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Effectiveness of Tamarind Peel (*Tamarindus indica* L.) Against *Staphylococcus aureus* Using Different Extraction Methods

Andi Indrawati[1]*, Suherman Baharuddin[2] , Nindia Reski Ardila A[3]
[1]Kurnia Jaya Persada Institute of Health and Business
[2,3]East Indonesia University
Corresponding Author: Andi Indrawati andindrawaty2303@gmail.com

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A B S T R A C T

This study aims to determine the effectiveness of tamarind rind against the growth of *Staphylococcus aureus* using different extraction methods. The research method is a laboratory experimental study to test the effectiveness of Tamarind peel (*Tamarindus indica* L.) against *Staphylococcus aureus* using different extraction methods, namely the maceration method and the soxhletation method. The results showed that the extract from the rind of Tamarind (*Tamarindus indica* L.) was effective in inhibiting the growth of *Staphylococcus aureus* using either maceration or soxhletation extraction methods. The most effective concentration is at a concentration of 0.8% w/v with a Sig value. 0.000 < 0.05 (Oneway Anova α = 0.05) in the strong category of inhibition (10 – 20 mm)

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INTRODUCTION

Activities regarding the use of various natural ingredients for health purposes are still being carried out by the community. One of the natural ingredients that is highly believed to play a role in health is *Tamarindus indica* L. In Indonesia, this ingredient is better known as Tamarind. The efficacy and benefits *of Tamarindus indica* L. in health has been widely believed by the world community so that it has led to the development of various lines of research, starting from things to find out the contents, ingredients, and active compounds of *Tamarindus indica* L which may have potential to the mechanism pathways that have a role in various conditions in body from various diseases (Putri, 2014).

Tamarindus indica or better known as Tamarind is a plant originating from Africa, but over time it has also grown in India, Sudan, Pakistan, the Philippines, Spain, Mexico, and also in Indonesia (Ranjan et al., 2009). Tamarind (*Tamarindus indica* L) is included in the class of leguminous plants or legumes that contain various bioactive components that are very useful for health (Hardoko and Abigail C, 2013). On the other hand, Tamarind is also categorized as one of the functional and multifunctional food plants (Astawan, 2009) .

Giving the name tamarind to this plant is thought to be closely related to the sour taste of the fruit and is found in the island of Java (Silalahi, 2020). As in the areas of West Java, Central Java, East Java including Madura, it is also found in other areas such as North Sumatra, West Kalimantan, Bali and South Sulawesi. Tamarind usually grows in the lowlands and becomes a tree planted on the roadside as a protective tree. Tamarind is believed to have various properties in medicine, including reducing fever, curing constipation, treating asthma, treating diabetes, reducing nausea in pregnancy, as a flatulence, reducing itching, as an ingredient for slimming the body, can be used to treat lung disease and so on (Princess, 2014).

The existence of various properties and uses of tamarind, both in the leaves, bark, fruit and seeds, is due to the many ingredients that tamarind has, including protein, fat, carbohydrates, fiber, alkaloids, saponins, tannins , flavonoids, amyloids, minerals such as potassium, magnesium, phosphorus, sulfur, calcium, minerals and some vitamins (Narina & Catanzaro, 2018; Soemardji, 2007) . Several studies have also been conducted to find that tamarind is an antioxidant (Imrawati et al., 2016) , as an antibacterial (Prabhu & Teli, 2014; Puspodewi et al., 2015), as antidiabetic mellitus (Shahraki et al., 2011), as an anticholesterol (Chong et al., 2012), as an analgesic (Khalid et al., 2010), anticancer (Aravind et al., 2012), anti-obesity (Azman et al., 2012).

In Indonesia, especially local people, have long used parts of Tamarind for various purposes such as charcoal, firewood, traditional medicine, and food ingredients, seasonings and preservatives (Silalahi, 2020). In tamarind fruit, sometimes many people, after taking the fruit, throw the skin away, when it accumulates it will cause environmental pollution. On the other hand, tamarind rind also has benefits in the health sector because it has several chemical compounds that have potential as a treatment.

Currently, research on tamarind peels is still small and very limited, but there are several studies as a basic reference, namely Syaputri's research in 2014,

which stated that the results of the TLC test of 70% ethanol extract of tamarind peel contained compounds, namely flavonoids, alkaloids and phenolics (tannins). This is also reinforced by the research of Prabhu *et al*. 2014 stated that *T. indica* fruit peel extract inhibited the growth of *Staphylococcus aureus*, *Escherichia coli* bacteria (Prabhu & Teli, 2014).

The purpose of this research is to determine the effectiveness of tamarind rind on the growth of *Staphylococcus aureus* using different extraction methods and to determine which concentration is most effective so that scientific data can be obtained which can add information about the effectiveness of tamarind peel (*Tamarindus indica* L.) on the inhibition or killing power of a microorganism.

LITERATURE REVIEWS

Tamarind (*Tamarindus indica* L.) contains protein, fat, fiber, alkaloids, saponins, tannins, flavonoids, minerals such as potassium, magnesium, phosphorus, sulfur, and calcium (Bhadoriya et al., 2011; Huey, 2017). Tannins and alkaloids have anti-inflammatory activity. Saponins have functions as anti-inflammatory, antibacterial and anti-carcinogenic (Bin Mohamad et al., 2012; Huey, 2017). Tamarind also contains minerals and vitamins such as thiamine (vitamin B1), pectin, riboflavin (vitamin B2), niacin (vitamin B3 or B complex), ascorbic acid (vitamin C), and β-carotene (vitamin A) (Razali et al., 2012).

Phytochemical research shows that *Tamarindus indica* has various contents as follows: phenolic compounds, glycosides, *mallic acid*, *tartaric acid*, gum, pectin, arabinose, xylose, galactose, glucose, and *uronic acid*. Through ethanol extract *Tamarindus indica* was found fatty acids and various essential trace elements such as arsenic, calcium, cadmium, copper, iron, sodium, manganese, magnesium, potassium, phosphorus, zinc and small amounts of vitamin A (Bhadoriya et al., 2011).

This fruit from Tamarind contains high levels of protein and carbohydrates. It also contains a variety of organic acids, including *tartaric acid* , *acetic acid* , *citric acid, formic acid, malic acid* , and *succinic acid* ; amino acids, *invert glucose* (25-30%); pectin; proteins; fat (Putri, 2014). *Tamarindus indica* seeds contain polysaccharides, and galactose. It also contains protein, fat and fatty oils, some keto acids and antioxidant phenols and fatty acids (Bhadoriya et al., 2011). The mineral composition contained in *Tamarindus indica seeds* sequentially is iron, phosphorus, potassium, magnesium, calcium, sodium (Putri, 2014). Tamarind Leaves contains 13 components, of which linonene and benzyl benzoate are the most dominant. This section also contains two triterpenes, lupanone and lupeol. Other ingredients are sitexin, isovetexin, orientin, isiorientin, 1-malic acid, tannins, glycosides, and peroxidase. Tamarind bark, contains tannins, saponins, glycosides, peroxidase and fat. Polyphenols found in the skin are dominated by proanthocyanidins in various forms, such as apigenin, catechin, procyanidin B2, apicatechin, procyanidin dimer, procyanidin trimer, together with taxifolin, eriodictyol, and naringenin (Bhadoriya et al., 2011; Soemardji, 2007). Tamarind rind, namely flavonoids, terpenoids, alkaloids, and phenolics (tannins) (Syahputri, 2013).

Basically, *Tamarindus indica* has long been used in various ethnicities throughout Indonesia and in the world as a traditional medicine. Research (Kuru, 2014) reported that *Tamarindus indica* is used to treat stomach pain, diarrhea, dysentery, some bacterial infections, treat wounds, constipation and inflammation. The use of *Tamarindus indica* as a traditional medicine is closely related to its bioactivity as an antimicrobial, antidiabetic mellitus, anticholesterol, analgesic, antiobesity and antioxidant and so on (Silalahi, 2020).

METHODOLOGY

Types of Research

This type of research is laboratory experimental research which is laboratory research to test the effectiveness Tamarind peel (*Tamarindus indica* L.) to *Staphylococcus aureus* using different extraction methods.

Research Population and Sample

The population of this research is Tamarind (*Tamarindus indica* L.) which is found throughout the city of Makassar, especially in Tamarind fruit which is still intact with the outer skin. The sample to be used in this research is the skin of tamarind fruit (*Tamarindus indica* L.) which has been separated from the pulp and seeds.

Retrieval and Processing of Test Materials

The sample used in this study was Tamarind peel (*Tamarindus indica* L.). Tamarind fruit samples that has been collected is then separated from the fruit and seeds and then the tamarind skin is cleaned of impurities by washing it with running water. After cleaning, the tamarind skin is drained, then air-dried while occasionally drying using the sun. The test material in the form of dried tamarind peel samples was then crushed using a blender until it became dry coarse powder (simplicia). The result is put in an airtight container.

Preparation of Extract from Tamarind Skin (*Tamarindus indica* L.)

With the maceration method, referring to the research process (Imrawati et al., 2016), namely the extraction process is carried out by considering 150 g of Tamarind skin simplicia powder (*Tamarindus indica* L.) was put into a container (glass jar), then macerated with 96 % ethanol as much as 500 mL until the sample was completely submerged. Covered with *aluminum foil* and left for 3 x 24 hours while stirring occasionally. After three days, the macerated sample was filtered using filter paper to produce filtrate and residue (1). The residue was then remacerated with 500 mL of 96% ethanol, covered with *aluminum foil* and left for 2 x 24 hours while occasionally stirring. After two days, the samples were filtered using filter paper, resulting in filtrate and residue (2). Filtrates 1 and 2 were combined, then the liquid extract was concentrated using a *rotary vacuum evaporator* at 50^0C with a rotational speed of 50 rpm to remove the solvent. Furthermore, the extract was further evaporated over a water bath with a temperature of $+40^0$ C to remove the remaining solvent to obtain a thick extract of Tamarind peel (*Tamarindus indica* L.). After that the extract was weighed to determine the yield and then stored in a closed container before being used for further testing.

For the *Soxhlet* method , referring to the research process (Fakhrurrazi et al., 2016), namely the extraction process is carried out by weighing 150 g of tamarind peel simplicia powder (*Tamarindus indica* L.) and put into a siphon then added with 2 times circulation of 95% ethanol (total solvent +544.6 mL per replication). The extraction is carried out until all the chemical ingredients of the simplicia have been extracted which is indicated by the clarity of the solvent in the siphon tube, usually the solvent in the siphon tube becomes clear after 20-25 circulations. Replication was carried out 2-3 times. All extracts were then evaporated using *a rotary vacuum evaporator* at 40^0C with a rotational speed of 50 rpm to remove the solvent. Furthermore, the extract was further evaporated over a water bath with a temperature of +40^0C to remove the remaining solvent so that a thick extract of Tamarind peel was obtained. (*Tamarindus indica* L.). After that the extract was weighed to determine the yield and then stored in a closed container in *the refrigerator* before being used for further testing.

1. **Extract Characterization Test (Extract Parameters** *)*

   Extract characterization tests included yield, shape, color, smell and taste as well as moisture content and ash content.

2. **Examination of the chemical content of Tamarind skin (*Tamarindus indica* L.)**

   Phytochemical screening was carried out to determine the secondary metabolites contained in Tamarind peel extract (*Tamarindus indica* L.). The secondary metabolites that were tested qualitatively included flavonoids, terpenoids, alkaloids, phenolic (tannins) research results (Syahputri, 2013) and saponins, glycosides, steroids, phenols. Secondary metabolite testing refers to testing (Rahmadani, 2015; Tiwari et al., 2011).

3. **Testing the concentration of tamarind peel extract (*Tamarindus indica* L.) Against *Staphylococcus aureus.***

   Preparation of Minimum Inhibitory Concentration (MIC) of Tamarind peel extract (Tamarindus indica L.)

   MIC determination was carried out by making the initial concentration of tamarind rind extract using the main concentration (stock), namely 2% w/v. Furthermore, the smallest concentration was made with each concentration, namely, 0.05%, 0.1%, 0.15%, 0.2% and 0.25%, then pipetted each of these concentrations as much as 0.5 mL and then put into each test tube that has been filled with NB (Nutrient Broth) as much as 3 mL and added 0.1 mL of bacterial suspension. Furthermore, for media control (KM) put 1 mL of NB (Nutrient Broth) into the tube and germ control (KK) 0.9 mL of NB (Nutrient Broth) and 0.1 mL of the test bacterial suspension were put into the germ tube. All tubes were vortexed until homogeneous and incubated at 37^0C for 24 hours in an incubator, then the turbidity was observed by comparing the tubes with the control. The lowest concentration of the sample solution that can inhibit bacterial growth is indicated by the onset of visual clarity. This concentration is determined as the Minimum Inhibitory Concentration (MIC) which will be used in testing the effectiveness for the initial concentration (Atikah, 2013).

Testing the Test Material with the Agar Diffusion Method

Testing the concentration of tamarind peel extract (*Tamarindus indica* L.) extracted by maceration and soxhletation of *Staphylococcus aureus* by means of Mueller Hinton Agar medium was poured aseptically into each sterile petri dish as much as 20 ml then added 1 ml of *Staphylococcus aureus suspension*, then homogenized and allowed to solidify. After that, put the disc paper previously soaked in a concentrated solution of Tamarind peel extract (MIC yield concentration) and positive control (30 ppm amoxicillin solution) and negative control DMSO solution 5% (dimethyl sulfoxide). Setting the distance of the disc paper from the edge of the petri dish at least 20 mm then incubated at 37^0C for 1 x 24 hours. The inhibition area formed was measured with a slide rule. This treatment was replicated 3 times, the average and standard deviation were calculated.

4. Observation, Barrier Diameter Measurement and Data Analysis

Observation and measurement of the diameter of the inhibition zone was carried out after an incubation period of 1 x 24 hours at 37^0C using a slide rule. Furthermore, data from measurements of the diameter of inhibition of bacterial growth were analyzed using the method of analysis of variance (*one-way* ANOVA) and correlation tests using the help of the IBM SPSS Statistics version 26 program.

RESULTS

1. Yield Value

Table 1. Yield Values Extracted from Tamarind (*Tamarindus indica* L.) Peel

No.	Extraction	Simplician weight of *T. indica* L. (g)	Extract Weight (g)	Yield Value (%)
1	Maceration	150	9.18	6.12
		150	9.22	6.14
		150	9.18	6.12
Average Yield value				**6.12**
2	Soxhletasi	150	9.87	6.58
		150	9.85	6.56
		150	9.82	6.54
Average Yield value				**6.56**

2. Characterization Testing

Table 2. The Results of Characterization Tests on Tamarind Peel (*Tamarindus indica* L.) Based on Different Extraction Methods

Specification	Description (Maceration Method)	Description (Soxhlet method)
Yield (%)	6.12	6.56
Form	Concentrated Extract	Concentrated Extract
Color	Dark brown	Dark brown

Smell	Typical, not stinging	Typical, not stinging
Flavor	Bitter	Bitter
Water content (%)	3.33	3.17
Ash Content (%)	0.39	0.28

3. Examination of Chemical Content

Table 3. Results of Chemical Content Examination (Phytochemical Screening) of Tamarind peel (*Tamarindus indica* L.)

Content Test	Reactor	Test result	Information
Alkaloids	Mayer	A yellow/white precipitate formed	Detected (+)
	Dragendorff	A reddish brown precipitate formed	Detected (+)
Phenol	$FeCl_3$ 1%	Formed brownish green color	Detected (+)
Phenolic (Tannin)	Gelatin 1% (NaCl)	A white precipitate formed	Detected (+)
Flavonoids	3 drops of solution NaOH	Formed a dark yellow color becomes colorless	Detected (+)
Glycosides	NaOH	No yellow color is formed	Not detected (-)
terpenoids	Liebermann-Burchard	A brown/violet ring is formed	Detected (+)
Saponins	H_2O	No foam formed	Not detected (-)
Steroids	Liebermann-Burchard	No greenish blue ring was found	Not detected (-)

4. Determination of Minimum Inhibitory Concentration (MIC)

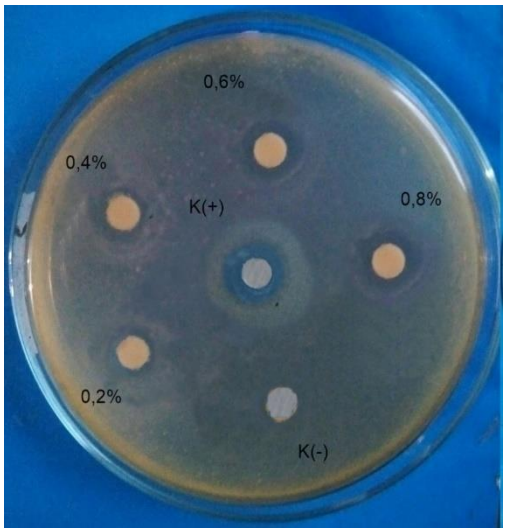
Table 4. Results of Determining the Minimum Inhibition Concentration (MIC) of Tamarind Peel Extract (*Tamarindus indica* L.)

Concentration (%)	Test result	Information
0.05	Cloudy	There is bacterial growth
0.1	Cloudy	There is bacterial growth
0.15	Cloudy	There is bacterial growth
0.2	Clear	No bacterial growth
0.25	Clear	No bacterial growth

5. Measurement Results with the Maceration Extraction Method

Table 5. Results of Measurements of Tamarind Peel Extract (*Tamarindus indica* L.) on Growth *Staphylococcus aureus* using the Extraction Method Maceration with an Incubation Period 1 X 24 Hours At 37^0 C.

Test Bacteria	Inhibition zone diameter(mm) *Tamarindus indica* L. peel extract					
	Control (-)	0.2% w/v	0.4% w/v	0.6% w/v	0.8% w/v	Control (+)
Staphylococcus aureus	6.3 6.3 6.3	7.5 7.5 8.0	9.5 8.8 8.8	10.5 11.3 10.8	11.8 12.0 11.8	21.6 21.8 22.2
Amount	**18.9**	**23.0**	**27.1**	**32.6**	**35.6**	**65.6**
Average	**6.3**	**7.66**	**9.03**	**10.6**	**11.86**	**21.86**
SD	±0.00	±0.289	±0.404	±0.404	±0.115	±0.306



Barrier Diameter

Tukey HSD [a]

Concentration	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
Control (-)-DMSO 5%	3	6.300					
Concentration 0.2%	3		7.667				
Concentration 0.4%	3			9.033			
Concentration 0.6%	3				10.867		
Concentration 0.8%	3					11.867	
Control (+)-amoxicillin 30 ppm	3						21.867
Sig.		1.000	1.000	1.000	1.000	1.000	1.000

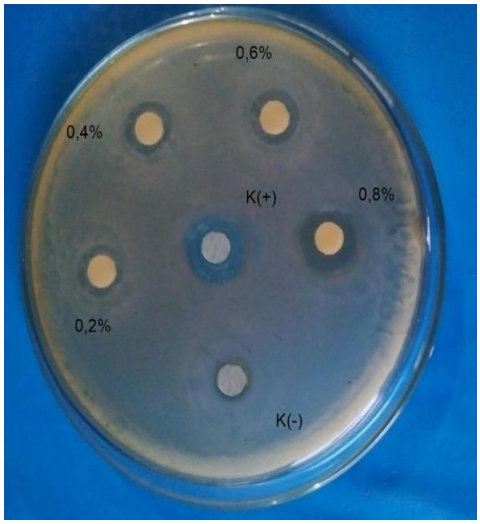
Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 3.000.

Figure 1.Barrier Diameter
Control (-) = DMSO 5% (dimethyl sulfoxide)
Control (+) = Amoxicillin Solution 30 Ppm

6. **Measurement Results with the Soxhletation Extraction Method**

Table 6. Results of Measurements of Tamarind Peel Extract (*Tamarindus indica* L.) on Growth *Staphylococcus aureus* using the Extraction Method Soxhletation with an Incubation Period 1 x 24 Hours at 37^0C.

Test Bacteria	Inhibition zone diameter(mm) *Tamarindus indica* L. peel extract					
	Control (-)	0.2% w/v	0.4% w/v	0.6% w/v	0.8% w/v	Control (+)
Staphylococcus aureus	6.3 6.3 6.6	8.8 9.3 9.5	10.5 11.0 10.8	11.7 12.5 12.5	13.3 13.3 13.5	21.6 21.8 22.5
Amount	**19.2**	**27.6**	**32.3**	**36.7**	**40.1**	**65.9**
Average+SD	**6.4**	**9.20**	**10.76**	**12.23**	**13.36**	**21.96**
SD	±0.173	±0.361	±0.252	±0.462	±0.115	±0.473



Barrier Diameter

Tukey HSD [a]

Concentration	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
Control (-)-DMSO 5%	3	6.400					
Concentration 0.2%	3		9.200				
Concentration 0.4%	3			10.767			
Concentration 0.6%	3				12.233		
Concentration 0.8%	3					13.367	
Control (+)-amoxicillin 30 ppm	3						21.967
Sig.		1.000	1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 3.000.

Figure 2. barrier Diameter
Control (-) = DMSO 5% (dimethyl sulfoxide)
Control (+) = *amoxicillin* solution 30 ppm

DISCUSSION

Antibacterial effectiveness test is a test conducted to measure the level of use of a compound or chemical component in inhibiting or killing a certain type of microorganism. Basically to obtain a compound or chemical component that has antibacterial properties is based on certain processes involving various methods such as the extraction process, the process of separating a compound and the process of identifying active compounds and involving a scientific process in terms of the latest scientific research in the context of development or discovery of traditional medicine.

In this research, the material that will be developed for testing to obtain a chemical compound or component that has antibacterial properties is tamarind rind with the scientific name *Tamarindus indica* L. Basically, many people have used or utilized parts of tamarind for daily needs, but the skin of the tamarind fruit is thrown away and in the end it can cause environmental pollution. Even though indirectly the tamarind rind has chemical compounds or components that can be utilized in the health sector because of its potential as a treatment.

In this research process, various processes and methods were involved to obtain a compound or chemical component from tamarind rind that has potential as an antibacterial starting from the processing of the test material, the extraction process, determining the characteristics, identifying chemical components, and testing as an antibacterial, where in the test using *Staphylococcus aureus* as a test indicator. The process of extracting tamarind rind involves maceration and soxhletation extraction processes, the maceration extraction process is a simple extraction method by soaking the material in a suitable solvent to obtain active compounds without any heating process while the soxhletation extraction process is the extraction of a solid material with a liquid solvent continuously through an indirect heating process involving solid-liquid contact.

Research results from tamarind rind (*Tamarindus indica* L.) by using a different extraction method in terms of characterization testing, namely for the maceration extraction method obtained in the form of a yield of 6.12%, in the form of a concentrated extract of blackish brown color, distinctive odor and not overpowering, bitter taste with a water content of 3.33% and ash content as big 0.39%. Whereas for method Soxhletation extraction obtained an average yield value of 6.56% in the form of a concentrated extract that is blackish brown in color, has a distinctive odor and does not sting with a bitter taste and has a water content of 3.17% and an ash content of 0.28%. Can be seen in table 1 and table 2.

According to (Indrawati et al., 2022), stated that it is important to identify a chemical compound or component of a plant in order to produce an overview of the structure or class of compounds contained in a plant to be studied. Identification can be carried out through phytochemical screening (phytochemical screening) using certain (specific) tools or reagents through preliminary tests to determine a class of secondary metabolite compounds that have compounds of biological activity which can be used as initial information in identifying and determining the class of compounds or chemical components that are found in a plant.

Examination of the chemical content of tamarind rind (*Tamarindus indica* L.) includes alkaloids, phenols, phenolics (tannins), flavanoids, glycosides, terpenoids, saponins and steroids. Where in examining the alkaloid content using Mayer's reagent, a yellow precipitate was found, as well as with the Dragendorff reagent, a reddish brown precipitate was found. This indicates that the tamarind rind may contain alkaloid compounds (detected). For the examination of phenolic compounds in tamarind rind, 3% FeCl reagent was used, where the results obtained were a brownish green color formed which indicated a positive presence of phenol content (detected). Similarly, the examination of phenolics (tannins) using 1% gelatin reagent (NaCl) also indicates that tamarind

rind may contain phenolic compounds (tannins) which are characterized by the formation of a white precipitate (detected).

In examining the flavanoids in tamarind rind using 3 drops of NaOH solution, after being observed at intervals of 1-2 minutes a change in the intensity of a deep yellow color to colorless indicates the possibility of flavanoid compounds (detected). For examination of glycoside compounds in tamarind rind using NaOH, no yellow color was found, this indicates that tamarind rind may not have glycoside compounds (undetectable). Examination of terpenoids using the Liebermann-Burchard reagent indicated that tamarind rind contains terpenoid compounds which are characterized by the formation of a brownish or violet ring (detected). It is different from the examination of saponin compounds in tamarind rind using H_2O and then shaken vigorously for ± 30 seconds and no foam is found, this indicates that there is no saponin content (undetectable). For the examination of steroid compounds also using the Liebermann-Burchard reagent, no blue ring was found which indicates that the skin of tamarind (*Tamarindus indica* L.) probably does not contain steroid compounds (not detected). This can be seen in table 3.

Examination results regarding the chemical content of tamarind skin (*Tamarindus indica* L.) was also reinforced in research conducted by (Syahputri, 2013) and (Rahmadani, 2015), where in their research it was stated that in the 70% ethanol extract of tamarind peel (*Tamarindus indica* L) based on the TLC test results there was compounds that are the same as the theory, namely flavonoids, alkaloids, terpenoids and phenolics (tannins) as well phenol.

The results of chemical content examination that have been obtained are then tested on the effectiveness of Tamarind peel (*Tamarindus indica* L.) to *Staphylococcus aureus* by using a different extraction method by diffusion so that the concentration of the resulting extract from MIC (*Minimum Inhibitory Concentration*) obtained was 0.2% w/v, 0.4% w/v, 0.6% w/v and 0.8 % w/v, while the negative control uses DMSO 5% (*dimethyl sulfoxide*) and the positive control used amoxicillin 30 ppm.

Testing the effectiveness of Tamarind peel extract to *Staphylococcus aureus* using the maceration extraction method with an incubation period of 1 x 24 hours at 37^0C obtained results in the form of an inhibition zone with an average diameter for a concentration of 0.2% w/v of 7.66 ± 0.289, a concentration of 0.4 % w/v of 9.03 ± 0.404, concentration of 0.6 % w/v of 10.86 ± 0.404, concentration of 0.8 % w/v of 11.86 ± 0.115 while for the negative control DMSO 5% of 6.30 ± 0.00 and a positive control of amoxicillin 30 ppm of 21.86 ± 0.306. The test results can be seen in table 5.

Testing the effectiveness of Tamarind peel extract to *Staphylococcus aureus* using the soxhletation extraction method with an incubation period of 1 x 24 hours at 37^0C obtained results in the form of an inhibition zone with an average diameter for a concentration of 0.2% w/v of 9.20 ± 0.361, a concentration of 0.4 % w/v of 10.76 ± 0.252, concentration of 0.6 % w/v of 12.23 ± 0.462, concentration of 0.8 % w/v of 13.36 ± 0.115 while for the negative control DMSO 5% was 6.40 ± 0.173 and the positive control was amoxicillin 30 ppm of 21.96 ± 0.473. The test results can be seen in table 6.

In the process of testing the effectiveness of Tamarind peel extract to *Staphylococcus aureus* using the extraction method by maceration and soxhletation with an incubation period of 1 x 24 hours at 37^0C, respectively, there was an increase in inhibition that occurred at each concentration, in other words, tamarind peel extract extracted by maceration and soxhletasi is effective in inhibiting the growth of *Staphylococcus aureus.* This can be seen from the data analysis using the analysis of variance test (oneway ANOVA), the SPSS output results are obtained with each Sig. of 0.000 <0.05 so that the average concentration variations and resulting inhibition zones were significantly different, which means there were differences between treatments, where the higher the concentration of tamarind peel extract tested, the greater the diameter of the inhibition zone produced on growth. *Staphylococcus aureus.*

In testing the effectiveness of tamarind peel extract to *Staphylococcus aureus,* it turns out that the inhibition resulting from each concentration variation in the soxhletation method of extraction is greater than the inhibition produced in the maceration extraction method, this is due to the possibility that in the soxhletation method of extraction there are more compounds that have the potential as antibacterial compared to the extraction method by maceration, besides that it is also possible that the extraction method by soxhletation is carried out at high temperatures so that the withdrawal of the active compound from the tamarind rind is greater than the extraction method by maceration. In the yield of Tamarind (*Tamarindus indica* L.) peel obtained, the extraction method by soxhletation was also more numerous than the extraction method by maceration.

Test results used in determining the effectiveness of Tamarind (*Tamarindus indica* L.) peel using maceration and soxhletation extraction methods, it turns out that with various concentrations starting from 0.2% w/v, 0.4% w/v, 0.6% w/v and 0.8% w/v have different barriers – different to the growth of *Staphylococcus aureus,* but in terms of the classification of the tamarind peel extract as an antibacterial or antimicrobial it is included in the medium – strong inhibition category. This can be seen in a quote from the research results (Suherman et al., 2018), stating that in the category of an inhibition based on the diameter of the inhibition zone, namely for the inhibition response in the weak category, it has an inhibition zone diameter (mm) of ≤ 5 mm, for the medium category is 5 – 10 mm, the strong category is 10 – 20 mm while for the inhibition response in the very strong category is ≥ 20 mm.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research results and data analysis, it can be concluded that the extract from Tamarind peel (*Tamarindus indica* L.) effective in inhibiting the growth of *Staphylococcus aureus* both by using maceration and soxhletation extraction methods. The most effective concentration is at a concentration of 0.8% w/v with a Sig. 0.000 < 0.05 (*Oneway Anova* $\alpha = 0.05$) in the category of strong inhibition (10 – 20 mm)

FURTHER STUDY

The results of research that has been done on the effectiveness of Tamarind (*Tamarindus indica* L.) peel to *Staphylococcus aureus* by using different extraction methods and various results in the literature, it is suggested that further research be conducted on tamarind peels in terms of pharmaceutical preparations and testing them in vivo on test animals.

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