Efficacy of Turmeric Extract (Curcuma domestica Val) 40%, 50%, AND 60% CONCENTRATIONS IN INHIBITING THE GROWTH OF Streptococcus mutans bacteria

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Abstract: The oral cavity is the entrance to the bacteria that can cause the caries disease. The main bacteria cause the caries is Streptococcus mutans. The purpose of this research was to know the effectiveness of turmeric (Curcuma domestica Val) extract against the growth of Streptococcus mutans bacteria. This research is an experimental lab in vitro using the design of the post test only control group with Kirby Bauer antibacterial test at concentration of 40%, 50%, and 60% with positive control (0.2% Chlorhexidine gluconate) and negative control (96% ethanol). The results showed that turmeric (Curcuma domestica Val) extract with a concentration of 40% there was an average inhibition zone of 8.4 mm, in the turmeric (Curcuma domestica Val) extract with a concentration of 50% there was an average inhibition zone of 8.98mm, and in the turmeric (Curcuma domestica Val) extract with a concentration of 60% there was an average inhibition zone of 9.28 mm. Mann Whitney shown that there were not significant differences of turmeric (Curcuma domestica Val) extract at all concentration with positive control, and there were significant differences with negative control. From the research results, it can be concluded that turmeric (Curcuma domestica Val) extract can inhibit the growth of Streptococcus mutans bacteria.

Key words: Turmeric (Curcuma domestica Val) extract, Streptococcus mutans, inhibition zone

I. INTRODUCTION

Health is a very important asset for every human being. Without good health, humans cannot perform their activities optimally. As we know, health is expensive. One of the cheap ways to get good health is to keep the body healthy with a healthy and clean lifestyle. In other words, prevention is better than cure. Prevention (preventive) and health promotion (promotive) are very important in the world of health without compromising treatment (curative) and rehabilitative (health restoration).

The World Health Organization (WHO) cit Huber, et al (2011), states that health is a perfect state of being physically, mentally and socially, not only free from disease or weakness/disability. The definition of health is also stated in the Law of the Republic of Indonesia Number 23 of 1992, which states that health is a state of well-being of body, soul, and society that enables everyone to live socially and economically productive.

Dental and oral health is an integral part of overall body health that cannot be separated, because the oral cavity is one of the entrances for disease-causing bacteria to other parts of the body. By maintaining oral and dental hygiene, you can reduce the risk of getting diseases that involve the health of the body, especially the health of the oral cavity and teeth. One of the dental and oral diseases that is the highest order in dental and oral health is dental caries. Based on data from the Basic Health Research (2018), the national prevalence of dental and oral problems is 57.6%, which if not handled properly the prevalence of caries will continue to increase.

Dental caries is one of the dental diseases experienced by most of the world's population. Caries means cavities and is characterized by progressive destruction of the enamel and dentin layers. This situation is caused by the activity of microorganisms in the mouth, or bacteria in plaque (Kidd and Bechal, 1992). The activity of microorganisms in the mouth causes the demineralization process. Demineralization is the dissolution of tooth enamel minerals due to acid concentrations that have a pH below 5.5 higher on the enamel surface than in the enamel (Dawes C, 2003). The process of caries in teeth involves several factors that do not stand alone but work together. There are 4 important factors that interact with each other in the formation of dental caries, namely microorganisms, host, food, and time (Ramayanti and Purnakarya, 2007).

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Microorganisms play an important role in causing caries. The main bacteria that causes caries is Streptococcus mutans bacteria. These bacteria are found in plaque. Plaque will form on all surfaces of teeth and fillings, developing best in areas that are difficult to clean, such as the gingival margins, on proximal surfaces, and in fissures. These cariogenic bacteria will ferment sucrose into very strong lactic acid, which can cause demineralization (Ramayanti and Purnakarya, 2013). To prevent and overcome various kinds of dental and oral diseases, especially dental caries, currently a lot of research is being carried out using natural materials that aim to produce medicines in an effort to support health care programs. (Horax, 2000).

Since the first Indonesian people have believed and believed that natural ingredients are able to cure various types of diseases. In addition, the use of natural ingredients used as drugs rarely causes adverse side effects and the price is more economical than drugs made from synthetic materials (Horax, 2000).

Indonesia is known as a country rich in biodiversity. Almost all types of plants can grow in this area of the country. In addition to enjoying its beauty and being food, plants can also be used as traditional medicine. The most commonly used plant species in Indonesia as traditional medicine is turmeric. Turmeric (Curcuma domestica Val) is one of the plants used for traditional medicine by our ancestors for a long time. This turmeric plant is one of the plants that is easy to get and the price is cheap. Turmeric is a spice plant that functions as an antibacterial because turmeric contains various compounds, including curcumin and essential oils. This essential oil can be used as an antibacterial because it contains hydroxyl and carbonyl functional groups which are phenol derivatives. The antibacterial activity of curcumin is by inhibiting the proliferation of bacterial cells (Yuliati, 2016).

A previous study conducted by Kumara et al (2019) regarding "Test the Effectiveness of Turmeric Extract (Curcuma longa) Against the Growth Inhibition of Streptococcus mutans Bacteria" found no inhibition on Streptococcus mutans bacteria from the lowest concentration of 5% to the highest 40% with inhibition 0 mm. The study used a positive control in the form of vancomycin and a negative control in the form of 96% ethanol.

The study also showed that various doses of turmeric extract (5%, 10%, 20%, and 40%) could not inhibit the growth of Streptococcus mutans bacteria. So in this study using a concentration of 40%, 50%, and 60% which is where there is an increase in concentration from previous studies.

Based on this description, a study was conducted on the antibacterial effectiveness of turmeric extract (Curcuma domestia Val) against Streptococcus mutans bacteria.

II. LITERATURE REVIEW

Based on the epidemiology of caries occurrence, Ramayanti and Purnakarya (2013) stated that the mechanism of caries occurrence consists of 3 theories, namely acidogenic theory, proteolytic theory, and flatfoot proteolysis theory.

a. Acidogenic Theory

Miller (1882) stated that tooth decay is a chemoparasite process consisting of two stages, namely decalcification of the enamel resulting in total destruction of enamel and decalcification of dentin in the early stages followed by dissolution of the softened residue. The acid produced by acidogenic bacteria in the carbohydrate fermentation process can decalcify dentin. According to this theory, carbohydrates, microorganisms, acids, and dental plaque play a role in the caries formation process.

b. Proteolytic Theory

Gottlieb (1994) stated that caries is a proteolysis process of organic matter in dental hard tissue and bacterial products. In this theory microorganisms invade organic pathways such as enamel lamellae and enamel rods sheaths, and damage these organic parts. Proteolysis is also accompanied by acid formation. Yellow pigmentation is a characteristic of caries caused by the production of pigment by proteolytic bacteria.

c. Classification Proteolysis Theory

Schatz (1955) stated that bacterial attack on enamel is initiated by keratinolytic microorganisms and consists of the destruction of proteins and other organic components of enamel, especially keratin. This causes the formation of substances that can form chelates and dissolve with the mineral components of the tooth resulting in decalcification of the enamel at neutral or alkaline pH.

2.1 Turmeric (Curcuma domestica Val)

Turmeric (Curcuma domestica Val) is a tropical plant originating from Southeast Asia and at present this plant is a trade crop in China, India, and Indonesia. Some other names of turmeric known in Indonesia are turmeric (Aceh), temukuning (Java), turmeric (Timor), cumin (Lampung), kewungi (Flores), and janar (Banjar) (Winarto, 2004).

Turmeric is a plant that is very easy to obtain and is rich in properties so that it has been widely used by humans for centuries. Turmeric is a plant that is used as a spice which is widely used as a cooking spice, food coloring, and traditional medicine (Septiana, 2015).

The morphology of the turmeric root is the shape of the rhizome is elliptical with a diameter of 1-2 cm and a length of 3-6 cm and forms a branch of the rhizome in the form of a stem that is in the ground. The rhizome is the main part of the turmeric plant which is where the shoots grow and has an aromatic odor. The rhizome has a yellow to orange color and measures 2.5-7.0 cm in length with a diameter of 2.5 cm (Kumar et al, 2017).

Turmeric has a pseudo stem composed of petals or leaf sheaths that cover each other. Turmeric stems are wet because they are able to store water well, are round and have a purplish green color. The height of the turmeric stem reaches 0.75 – 1m. Turmeric leaves are arranged alternately following the petals which consist of the leaf midrib, leaf stalk, and leaf blade. The length of the leaf blade is between 31-84 cm. Leaf width between 10-18 cm. Turmeric leaves are oval in shape with a slightly rough surface. Leaf spines are flat and tapered or curved to resemble a tail. Leaf surface is light green. One plant has 6-10 leaves. (Winarto, 2004).

Turmeric is known to contain chemical compounds such as alkaloids, flavonoids, curcumin, essential oils, saponins, tannins, terpenoids. The main components in turmeric rhizome are curcumin and essential oils. Curcumin

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and essential oils have been shown to have anti-inflammatory properties. In addition, the curcuminoid group of compounds has properties that are antibacterial, anticonvulsant, analgesic, antidiarrheal, antipyretic, and antitumor. Curcumin compounds are the same as other chemical compounds such as antibiotics, alkaloids, steroids, essential oils, resins, and phenols which are included in the secondary metabolites of a plant (Indrayanto, 1987; Kristina et al, 2007; and Wijayakusuma, 2008). The chemical content of turmeric essential oil ranges from 2.5 to 6.0 which consists of components artumeron, alpha and beta tumeron, tumerol, alpha atlanton, beta kario filen, linalol, 1,8 cineol, zingiberen, dd felandren, d-sabinen, and borneol. In addition to curcuminoids and essential oils, turmeric rhizomes also contain other compounds such as starch, fat, protein, camphor, resin, resin, gum, calcium, phosphorus, and iron (Asnia et al, 2019).

Utilization of various chemical content of turmeric has been widely used by the community to treat various diseases. The use of turmeric as a traditional medicine is widely used as an anti-inflammatory, antidiarrheal, cold medicine, treating itching, wounds, and shortness of breath (Maulidya and Sari, 2016). Other pharmacological activities of turmeric are as anti-inflammatory, anti-immunodeficiency, antiviral, antibacterial, antifungal, antioxidant, anticarcinogenic, and anti-infective (Rajesh et al, 2013). Turmeric can also be used as a dye, a mixture of cosmetics, bactericides, fungicides, and stimulants (Bursatriannyo et al, 2014).

Turmeric has been used in traditional medicine for centuries in various parts of the world. There are many countries in South Asia using turmeric as an antiseptic for burns, bruises, and antibacterial. In Pakistan, turmeric is used as an anti-inflammatory agent and remedy for indigestion. While in Afghanistan, turmeric is used to clean wounds and stimulate wound healing by placing burnt turmeric over the wound. Since ancient times, turmeric has been used to treat sprains and swellings. In Ayurvedic medicine (India), turmeric is used as a treatment for various respiratory disorders (such as asthma, bronchial hyperactivity, and allergies), as well as for liver disorders, anorexia, rheumatism, diabetic wounds, colds, coughs, and sinusitis (Araújo and Leon, 2001).).

Curcumin and essential oils contained in turmeric are reported to have many pharmacological effects, one of which is as an antibacterial. Essential oils can be used as antibacterial because they contain hydroxyl and carbonyl functional groups which are phenol derivatives. These phenol derivatives will interact with the bacterial cell wall, then be absorbed and penetrate into the bacterial cell causing precipitation and protein denaturation, resulting in the lysis of the bacterial cell membrane. Antibacterial activity of curcumin by inhibiting the proliferation of bacterial cells (Yuliati, 2016).

Research conducted by Mohammed (2015) showed that the antibacterial activity of curcumin was very good against Streptococcus mutans and Streptococcus pyogenes, with inhibition zones of 9.7 mm and 10.2 mm, respectively. This study is in accordance with the theory which states that curcumin extract produces antibacterial activity against various microbes and also on bacteria such as Streptococcus, Staphylococcus, Lactobacillus, Helicobacter pylori (Chattopadhyay et al, 2004). In addition, curcumin is also a strong growth inhibitor against Gram positive bacteria (Staphylococcus aureus and Streptococcus mutans), Gram negative bacteria (E. coli and Pseudomonas aeruginosa), and pathogenic fungi (Candida albicans) (Shahi et al, 2000; Mohammed, 2015).

Framework of thinking

Of the various health conditions in the teeth, one of the most common problems experienced is dental caries. Caries requires proper treatment and handling by dentists who are experts in their fields. Caries itself is a disease that occurs due to 4 factors, namely the host, microorganisms, substrate, and time (Shafer, 2012).

One of the bacteria that causes caries is Streptococcus mutans. This bacterium is a Gram-positive cocci bacteria which are normal flora in the human body but can also be pathogenic in humans. Previously, antibiotics were the first-line therapy for dental caries. However, currently Streptococcus mutans bacteria are often found to be resistant to several antibiotics, making it difficult to select the appropriate antimicrobial for therapy. Therefore, the use of drugs from natural ingredients was chosen as an alternative treatment because it is considered safer and has few side effects (Budirahardjo, 2010).

A natural ingredient that has potential as a natural antibiotic is turmeric (Curcuma domestica Val). Curcumin and essential oils are two of the ingredients contained in turmeric which have the ability as an antibacterial to inhibit Gram-positive bacteria such as Streptococcus mutans. To use turmeric as a natural antibiotic, turmeric must first be extracted using existing extraction methods (Indrayanto, 1987).

Research Hypothesis

The hypothesis of this research is that turmeric extract (Curcuma domestica Val) at concentrations of 40%, 50%, and 60% has effectiveness in inhibiting the growth of Streptococcus mutans bacteria.

III. RESEARCH METHODS

This research is an experimental in vitro laboratory study using The Post Test – Only Control Group design.

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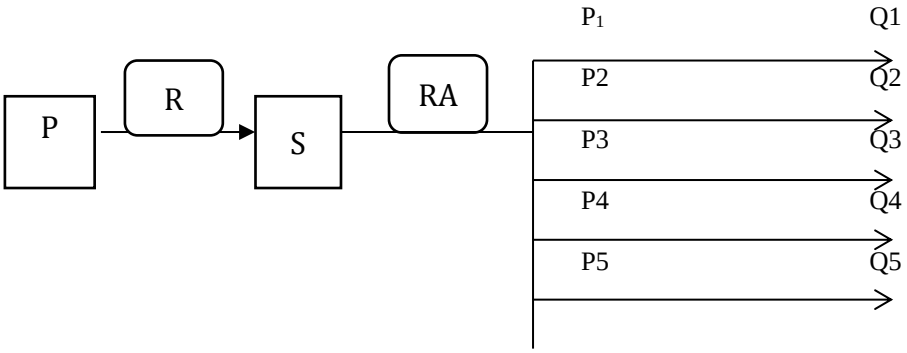

Figure1 Research Design

Information:
P : Population
S : Sample
R : Random
RA : Randomization of allocation
P1 : Administration of 0.2% Chlorhexidine gluconate in the positive control group
P2 : Treatment with turmeric extract using the maceration method with a concentration of 40%
P3 : Treatment with turmeric extract using the maceration method with a concentration of 50%
P4 : Treatment with turmeric extract using the maceration method with a concentration of 60%
P5 : Treatment with 96% ethanol in the negative control group
Q1 : Observation of results in the P1 . group
Q2 : Observation of results in the P2 . group
Q3 : Observation of results in the P3 . group
Q4 : Observation of results in the P4 . group
Q5 : Observation of results in the P5 . group

The population in this study were bacterial colonies obtained from Streptococcus mutans ATCC 35668 Laboratory of Microbiology, Faculty of Medicine, Udayana University Denpasar. The sample used in this study was Streptococcus mutans ATCC 35668 bacteria obtained from bacterial stock cultures stored in the Microbiology Laboratory, Faculty of Medicine, Udayana University Denpasar.

The sample size in this study used the general formula (Federer 1997). Based on the calculation results, the number of samples required for each treatment is 5. This sample size is used as a reference for repeating the research. The sampling technique uses a purposive sampling technique, which is sampling intentionally, in accordance with the required sample requirements with the assumption that the sample taken can represent the population of the research location.

The variables in this study can be divided into 3 types of variables, namely First, Independent Variables. The independent variable in this study was turmeric extract (Curcuma domestica Val) using the maceration method with concentrations of 40%, 50%, and 60%. Second, the Bound Variable. The dependent variable in this study was the growth of Streptococcus mutans. Third. Controlled variable. Temperature 37°, incubation duration of 24 hours, contact time, method of measuring the inhibition zone of Streptococcus mutans colonies, and research flow.

Data collection in this observation was carried out using a caliper to measure the diameter of the growth inhibition zone of Streptococcus mutans on Mueller Hinton Blood Agar media.

The manufacture of turmeric extract (Curcuma domestica Val) was carried out at the Laboratory of the Faculty of Pharmacy, Mahasaraswati University Denpasar. Phytochemical testing was carried out at the Faculty of Pharmacy, Mahasaraswati University, Denpasar. Testing the inhibition of turmeric extract (Curcuma domestica Val) against Streptococcus mutans bacteria at the Bali Provincial Health Laboratory. This research took place from September – November 2020.

The tools used in this research are Rotary evaporator, Incubator, Autoclave, Petri dish, Test tube and test tube rack, Micropipette and tip, caliper, Paper disc (blank disk), Tweezers, Ose, sterile container, Mask, Handscoon, Ice box.

The materials used in this study were turmeric extract with a concentration of 40%, turmeric extract with a concentration of 50%, turmeric extract with a concentration of 60%, chlorhexidine gluconate 0.2%, Streptococcus mutans bacteria ATCC 35668, sterile Aquades, ethanol 96%, cotton sticks sterile, filter paper

The research procedure to be carried out is sterilization of tools, manufacture of turmeric extract by maceration method, manufacture of Streptococcus mutans suspension, provision of positive control, provision of negative control, manufacture of Mueller Hinton blood agar media, in-vitro antibacterial activity test, observation and measurement, data analysis , Descriptive analysis, Normality and Homogeneity Test, Comparison Test and Treatment Effect Analysis.

IV. RESEARCH RESULT

This research was conducted at the Bali Provincial Health Laboratory in November 2020. The sample in this study was a preparation of Streptococcus mutans bacterial colonies that had been cultured at the Microbiology Laboratory, Faculty of Medicine, Udayana University Denpasar, which was then distributed to the Bali Provincial

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Health Laboratory. The number of samples used in this study were 25 samples consisting of five groups, namely the treatment of turmeric extract 40%, 50%, 60%, positive control and negative control. Each extract concentration was taken from turmeric that had been dried and mashed, then macerated using 96% ethanol solvent which had been thickened with a vacuum rotary evaporator at 40°C.

Phytochemical Identification Test Results of Turmeric Extract (Curcuma domestica Val)

In this study, a phytochemical test was conducted to determine the active content of turmeric extract (Curcuma domestica Val) qualitatively. The active ingredients tested included alkaloids, flavonoids, triterpenoids/steroids, tannins, saponins, and quinones.

The results of the phytochemical test on turmeric extract (Curcuma domestica Val) are shown in Figure 1 A, showing the results that turmeric extract does not contain alkaloids, Figure 1 B shows the results that turmeric extract contains flavonoids, Figure 1 C shows the results that turmeric extract contains triterpenoids. Figure 1 D shows the results that turmeric extract contains tannins, in Figure 1 E shows the results that turmeric extract does not contain saponins, in Figure 1 F shows the results that turmeric extract contains quinones.

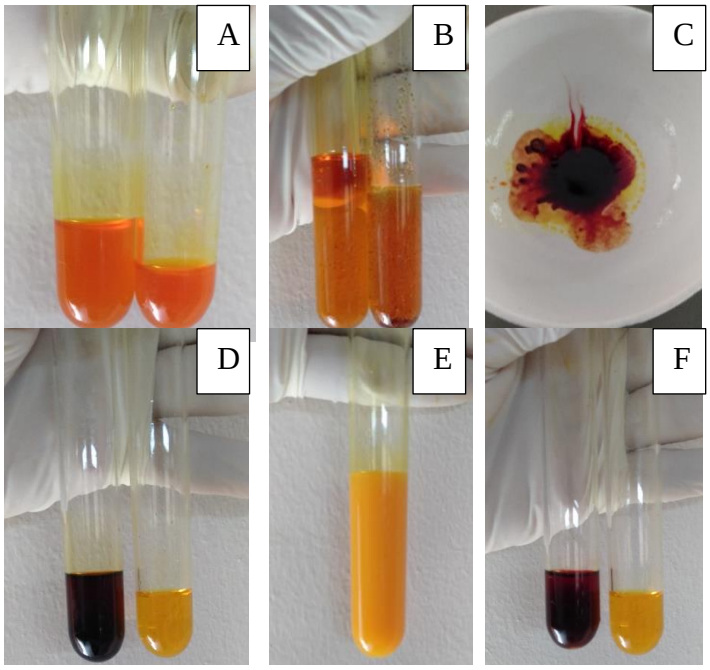

Figure 2 Phytochemical test results; A) Alkaloid test on turmeric extract, B) Flavonoid test on turmeric extract, C) Triterpenoid/Steroid test on turmeric extract, D) Tannin test on turmeric extract, E) Saponin test on turmeric extract, F) Quinone test on turmeric extract.

Table 1 Phytochemical test results of turmeric extract

Chemical Group	Results	Method
Alkaloids	-	Extract + 2 drops of Dragendorf reagent, a red/brown precipitate will be formed
		Extract + 2 drops of Meyer's reagent, a white or yellow precipitate will form
Flavonoids	+	Extract + 0.3 g plate Mg + 1 ml alcohol chlorhydrate + 2 ml amyl alcohol, shake vigorously, will form red, yellow or orange color
Triterpenoids/Steroids	+ (Triterpenoids)	Extract + 3 drops of Liebermaan burchard, will form orange or purple color (triterpenoids) or blue green (steroids)
Tannin	+	Extract + 2 drops of 1% FeCl3 solution, a green violet/brown green or blue-black color will be formed

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Saponins	-	The extract is put into a test tube, shake vertically for 10 seconds, a stable foam will be formed
Quinone	+	Extract + 2 drops of 1N NaOH, a red color will be formed

Streptococcus mutans Inhibitory Zone Test Results

Based on the research conducted, the results of the inhibition zone diameter of turmeric extract (Curcuma domestica Val) against Streptococcus mutans bacteria were obtained.

Table 2 Measurement results of the inhibition zone diameter (mm) of Streptococcus mutans bacteria.

Repetition	Inhibition Zone (mm)				
	40%	50%	60%	Control (+)	Control (-)
I	8.2	8.4	8.8	9	0
II	9.1	9.1	9.3	9	0
III	8.3	9.2	9.4	10	0
IV	8.2	9.1	9.4	8	0
V	8.2	9.1	9.5	10	0
Average	8.4	8.98	9.28	9.2	0

Information:
Positive Control : *Chlorhexidine gluconate 0.2%*
Negative Control : Ethanol 96%
Test Bacteria : *Streptococcus mutans*
Test Method : Agar Diffusion (Kirby Baurer)

Descriptive Analysis

The number of samples used in this study were 25 samples consisting of five groups, namely the treatment of turmeric extract 40%, 50%, 60%, positive control and negative control. Each extract concentration was taken from turmeric that had been dried and mashed, then macerated using 96% ethanol solvent which had been thickened with a vacuum rotary evaporator at a temperature of 40°C.

The results of the descriptive analysis of the average number of Streptococcus mutans bacteria in each group are presented in table 3.

Table 3 Results of descriptive analysis of the effectiveness of turmeric extract in inhibiting the growth of Streptococcus mutans bacteria (n=5).

Group	Average	Minimum value	Maximum value
Turmeric Extract 40%	8.40±0.39	8.2	9.1
50% turmeric extract	8.98±0.33	8.4	9.2
Turmeric Extract 60%	9.28±0.28	8.8	9.5
Control (+)	9.20±0.84	8	10
Control (-)	0.00	0	0

Based on Table 3 it can be seen that the measurement of the inhibition zone of turmeric extract (Curcuma domestica Val) against Streptococcus mutans bacteria. In this study, it was repeated five times. In the treatment group turmeric extract (Curcuma domestica Val) with a concentration of 40% was 8.40 mm with the highest inhibition of 9.1 mm and the lowest of 8.2 mm. The average inhibition of the 50% turmeric extract was 8.98 mm with the highest inhibition of 9.2 mm and the lowest of 8.4 mm. The average inhibition of the 60% turmeric extract was 9.28 mm with the highest inhibition of 10 mm and the lowest of 8 mm. The average inhibitory power in the control (+) is Chlorhexidine gluconate 0.2% of 9.20 mm with the highest inhibition of 10 mm and the lowest of 8 mm.

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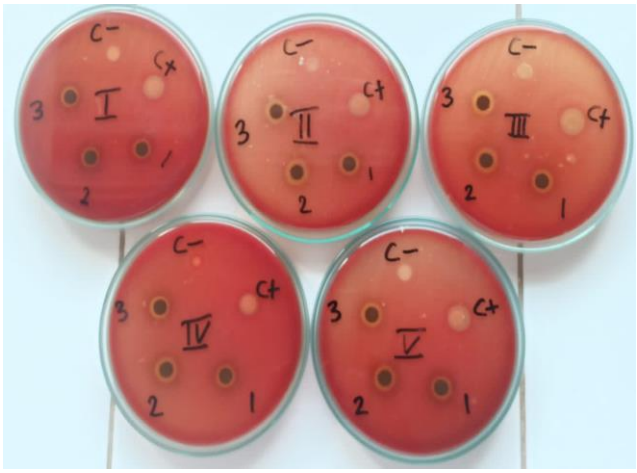
Figure 3 Kirby Baurer . test results

Statistical Data Analysis
Data Normality and Homogeneity Test



Normality test is performed as a prerequisite in conducting parametric tests. To find out whether the data obtained from this study were normally distributed or not, a normality test was performed using the Kolmogorov-Smirnov test, as presented in table 4.

Table 4. The results of the normality test of the effectiveness of turmeric extract (Curcuma domestica Val) in inhibiting the growth of Streptococcus mutans bacteria

Group	N	Average	SB	*p*
Turmeric Extract 40%	5	8.40	0.39370	0.001
50% turmeric extract	5	8.98	0.32711	0.004
Turmeric Extract 60%	5	9.28	0.27749	0.053
Control (+)	5	9.20	0.83666	0.314
Control (-)	5	0.00	0.00000	Constant

The test results show that the data used are not normally distributed, because the significance value is <0.05 for constant data and the 40% and 50% turmeric extract treatments. So that the next test uses a non-parametric test, namely Kruskal Wallis and Man Whitney.

Kruskal Wallis Test
This test was conducted to determine whether or not there were differences in the inhibition of Streptococcus mutans bacteria between the treatment group and the control group, as presented in table 5

Table 5. The results of the difference in inhibition test*Streptococcus mutans* between groups

Group	N	Average rating	*P*
Turmeric Extract 40%	5	10,10	0.000
50% turmeric extract	5	15.90	
Turmeric Extract 60%	5	19.60	
Control (+)	5	16.40	
Control (-)	5	3.00	

The results of the test using Kruskall Wallis obtained a significance value of 0.000, explaining that there was a significant difference in turmeric extract (Curcuma domestica Val) in inhibiting the growth of Streptococcus mutans bacteria.

Mann Whitney test
This test was conducted to determine the significant value of comparison of the inhibition of Streptococcus mutans bacteria between the two groups, both between the treatment group and the control group.This test can also be used to determine the significant value of the comparison of Streptococcus mutans inhibition as presented in Table 6.

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Table 6. Comparative test results of turmeric extract (Curcuma domestica Val) in inhibiting the growth of Streptococcus mutans bacteria.

Group		Z	*P*
Extract 40%	50% Extract	-2.184	0.029
	Extract 60%	-2,440	0.015
	Control (+)	-1,170	0.242
	Control (-)	-2.825	0.005
50% Extract	Extract 60%	-1,803	0.071
	Control (+)	-0.106	0.915
	Control (-)	-2.825	0.005
Extract 60%	Control (+)	-0.105	0.916
	Control (-)	-2,795	0.005
Control (+)	Control (-)	-2.805	0.005

The test results showed that there was a significant difference between the 40% extract and 50% extract with p <0.05. There was a significant difference between extract 40% and extract 60% with p value < 0.05. There was no significant difference between the 40% extract and the control (+) with p value > 0.05. There was a significant difference between the 40% extract and the control (-) with p < 0.05. There was no significant difference between the 50% extract and 60% extract with p <0.05. There was no significant difference between 50% extract and control (+) with p value > 0.05. There was a significant difference between the 50% extract and the control (-) with p < 0.05. There was no significant difference between the 60% extract and the control (+) with p value > 0.05. There was a significant difference between the 60% extract and the control (-) with p < 0.05. There was a significant difference between control (+) and control (-) with p value <0.05.

DISCUSSION

This research was conducted at the Bali Provincial Health Laboratory in November 2020, aiming to find out that turmeric extract (Curcuma domestica Val) at concentrations of 40%, 50%, and 60% had an antibacterial effect in inhibiting the growth of Streptococcus mutans bacteria.

Turmeric extraction was carried out using ethanol as a solvent. The extraction method chosen is maceration, because its implementation is simple and to reduce the possibility of decomposition of the active substances contained in turmeric by the influence of temperature, because in maceration there is no heating process. The purpose of maceration is to provide an opportunity for simplicia to diffuse into the solvent (Beatrice, 2010).

A previous study conducted by Kumara et al (2019) regarding "Test the Effectiveness of Turmeric Extract (Curcuma longa) Against the Growth Inhibition of Streptococcus mutans Bacteria" found no inhibition on Streptococcus mutans bacteria from the lowest concentration of 5% to the highest 40% with inhibition 0 mm. The study used a positive control in the form of vancomycin and a negative control in the form of 96% ethanol.

From Previous research conducted by Kumara et al (2019) regarding the antibacterial activity of turmeric extract (Curcuma domestica Val) against Streptococcus mutans bacteria using concentrations of 5%, 10%, 20%, and 40% showed that various doses of turmeric extract could not inhibit bacterial growth. Streptococcus mutans. So in this study using a concentration of 40%, 50%, and 60% which is where there is an increase in concentration from previous studies.

The results of the descriptive study showed that the most extensive inhibition of Streptococcus muntans bacteria was in the 60% turmeric extract treatment, which was 9.28, then followed by the positive control treatment which was 9.20, the 50% turmeric extract treatment was 8.98 and the 40% turmeric extract. ie 8.40.

Tests using Man Whitney on the treatment of 40% extract with positive control, 50% extract with positive control and 60% extract with positive control showed no significant difference (p > 0.05). There was no significant difference between the 40%, 50% and 60% extract treatments with positive control proving that turmeric extract was as effective as 0.2% Chlorhexidine gluconate.

In the test of 40% extract with 50% extract, 40% extract with 60% extract, 40% extract with negative control, 50% extract with 60% extract, 50% extract with negative control, 50% extract with negative control, and positive control with negative control showed a significant difference (p < 0.05).

The test results were significant in the treatment group due to the presence of chemical compounds in turmeric rhizome with water as a solvent, including alkaloids, tannins, flavonoids, glycosides and carbohydrates. The results of the study by Kumara et al (2019) explained that from the results of the phytochemical test it was found that turmeric extract was positive for essential oils, phenols, flavonoids, tannins, and saponins. The five compounds are compounds that are antibacterial.

Based on phytochemical tests that have been carried out on turmeric (Curcuma domestica Val) the results showed that the flavonoid content was positive, alkaloids were negative, triterpenoids were positive, tannins were positive, saponins were negative, and quinones were positive. These different phytochemical test results may be caused by geographical factors such as growing location and soil conditions where turmeric grows. The growing location is related to the height where the plant grows. Altitude is very influential on plant growth because it is very closely influenced by local climatic conditions, such as air temperature, humidity, rainfall, and the intensity of sunlight.

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Soil conditions also have a very important role in plant growth because in the soil there are materials that can improve the quality of plant growth, namely water,

The important chemical constituents of turmeric rhizome are curcumin and essential oils. Curcumin is the active component of turmeric which plays a role in producing a yellow color (Shan and Iskandar, 2018). Antibacterial activity of curcumin by inhibiting the proliferation of bacterial cells (Yuliati, 2016).

This essential oil can be used as an antibacterial because it contains hydroxyl and carbonyl functional groups which are phenol derivatives. This phenol derivative will interact with the bacterial cell wall, then be absorbed and penetrate into the bacterial cell, causing precipitation and protein denaturation, consequently lysing the bacterial cell membrane (Yuliati, 2016).

Flavonoid compounds function as antibacterial by forming complex compounds with extracellular proteins. The complex formed disrupts the integrity of the bacterial cell membrane by denaturing bacterial cell proteins and irreparably damaging the cell membrane (Reveny, 2011). Flavonoids can inhibit energy metabolism by inhibiting the use of oxygen by bacteria. Energy is needed by bacteria for macromolecular biosynthesis, so that if their metabolism is inhibited, these bacterial molecules cannot develop into complex molecules (Cushnie, and Lamb, 2005).

Tannin compounds have the ability to damage bacterial cell membranes, by shrinking the cell wall or cell membrane so that it interferes with the permeability of the cell itself. Due to the disruption of permeability, cells cannot carry out living activities, resulting in coagulation of bacterial protoplasm and then stunted growth and even death. Tannin is also a compound capable of forming iron. In aerobic bacteria, iron is needed because it can cause interference with bacterial cell membranes (Salasa, 2012).

The mechanism of action of quinones as an antibacterial in inhibiting bacterial growth is by forming irreversible complex compounds with nucleophilic amino acid residues on transmembrane proteins on the plasma membrane, cell wall polypeptides, and enzymes found on the surface of cell membranes, thereby disrupting the life of bacterial cells. . (Cowan, 1999).

Terpenoids have the same polarity as the phenol group. The mechanism of action of terpenoid compounds is the same as that of phenolic compounds, namely interfering with the transport of important ions into bacterial cells. Terpenoids are able to bind to fats and carbohydrates which will cause the permeability of the bacterial cell wall to be disturbed (Rachmawati et al., 2011).

Looking at the facts of the research results, namely the decrease in the number of Streptococcus mutans colonies, there is evidence of related research and the analysis of Kruskal Wallis and Mann Whitney that turmeric extract (Curcuma domestica Val) contains active ingredients that have an antibacterial effect against Streptococcus mutans, it can be concluded that turmeric extract (Curcuma domestica Val) has been shown to have an antibacterial effect that can inhibit the growth of Streptococcus mutans bacteria.The results of this study also show that the higher the concentration of turmeric extract (Curcuma domestica Val), the higher the concentration of turmeric extract (Curcuma domestica Val). the higher the inhibition or antibacterial power formed. While the negative control, namely 96% ethanol, did not show any inhibition zones formed around the disc, which means that 96% ethanol did not have antibacterial activity against Streptococcus mutans bacteria.This proves that the hypothesis that has been prepared previously is proven.

V. CONCLUSIONS AND SUGGESTIONS

Conclusion

1. Turmeric extract (Curcuma domestica Val) has been shown to have an antibacterial effect that can inhibit the growth of Streptococcus mutans bacteria.
2. The higher the concentration of turmeric extract (Curcuma domestica Val), the higher the inhibition or antibacterial power formed.

Suggestion

1. Further research needs to be done by increasing the concentration of turmeric extract (Curcuma domestica Val) to get the most optimum effectiveness.
2. Further research is needed on turmeric extract in vitro and in vivo.
3. It is necessary to do another research on turmeric using different extraction methods and different bacteria.
4. Further research needs to be done using different parts of turmeric.

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