning Integrated Soft Skill Higher Level Thinking for Health Students in Samarinda. *Pharmacogn J*. 2023;15(2):418-423. doi:10.5530/pj.2023.15.65

58. Mallongi A, Rauf AU, Astuti RDP, Palutturi S, Ishak H. Ecological and human health implications of mercury contamination in the coastal water. *Glob J Environ Sci Manag*. 2023;9(2):261-274. doi:10.22034/gjesm.2023.02.06

Cite this article: Ahmad R, Amiruddin R, Arsin AA, Stand S, Ishak H, Thamrin Y, Mallongi A. Antibacterial Potential of Durian (*Durio zibethinus* murr.) Waste as an Alternative Disinfectant in Raw Drinking Water - A Literature Review. Pharmacogn J. 2024;16(1): 255-262.