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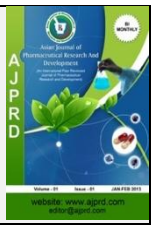

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Review Article

Antibacterial Activity Test of Mangosteen Plants (*Garcinia Mangostana* L.): A Review

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ABSTRACT

Background: Bacterial infection was a health problem thathard to overcome, due to the presence of bacterial resistance to current antibacterial drugs. Therefore, the use of herbal antibacterials is an alternative that can be used. Mangosteen (*Garciniamangostana* L.) is a plant that contains xanthone compounds and its derivatives have antimicrobial, antioxidant, cytotoxic, anti-inflammatory, and anti-HIV activity.Part of the mangosteen was used as a medicinal plant such as bark, fruit peel, fruit, seeds, and leaves.This review aimed to determine the antibacterial effectiveness of the mangosteen and inhibitory diameter that was resulting.

Data Collection: The author was created this article review by conducting literature studies. The works of literature were collected from national and international journals in the last ten years (2010-2020) and pharmaceutical scientific books. The works of literature were collected from trusted online journal sites such as the digital library, PubMed, PubChem, ScienceDirect, NCBI, Elsevier, NCBI, Researchgate, Google Scholar, Springer, and other trusted E-resource with the keyword "mangosteen", "Garcinia mangostana L", "antibacterial activity", and "inhibitor zone".

Result: According to literature showed that the mangosteen fruit peel, bark, leaves, seeds and fruit effective as antibacterialfor several types of bacteria.

Conclusion:N-hexane that was extracted from mangosteen peel has potential as an antibacterial activity at a concentration of 15.62 mg/ml and inhibit the growth of *Staphylococcus aureus* ATCC25923 with an inhibitory diameter of 17mm.

Keywords: Mangosteen, *Garcinia mangostana* L., Antibacterial activity, Inhibitor zone.

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INTRODUCTION

Bacterial infection was a health problem thathard to overcome. The main cause of infection are microorganisms, such as bacteria, protozoa, viruses, fungi, and others. Antibiotics are the drugs for infections caused by microorganisms. Antibiotics obtained from various sources such as bacteria, fungi, plants, or anything that can inhibit growth and kill microorganisms is called antibiotics [4]. Clindamycin, tetracycline, erythromycin, dapsone, and benzoyl peroxide are antibiotics that against *Propionylbacterium acne* (acnecauses) [3]. Allergic, idiosyncratic, toxic, and biological changes are side effects of antibiotics used [5]. Anti-antibacterial could be sourced from natural or synthetic [6]. All parts of mangosteen plants can be used, such as leaves, fruit peel, bark, and seeds. Xanthone derivatives from mangosteen have biological effectiveness as anticancer, antimicrobial, anti-inflammatory, antioxidant, and can inhibit the growth of cancer cells [7].

This review is expected to provide information on the chemical content and antibacterial activity of each parts of the mangosteen plant.

Classification of Mangosteen *(Garcinia mangostana L.)* [9].

Kingdom	: Plantae
Divisi	: Spermatophyta
Sub-divisi	: Angeospermae
Kelas	: Dicotyledoneae
Ordo	:Guttiferanales
Family	:Guttiferae
Genus	:Garcinia
Spesies	: *Garcinia Mangostana* L.

Figure 1. Maggosteen (*Garcinia mangostana* L)[9].

Mangosteen has a height of about 15 meters, rounded wooden, upright, has sympodial branches, and is dirty green.Single-leaf with oval shape, tapered tip,leaf length about 20 to 25 cm with a width of 6 to 9 cm, thick and cylindrical stalks are green.Mangosteen was single-flowered and androgynous, in the axilla with a length of about 1 to 2 cm.The fruit mangosteen was a spherical shape, 6 to 8 cm in diameter and purplish-brown in color. The seeds are spherical in shape, yellow with a diameter of 2 cm and there are 5 to 7 seeds in one mangosteen fruit.Taproot with a brownish-white color [9].

DATA COLLECTION

The author was created this article review by conducting literature studies. The works of literature were collected from national and international journals in the last ten years (2010-2020) and pharmaceutical scientific books. The works of literature were collected from trusted online journal sites such as the digital library, PubMed, PubChem, ScienceDirect,NCBI, Elsevier, NCBI, Researchgate, Google Scholar, Springer, and other E-resource with the keyword "mangosteen", "*Garcinia mangostana* L", "antibacterial activity", and "inhibitor zone".

Table 1: Phytochemical content of mangosteen (*Garcinia mangostana* L.)

No.	Plant part	Solvent	Phytochemical content						Ref
			Alkaloids	Flavonoids	Saponins	Triterpenoids	Steroids	Tannins	
1	Bark	Ethanol	-	+	-	-	-	-	[10]
2	Leaves	Water	-	+	+	-	-	-	[11]
		Ethanol	-	+	+	-	+	-	
		Ethyl acetate	-	+	+	-	+	-	
		n-hexane	-	+	+	-	+	-	
3	Fruit peel	Ethanol	+	+	+	+	-	+	[15]
		Ethyl acetate	+	+	+	+	-	-	[6]
		Acetone	+	+	+	+	+	+	[26]
		Methanol	+	+	+	+	+	+	
		Water	-	+	-	-	+	-	[28]
		Chloroform	+	+	-	-	-	+	
		n-hexane	+	+	-	-	-	+	
4	Fruit	Methanol	-	+	+	-	-	-	[31]
5	Seed	Methanol	+	+	+	-	-	-	

Some parts of the mangosteen plant were subjected to phytochemical examinations, such as bark, leaves, fruit peel, fruit, and seeds. The mangosteen plant contains tannins, flavonoids, alkaloids, and saponins. However, not all parts of the mangosteen plant contain steroids and triterpenoids [10,11,15,6,26,28,31].Mangosteen fruit peel contains the best phytochemicals because it contains more chemicals that are found than in the bark, leaves, fruit, and seeds.This indicates that mangosteen plants have different compound content in each part. several types of bacteria are inhibited by the mangosteen plant shown in Table 1.

Table: 2 Bacteria inhibited by mangosteen plants and diseases caused

No	Name of bacteria	Type of bacteria	Habitat	Role	Ref
1	*Bacillus subtilis*	Gram-positive	Digestive System	Causes meningitis, endocarditis, eye infections	[10]
2	*Escherichia coli*	Gram-negative	Colon	Causes gastrointestinal disease (diarrhea)	
3	*Staphylococcus Aureus*	Gram-positive	Nose and skin	Causes skin damage such as inflammation, necrosis, abscess formation.	[11]
4	*Pseudomonas aeruginosa*	Gram-negative	Sputum, urine, blood, feces, ear secretions	Causes infections of respiratory tract, urinary tract and eyes.	
5	*Klebsiella pneumoniae*	Gram-negative	respiratory system	Causes respiratory infections (bronchitis)	[13]
6	*Enterobacter*	Gram-negative	Termite (*coptotermes curvignathus*)	Causes urinary tract infections	[14]
7	*Staphylococcus Epidermidis*	Gram-negative	Skin and mucous membranes	Cause acne	[16]
8	*Streptococcus sanguinis*	Gram-positive	Saliva and oral cavity	Causes periodontal disease	[17]
9	*Streptococcus salivarius*	Gram-positive	Oral cavity	Cause plaque in the teeth	
10	*Streptococcus oralis*	Gram-positive	Oral cavity	Causes dental caries	

11	*Leuconostoc mesenteroides*	Gram-positive	Stale food	Causes infections of the urinary tract and gastrointestinal tract.	[8]
	Lactobacillus plantarum	Gram-positive	Milk	Causes acidity in milk	
12	*Enterococcus faecalis*	Gram-positive	Saliva	Causes endodontic infections	[21]
13	*Propionibacterium acne*	Gram-positive	pilosebaceous glands of the skin	Cause acne	[22]
14	*Proteus mirabilis*	Gram-negative	Urinary system	Causes a UTI (urinary tract infection)	[25]
15	*Streptococcus mutans*	Gram-positive	Tooth surface	Cause dental plaque and caries.	[27]
16	*Lactobacillus acidophilus*	Gram-positive	Digestive system	Maintaining a balance of good bacteria in the digestive system	[1]
17	*Salmonella typhi*	Gram-negative	Animal meat	Causes typhus or typhoid fever	
18	*Porphyromonas gingivalis*	Gram-negative	Tooth root	Causes dental caries and periodontal disease	[27]
19	*Streptococcus pyogenes*	Gram-positive	Respiratoty system	Causes Pharyngitis Infection (laryngitis) and impetigo infection (local skin infection)	[28]
20	*Shigella dysenteriae*	Gram-negative	Feces	Causes dysentery, shigellosis (an infection of the gastrointestinal system)	[29]
21	*Fusobacterium nucleatum*	Gram-negative	Tooth root	Causes dental caries and periodontal disease	[30]

Table: 3 Antibacterial Activity of Mangosteen Plants (*Garcinia mangostana* L.)

No	Plant part	Method	Microba	Separation Method	Solvent	Concentration	Inhibition Zone (mm)	Ref
1	Bark	Diffusion	*Bacillus subtilis*	Extraction	Ethanol 80%	5.000 bpj 10.000 bpj 20.000 bpj 40.000 bpj 60.000 bpj	13,51 14,62 15,92 16,53 18,02	[10]
			Escherichia coli ATCC 25922			5.000 bpj 10.000 bpj 20.000 bpj 40.000 bpj 60.000 bpj	11,68 13,19 14,25 15,17 16,65	
2	Leaves	Diffusion	*StaphylococcusAureus*	Extraction	Ethanol 96%	12,5 % 25 % 50 %	- 7.5 8	[11]
			Pseudomonas aeruginosa			12,5 % 25 % 50 %	- 7 8	
			Staphylococcus Aureus	Fractionation	Water	12,5 % 25 % 50 %	7.5 8 10	
			Pseudomonas aeruginosa			12,5 % 25 % 50 %	5 6 8	
			Staphylococcus Aureus	Fractionation	Ethyl Acetate	12,5 % 25 % 50 %	- 8.6 9	
			Pseudomonas aeruginosa			12,5 % 25 % 50 %	- 7 7	
			Staphylococcus Aureus	Fractionation	n-hexane	12,5 % 25 % 50 %	3 5 5,5	
			Pseudomonas aeruginosa			12,5 % 25 % 50 %	- 4 5,5	
3	Leaves	Diffusion	*Pseudomonas aeruginosa*	Extraction	Ethanol 70%	10% 20% 30% 40% 50% 60% 70% 80% 90%	13.20 14.00 14.65 15.85 16.05 16.9 17,55 18.75 19.25	[12]

						100% .	24.80	
4	Leaves	Diffusion	*Staphylococcus aureus*	Fractionation	Methanol	10% 20% 30%	11,90 14,08 16,58	[23]
					Ethyl Acetate	10% 20% 30%	10,75 13,25 7,43	
					N-hexane	10% 20% 30%	7,50 7,43 8,45	
			Escherichia coli	Fractionation	Methanol	10% 20% 30%	11,80 12,41 14,91	
					Ethyl Acetate	10% 20% 30%	14,61 15,00 17,58	
					N-hexane	10% 20% 30%	6,60 6,66 8,33	
5	Fruit peel	Diffusion	*Klebsiella pneumonlae*	Extraction	Ethanol 96%	25% 50% 75% 100%	6,66 8,83 9,16 10,16	[13]
6	Fruit peel	Diffusion	*Enterobacter*	Extraction	Ethanol 96%	10% 15% 20% 25% 30% 35% 40%	4,525 4,900 5,025 5,325 5,800 6,300 6,805	[14]
7	Fruit peel	Diffusion	*Escherichia coli*	Extraction	Ethanol 96%	20 % 50% 75% 100%	17,6 21,4 24 29,4	[15]
8	Fruit peel	Diffusion	*Staphylococcus Epidermidis*	Extraction	Ethyl Acetate	4% 6% 8% 10%	12 12 12,5 13,5	[16`]
9	Fruit peel	Diffusion	*Streptococcus sanguis*	Extraction	Chloroform	100 mg/ml	13,6	[17]
			Streptococcus salivarius			100 mg/ml	3	
			Streptococcus oralis			50 mg/ml	11,3	
			Streptococcus mutans			100 mg/ml	10,6	
			Lactobacillus acidophillus			25 mg/ml	13,6	
10	Fruit peel	Diffusion	*Lactobacillus plantarum*	Fractionation	Chloroform	5%	10,1	[8]
			Leuconostoc mesenteroides		Ethyl Acetate	5%	13,4	
			Lactobacillus plantarum		Chloroform	5%	8,2	
			Leuconostoc mesenteroides		Ethyl Acetate	5%	11,0	
11	Fruit peel	Diffusion	*Staphylococcus aureus* ATCC 25923	Extraction	Ethyl Acetate	500 mg/ml 250 mg/ml 125 mg/ml 62,5 mg/ml 31,25 mg/ml 15,62 mg/ml	10 7 8 7.7 - 8	[18]
					n-hexane	500 mg/ml 250 mg/ml 125 mg/ml 62,5 mg/ml 31,25 mg/ml 15,62 mg/ml	14 14,3 16 11,7 16,3 17	
			Pseudomonas aeroginosa ATCC 27853		Ethyl Acetate	500 mg/ml 250 mg/ml 125 mg/ml	13,3 11,3 11,3 11,3	

						62,5 mg/ml 31,25 mg/ml 15,62 mg/ml	10,7 11	
					n-hexane	500 mg/ml 250 mg/ml 125 mg/ml 62,5 mg/ml 31,25 mg/ml 15,62 mg/ml	20 16,3 15,7 13,3 13,7 13	
12	Fruit peel	Diffusion	*Escherichia coli*	Extraction	Ethanol 70%	3,9% 4% 4,1% 4,2% 4,3%	0,9875 1 1,0075 1,0575 1,0775	[19]
13	Fruit peel	Diffusion	*Staphylococcus aureus*	Extraction	Ethanol 70%	5 µl 10 µl 15 µl	11 14 16	[20]
			Salmonella typhi			5 µl 10 µl 15 µl	12 13 16	
			Escherichia coli			5 µl 10 µl 15 µl	9 11 11	
14	Fruit peel	Diffusion	*Enterococcus faecalis*	Extraction	Ethanol 70%	50 %	10,3	[21]
15	Fruit peel	Diffusion	*Propionibacterium acne*	Extraction	Ethyl Acetate	4% 6% 8% 10%	10,30 10,67 11,167 11,67	[22]
16	Fruit peel	Diffusion	*Escherichia coli*	Extraction	Ethanol 70%	10% 5% 2.5% 1.25% 0.6%	15 13 10,8 8,8 5,8	[24]
17	Fruit peel	Diffusion	*Proteus mirabilis*	Extraction	Ethanol 70%	200 µg/ml	10	[25]
			Staphylococcus epidermidis				10	
18	Fruit peel	Diffusion	*Staphylococcus aureus*	Extraction	Methanol	100 µg/ml	14	[1]
			Streptococcus mutans				10,6	
			Lactobacillus acidophilus				13,6	
			Salmonella typhi				13	
			Staphylococcus aureus	Extraction	Acetone	100 µg/ml	10,5	
			Streptococcus mutans				9	
			Lactobacillus acidophilus				11,4	
			Salmonella typhi				9,6	
19	Fruit peel	Diffusion	*Escherichia coli*	Extraction	Ethanol 95%	500 ppm 1000 ppm 10000 ppm	2,80 5,70 4,58	[26]
			S. aureus			500 ppm 1000 ppm 10000 ppm	- - 6,92	
20	Fruit peel	Diffusion	*Streptococcus mutans*	Extraction	Ethanol 96%	100%, 50%, 25%, 12.5%, 6.25%	0,8 0,7 1,7 1,6 1,8	[27]
			Porphyromonas gingivalis			100%, 50%, 25%, 12.5%, 6.25%	0,3 0,6 0,4 0,7 0,9	
			Staphylococcus aureus	Extraction	Water	400 mg / ml	13	
			Streptococcus pyogenes				12	
			Bacilllus subtillis				13	
			Escherichia coli				18	
			Pseudomonas aeruginosa				16	
			Staphylococcus aureus				15	

21	Fruit peel	Diffusion	*Streptococcus pyogenes*	Extraction	Methanol	400 mg / ml	18	[28]
			Bacilllus subtillis				20	
			Escherichia coli				25	
			Pseudomonas aeruginosa				20	
			Staphylococcus aureus	Extraction	Ethanol 70%	400 mg / ml	17	
			Streptococcus pyogenes				31	
			Bacilllus subtillis				30	
			Escherichia coli				25	
			Pseudomonas aeruginosa				20	
			Staphylococcus aureus	Extraction	Acetone	400 mg / ml	30	
			Streptococcus pyogenes				15	
			Bacilllus subtillis				17	
			Escherichia coli				20	
			Pseudomonas aeruginosa				20	
			Staphylococcus aureus	Extraction	chloroform	400 mg / ml	14	
			Streptococcus pyogenes				17	
			Bacilllus subtillis				15	
			Escherichia coli				20	
			Pseudomonas aeruginosa				18	
			Staphylococcus aureus	Extraction	Ethyl ether	400 mg / ml	13	
			Streptococcus pyogenes				14	
			Bacilllus subtillis				12	
			Escherichia coli				15	
			Pseudomonas aeruginosa				14	
22	Fruit peel	Diffusion	*S. aureus*	Extraction	Methanol	0.1 mL	18,7	[29]
			S. albus				18,0	
			B. subtilis				19,8	
			S. typhimurium				17,2	
			S. dysenteriae				13,4	
			E. coli				14,8	
			S. aureus	Extraction	Ethanol 96 %	0.1 mL	16,1	
			S. albus				16,2	
			B. subtilis				19,1	
			S. typhimurium				14,8	
			S. dysenteriae				10,6	
			E. coli				14,5	
			S. aureus	Extraction	Acetone	0.1 mL	15.4	
			S. albus				15.8	
			B. subtilis				18.5	
			S. typhimurium				14.1	
			S. dysenteriae				10.2	
			E. coli				13.8	
			S. aureus	Extraction	Ethyl Acetate	0.1 mL	11.2	
			S. albus				11.3	
			B. subtilis				12.4	
			S. typhimurium				11.5	
			S. dysenteriae				8.6	
			E. coli				8.3	
			S. aureus	Extraction	n- heksan	0.1 mL	9.2	
			S. albus				10.5	
			B. subtilis				9.0	
			S. typhimurium				-	
			S. dysenteriae				-	
			E. coli				-	
23	Fruit peel	Diffusion	*Fusobacterium nucleatum.*	Extraction	Ethanol 96%	0.78 %	9.62	[30]
24	Fruit peel	Diffusion	*Staphylococcus aureus* ATCC11632	Extraction	Methanol	20 µL 40 µL 60 µL 80 µL	1.25 1.94 2.31 4.50	[31]
25	Fruit	Diffusion	*Staphylococcus aureus* ATCC11632	Extraction	Methanol	20 µL 40 µL 60 µL 80 µL	1.25 1.94 2.31 4.50	
26	Seed	Diffusion	*Staphylococcus aureus* ATCC11632	Extraction	Methanol	20 µL 40 µL 60 µL 80 µL	3.50 6.50 9.00 12.50	

DISCUSSION

All parts of mangosteen plants can be used, such as leaves, fruit peel, bark, and seeds.According to literature, the phytochemical content of each part of mangosteen, such as leaves; flavonoids, steroids, saponins [11]. Fruit peel; polyphenols, flavonoids, tannins, alkaloids, quinones, terpenoids [14]. Bark; flavonoids [10]. Seed; alkaloids, flavonoids, saponins [31]. Fruit; flavonoids and saponins [31]. Shown in Table 1.

The Phytochemical compound contained in mangosteen has a different mechanism for inhibiting bacterial growth activity. Flavonoids; act as antibacterial by binding to bacterial proteins, thus inhibiting the enzyme activity by interfering with the metabolic processes of bacteria. The properties of lipophilic flavonoids can damage bacterial cell membranes because the cell membrane contains lipids thus allowing the compound to break the membrane [33]. Alkaloids; affect the formation of peptidoglycan constituent components in bacterial cells, so that it can result in bacterial cells becoming lysis [34]. Polyphenols and tannins; an inhibitor of enzyme protease activity, inhibit enzymes in proteins transporting bacterial cell sheaths, and destruction or inactivation of the function of genetic material [35]. Besides, tannins can wrinkle the cell walls andinterfere with the cell permeability of bacteria, as a result of inhibited cell growth or then dies [36]. Triterpenoids; interfere with the constituent components of the bacterial cell wall causing cell death [33]. Saponins; interfere with the stability of bacterial cell membranes causing lysis in these bacteria [37].

Examination of antibacterial has to be done by using the diffusion methodbecause the process was simple and fast. Test results are determined from the diameter of the clear zone around the disc as the area inhibits bacterial growth [32].

According to Table 2, bacteria are divided into two groups, namely gram-positive bacteria, and gram-negative bacteria. It has a different response to antibacterial substances.Gram-positive bacteria have a single-layered cell wall with lipid content of 1-4% [38]. Therefore, these bacteria are more easily entered by antibacterial substances, such as flavonoids that are lipophilicity [33]. Gram-negative bacteria have a three-layered cell wall consisting of; lipoproteins, outer membranes of phospholipid cells, and lipopolysaccharides. Lipid content on cell walls ranges from 11-22%. The outer membrane of phospholipids in gram-negative bacteria can reduce the entry of antibacterial substances into cells [38]. Lipopolysaccharide has a selection system for foreign substances [39]. Generally,gram-negative bacteria have more resistance. However, gram-negative bacteria such as Enterobacter and Flavobacterium can be inhibited by mangosteen rind extracts at concentrations of 35% and 30% [14].

Some parts of the mangosteen plant such as bark, leaves, fruit, fruit peel, and seeds, have antibacterial effectiveness on some bacteria. Several kinds of solvents, concentrations, and inhibition zones produced was shown in Table 3.

Based on the antibacterial effectiveness of some parts of the mangosteen plant, Mangosteen fruit peel has the highest antibacterial effect than any other part. Especially on the extraction separation method using a solvent n-hexane [18]. N-hexanes are non-polar solvents, so the non-polar compound group will dissolve in this solvent [18]. The n-hexane solvent can attract flavonoids, tannins, and xanthones contained in the mangosteen fruit peel. At a drying temperature of 80ºC, indicates that both inside and outside of mangosteen peel produces alkaloid and flavonoid compounds [40].

N-hexane extract of mangosteen peel contains antibacterial compounds, namely flavonoids, tannins, and xanthones that can inhibit the growth of *Staphylococcus aureus* bacteria [18]. *Staphylococcus aureus* bacteria are gram-positive bacteria that have a layer cell wall composed of peptidoglycan macromolecules and a single cell membrane composed of proteins and lipids [41]. Flavonoids inhibited bacterial growth by passing through the cell membrane of *Staphylococcus aureus* bacteria which is composed of lipids and proteins [33,41]. The properties of lipophilic made the compound easily pass through the cell membrane of bacteria *Staphylococcus aureus* which is also lipid [33,41]. Bacterial proteins bound to inhibit the activity of enzymes that interfere with bacterial metabolism [33]. Tannins can wrinkle the cell walls and interfere with cell permeability of bacteria, as a result of inhibited cell growth or then dies [36]. Xanthone contained in the mangosteen peel is a natural chemical substance that was classified as a polyphenolic phytonutrient compound, namely bioflavonoids.Although in low concentrations, bioflavonoids can poison protoplasms, destroy and penetrate cell walls, as well as precipitate bacterial cell proteins so that they interfere with metabolic processes [42]. N-hexane extract of mangosteen rind has the highest potential as an antibacterial activity at a concentration of 15.62 mg/ml, which can inhibit the growth of *Staphylococcus aureus* ATCC25923 with an inhibitory diameter of 17mm.

Note: To determine theeffective concentration, should to equating units of mg/ml, μL, bpj(ppm), mL to%. After all units are equalized to%, the effective concentration was 15.62 mg / ml (0.015%).

CONCLUSION

The extract of mangosteen (*Garcinia mangostana* L.), namely bark, leaves, fruit, fruit peel, and seeds, have antibacterial effectiveness on some bacteria.Mangosteen peel extract showed the highest antibacterial effectiveness, the extraction separation method using n-hexane solvent can attract alkaloids, flavonoids, tannins, which are contained in it.N-hexane extract at a concentration of 15.62 mg/ml, can inhibit the growth of *Staphylococcus aureus* ATCC25923 with an inhibitory diameter of 17mm.

REFERENCES

1. Goud, N. S., Prasad, G., & Kumar, S.*Phytochemical Analysis, Antibacterial and Antioxidant Capacity of Acetone and Methanol Pericarp Extract of Mangosteen*, 2019; 8(11):44-47.
2. Nugraha, S. C. A., Prasetya, T. A., Mursiti., 2016. Isolasi, Identifikasi, Uji Aktivitas Senyawa Flavonoid Sebagai Antibakteri dari Daun Mangga. *Indones., J. Chem. Sci.* 6(2).
3. Djajadisastra, Joshita et al. Formulasi Gel Topikal Dari Ekstrak Nerii Folium Dalam Sediaan Anti Jerawat. *Jurnal Farmasi Indonesia*,2009; 4(4): 210-216 .
4. R. H. Pratiwi. Mekanisme Pertahanan Bakteri Patogen Terhadap Antibiotik. *J. Berk*, 2017; 4(3):418-429.
5. Setiabudy., Rianto. 2007. *Farmakologi dan Terapi Ediai 5*. Jakarta: Balai Penerbit Fakultas Kedokteran Universitas Indonesia.
6. Cunha, B. A., MD., MACP., 2015. *Antibiotic Essentials Fourteenth Edition*. The Health Sciences Publisher Panama. ISBN 978-93-5152-850-0.
7. Yodhu, S., Sirikatitham, A., Wattanapiromsaku, C. Validation of LC For The Determination of a-Mangostin In Mangosteen Peel Extract: A Tool For Quality Assessment Of *Garcinia Mangostana* L. *Journal of Chromatographic Science*, 2009; 47
8. Putra, I. N. K. Aktivitas Antibakteri Ekstrak Kulit Buah Manggis (*Garcinia Mangostana* L.) Serta Kandungan Senyawa Aktifnya

[Antibacterial Activity of Mangosteen (*Garcinia Mangostana* L.) Husk Extract, And Its Active Compounds]. *Jurnal Teknologi Dan Industri Pangan*, 2010; 21(1):1-1.

9. Hutapea, J.R. (1994). *Inventaris Tanaman Obat Indonesia*. (Jilid Iii). Jakarta: Departemen Kesehatan Republik Indonesia Dan Badan Penelitian Dan Pengembangan Kesehatan.
10. Kumalasari, N. P. R. Aktivitas Antibakteri Ekstrak Etanol Kulit Batang Manggis (Garcinia Mangostana Linn.) Terhadap Bacillus Subtilis Dan Escherichia Coli Atcc 25922. *Calyptra*, 2013; 2(2):1-10.
11. Sari, G. N. F., & Turahman, T. Aktivitas Antibakteri Ekstrak Dan Fraksi Daun Manggis (Garcinia Mangostana) Terhadap Staphylococcus Aureus Dan Pseudomonas Aeruginosa. *In Prosiding Seminar Nasional Unimus*, 2018; 1: 2654-3257; 2654-3168.
12. Suhartati, R., Apriyani, F., Virgianti, D. P., & Fathurohman, M. Antimicrobial Activity Test of Mangosteen Leaves Ethanol Extract (Garcinia mangostana Linn) Against Pseudomonas Aeruginosa Bacteria. *In Journal Of Physics: Conference Series*, 2019; 1179(1):012167 .
13. Melkianus, B., Fatimawali, F., & Sudewi, S. Uji Aktivitas Antibakteri Ekstrak Kulit Buah Manggis (Garcinia Mangostana L.) Terhadap Bakteri Klebsiella Pneumonlae. *Pharmacon*, 2019; 8(1):88-93.
14. Maliana, Y., Khotimah, S., & Diba, F. Aktivitas Antibakteri Kulit Garcinia Mangostana Linn. Terhadap Pertumbuhan Flavobacterium Dan Enterobacter Dari Coptotermes Curvignathus Holmgren. *Protobiont*, 2013; 2(1): 7 – 11.
15. Arsana, I. N. Uji Sensitifitas Bakteri Escherichia Coli Terhadap Ekstrak Kulit Buah Manggis (Garcinia Mangostana L.) Secara In-Vitro. 2015; 6(1): 2086-5783 .
16. Valmai, V. R., Choironi, N. A., & Sunarto, S. Aktivitas Antibakteri Ekstrak Etil Asetat Kulit Manggis (Garcinia Mangostana L.) Terhadap Staphylococcus Epidermidis. *Acta Pharmaciae Indonesia*, 2019; 7(1):36-41.
17. Janardhanan, S., Mahendra, J., Girija, A. S., Mahendra, L., & Priyadharsini, V. Antimicrobial effects of Garcinia mangostana on cariogenic microorganisms. *Journal of clinical and diagnostic research*: JCDR, 2017; 11(1):ZC19-ZC22.
18. Srikandi, S., & Widhyastini, I. M. Antibakteri Ekstrak Kulit Buah Manggis (Garcinia Mangostana L.). *Jurnal Sains Natural*, 2017; 4(2):172-179.
19. Permata, P., Kawuri, R., & Darmadi, A. K. Uji Aktifitas Antibakteri Ekstrak Etanol Kulit Buah Manggis (Gracinia Mangostana L.) Terhadap Pertumbuhan Bakteri Escherichia Coli. *Simbiosis*, 2018; 4(1); 2337-7224.
20. Jacob, D., Vigasini, N., & Iyer, P. R. Antibacterial Activity of Mangosteen (Garcinia Mangostana) Pericarp. *World J. Pharm. Res*, 2016; 5(9): 1797-1802.
21. Wahyudi, H. E., Ardy, E. S., & Nawawi, A. P. Potensi Hambat Ekstrak Kulit Buah Manggis (Garcinia Mangostana L.) Terhadap Pertumbuhan Enterococcus Faecalis. *Medika Kartika: Jurnal Kedokteran Dan Kesehatan*, 2019; 2(2):123-134.
22. Tellu, F. Y., Sunarto, S., & Utami, E. D. Aktivitas Antibakteri Ekstrak Etil Asetat Kulit Buah Manggis (Garcinia Mangostana L.) Terhadap Propionibacterium Acnes. *Acta Pharmaciae Indonesia*, 2019; 7(2):58-67.
23. Jayanto, I., Paputungan, A. N., Lolo, W. A. Aktivitas Antibakteri Dan Analisis KLT-Bioautografi Dari Fraksi Daun Manggis (Garcinia mangostana L.). *Pharmacon-Program Studi Farmasi, FMIPA, Universitas Sam Ratulangi*, 2019; 8(3) .
24. Soetikno, J. S., Handayani, R., & Rahayu, R. D. Assay For Antimicrobial Activity Of Mangosteen Rind Extracts. *Journal Of Innovations In Pharmaceuticals And Biological Sciences*, 2016;3(1): 54-60.
25. Sari, R., Pratiwi, L., Apridamayanti, P. Efektivitas SNEDDS Ekstrak Kulit Manggis Terhadap Bakteri P.mirabillis dan S.epidermis Yang Terdapat Pada Ulkus Diabetik. *Pharm Sci Res*, 2016; 3(3): 2407-2354.
26. Indrianingsih, A. W., Rosyida, V. T., & Ratih, D. *In Vitro Study of Antioxidant and Antimicrobial Activities of Garcinia Mangostana L. Peel Extract*.In 5th International Conference on Food, Agriculture And Natural Resources (Fanres 2019) (Pp. 152-155). Atlantis Press, 2020; 194.
27. Widyarman, A. S., Lay, S. H., Wendhita, I. P., Tjakra, E. E., Murdono, F. I., & Binartha, C. T. O. *Indonesian Mangosteen Fruit (Garcinia Mangostana L.) Peel Extract Inhibits Streptococcus Mutans And Porphyromonas Gingivalis In Biofilms In Vitro*. Contemporary Clinical Dentistry, 2019; 10(1):123.
28. Bhat, R. S., & Al-Daihan, S. Antimicrobial Activity of Garcinia Mangostana Using Different Solvents Extracts. *International Journal Of Biosciences* (Ijb), 2013; 3(10):267-272.
29. Li, Q., & Xu, J. G. Effects of Extraction Solvents on Phytochemicals and Antibacterial Activities of Garcinia Mangostana Pericarp. *Asian Journal Of Agriculture And Food Sciences*, 2014; 2(4):2321-1571.
30. Octaviani, N. P., Mooduto, L., & Sudirman, A. Antibacterial Potency Of Mangosteen Pericarp Extracts (Garcinia Mangostana L.) Against Fusobacterium Nucleatum. *Conservative Dentistry Journal*, 2020; 10(2):44-47.
31. Sze Lim, Y., Sze Hui Lee, S., & Chin Tan, B. *Antioxidant Capacity and Antibacterial Activity of Different Parts of Mangosteen (Garcinia Mangostana* Linn*.) Extracts.* Fruits, 2013; 68(6) .
32. Davis, W. W., & Stout, T. R. (*).* Disc plate method of microbiological antibiotic assay. *Journal of microbiology*, 1971; 22(4):659-665.
33. Robinson, T., 1995. *Kandungan Organik Tumbuhan Tinggi*. Edisi 6. ITB Press, Bandung.
34. Harbone, B. J., 1987, *Metode Fitokimia: Penuntun Cara Modern Menganalisis Tumbuhan*. Penerjemah: Kosasih Padmawinata dan Iwang Soediro, ITB, Bandung.
35. Cowan, M. M. Plant Product as Microbial Agent, *Clinical Microbial Review*, 1999; 12:564-582.
36. Ajizah, A. Sensitivitas Salmonella thypimurium Terhadap Ekstrak Daun Psidium guajava L., *J. Bioscientiae*,2004; 1(1):31-38.
37. Madduluri, S., Rao, K. B., Sitaram, B. In Vitro Evaluation of Antibacterial Activity of Five Indigenous Plants Extracts Against Five Bacteria Pathogens of Humans, *International Journal of Pharmacy and Pharmaceutical Sciences*, 2013; 5:679-684.
38. Jawetz, M., Adelberg's., 1996, *Medical Microbiology*, Edisi 20, Alih Bahasa: Edi Nugroho., Maulany, R. F., Penerbit Buku Kedokteran ECG., Jakarta.
39. Prescott, L, M., Harley, J. P., Klien, D. A., 2005, *Microbiology*, Edisi 6, Mc-Graw Hill, New York.
40. Widhyastini, I. M. Pengaruh Suhu Pengeringan Kulit Bagian Luar Dan Bagian Dalam Manggis (Gracinia Mangostana, L.) Terhadap Kandungan Proksimat, Alkaloid Dan Flavonoid. *Jurnal Sains Natural*, 2017; *3*(2):193-200.
41. Jawetz, E., Melnick, J. L., Adelberg, E. A., 2005. *Mikrobiologi Kedokteran*. Buku 1. Penerbit Salemba Medika. Jakarta.
42. Meilina, N. E., Hasanah, A. N. Review Artikel: Aktivitas Antibakteri Ekstrak Kulit Buah Manggis (Grachinia mangostana L.) Terhadap Bakteri Penyebab Jerawat. *Julnal Farmaka*.2018; 16(2):322-328