



Phytochemical Analysis and Potential Inhibitory Property of Tubli (*Derris elliptica* Benth) Root Extract on *Escherichia coli* and *Staphylococcus aureus*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Medicinal plants contain bioactive compounds which are used for the treatment of various human diseases. One of these plants is the Tubli (*Derris elliptica* Benth) which comes from the genus of the family Papilionaceae locally known in Southeast Asian Countries as "Derris" or Tuba" and "Tubli" or "Tugling-pula" in Philippines. In this paper, is reported inhibitory property of this plant which had been studied against *Escherichia coli* and *Staphylococcus aureus* to find new substances with antimicrobial properties. The main purpose of the study was to identify the biochemical compounds of Tubli (*Derris elliptica* Benth) that inhibit the growth of *Escherichia coli* and *Staphylococcus aureus*; to determine the result of the mean average of zone inhibition between *Escherichia coli* and *Staphylococcus aureus* and to differentiate the mean average of zone of inhibition between

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Escherichia coli and *Staphylococcus aureus*. The experiments conducted used the Completely Randomized Designed (CRD). The data were analyzed using T-Test. Phytochemical analysis of Tubli (*D. elliptica* Benth) revealed the presence of tannins, flavonoids, alkaloids, saponins, and steroids which contributed to the antimicrobial ability of the root extract. It was found out that Tubli (*D. elliptica* Benth) was more active against the *S. aureus* having the total average zone of inhibition of 24.66 mm than the *E. coli* having the total average zone of inhibition of 20 mm. T-Test revealed that there is a significant difference on zone of inhibitions of the *S. aureus* and *E. coli* tested under Tubli (*D. elliptica* Benth) ethanolic root extract. The presence of phytochemicals suggests that *D. elliptica* has a potential antimicrobial property that could serve as a natural source of traditional medicine for treatment of various diseases.

Keywords: *Phytochemical analysis; inhibitory property; Tubli; Escherichia coli; and Staphylococcus aureus.*

1. INTRODUCTION

1.1 Background of the Study

“Humankind has provided many things by nature over the years, including the tools for the first steps at therapeutic intervention. Early civilization relied on plant extracts used as medicines. As of now, plant materials are still important resources for combating ailments, such as contagious diseases and many of herbal plants are studied for the discovery of new medicines, preservatives, industrial chemicals, and agrochemicals” [1].

A medicinal plant has phytochemicals that are used for traditional medicine and used as predecessor for chemo-pharmaceutical semi synthesis [2]. The leaves, fruits, and roots of herbal plants are useful for treating human diseases since it contains phytochemicals that have medicinal properties [3,4]. These phytochemicals are responsible for protection from microbial and pest disturbance [4]. Moreover, herbal extracts have been discovered to be safer medicines with minimum side effects when compared to chemical drugs [5].

Tubli (*Derris elliptica* Benth) is also considered as a herbal plant [6]. This comes from the genus of the family Papilionaceae (Orwa, et al., 2009), and locally in Southeast Asian Countries as "Derris" or "Tuba" and in Thailand as "Lotin" or "Hang laidaeng" [7] and "Tubli" or "Tugling-pula" in Philippines [6]. Tubli is a climbing plant with branches covered with brown hairs and pinnate shape of leaves which measures 30 to 50 cm long. The lax of racemes has a measurement of 15-30 cm in length and blossoms a reddish flower. The pods measure 5-8 cm long and

contain seeds which are flat and reniform with brown or black color [6].

Tubli plant is often confined to low altitudes but it can stay alive for months during summer and it is abundant in roadsides, forest edges, and along rivers in the tropical country up to 1500 m altitude (Orwa, et al., 2009). In the Philippines, it is widely spread in mountain ranges that have water system at a moderate temperature from the north of Luzon to Mindanao islands [6].

Throughout Southern Asia and the Pacific, *D. elliptica* pounded root is classified as one the strongest fish poison over the centuries. Recently, it was discovered that it could be an effective insecticide. It is also traditionally used to apply to the skin to prevent the development of abscesses against itch, leprosy, and antisepsis. In Thailand, they used Tubli stem as a blood tonic and the roots as an emmenagogue (Orwa, et al., 2009).

Since Tubli (*D. elliptica*) possesses medicinal value and insecticidal property, this study focused on the investigation of phytochemicals present in the root extract and assessed its antimicrobial activity against *Escherichia coli* and *Staphylococcus aureus*. Thus, this study was conducted in the Department of Science and Technology-Caraga, CSU Campus, Ampayon, Butuan City during the first semester of Academic Year 2016-2017.

1.2 Statement of the Problem

The purpose of this study was to focus on the investigation of phytochemical content and determine the inhibitory property of Tubli (*D. elliptica*) root extract on *Escherichia coli* and *Staphylococcus aureus*.

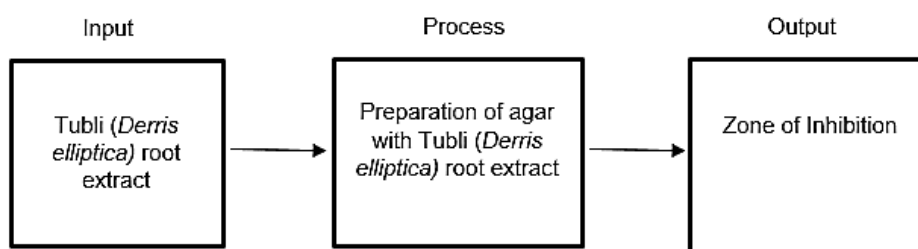


Fig. 1. Shows the research paradigm of the study, specifically the relationship between the input Tubli (*D. elliptica*) root extract, the process (Preparation of Agar media) with Tubli (*D. elliptica*) root extract, and the output Result of Inhibitory Property evaluation

Specifically, it attempted to answer the following questions:

1. What are the phytochemicals present in Tubli (*Derris elliptica*) root extract?
2. What is the mean average of zone of inhibition between *Escherichia coli* and *Staphylococcus aureus*?
3. Is there a significant difference in the mean average of zone of inhibition between *Escherichia coli* and *Staphylococcus aureus*?

2. LITERATURE REVIEW

2.1 Phytochemicals

Plants contain chemicals which serve as its secondary metabolites [8] these chemicals are not necessary nutrients but they can affect health [9]. Flavonoids, isoflavones, flavones, phenolic acids, and glucosinolates are common types of phytochemicals. The formation of phytochemicals structure is due to the process of conjugation of sugar and aglycones [10]. The study of natural products is called Phytochemistry. These Phytochemicals are present in vegetables, fruits, drinks and preservatives [4]. In plants, phytochemicals serve as protection and defense mechanism of plants against pest and microbial organism [11].

In almost all plants, 10-15% of concentrations are alkaloids. They are water soluble and heterocyclic compound because they contain nitrogen in a negative oxidation state that can form salt with acids. Most of the alkaloids are having definite melting points, a crystalline solid, colorless, and bitter in taste. It activated and inhabited during the central process at cellular and organ level in animals. They impair the functioning in the liver and kidney. Some alkaloids affect the reproductive system of animals. Moreover, alkaloids possess allergic and antimitotic effects at cellular level. Alkaloids

play a vital role in chemical ecological perspectives like plant-microbial interaction, plant herbivore interaction, and plant-plant interaction. Though poisonous, many alkaloids have a physiological effect that has medicinal value that can cure diseases including diabetics, cardiac dysfunction, cancer, malaria, etc. In addition, Alkaloids are also used as anesthesia to relieve pain [12].

“Flavonoids are another type of phytochemicals which consist of a large group of polyphenolic compounds having a benzo-y-pyrone structure and are ubiquitously present in plants. Plants can synthesize them in response to infection which is hydroxylated phenolic substances. Flavonoids have potential pharmaceutical properties because of its antioxidant activities. Free radicals are scavenged by functional hydroxyl groups of alkaloids because it mediates their antioxidant effects. Due to its high antioxidant capacity both in vivo and in-vitro systems flavonoids have health-promoting properties. In addition, flavonoids have protective effects on infectious and degenerative diseases like cancers, cardiovascular diseases, and other age-related diseases” [13].

Saponins are structurally constructed of sugars and aglycone. In addition, saponins serve as a natural detergent. Saponins have commercial and industrial applications ranging from their uses as a source of raw-materials for the manufacture of steroid hormones in the pharmaceutical industry, to their functions as food additives, photographic emulsions ingredients, fire extinguishers, and other industrial applications. Furthermore, they also exhibit different biological activities and have been investigated to create new natural medicines [14]

Terpenoids are natural occurring compounds in which are mostly present in plants. They are volatile compounds which give the fragrance in

plants and flowers. They usually occur in the fruits and leaves of higher plants, citrus, eucalyptus and conifers [15]. Tannins are compounds which are displeasing but do not affect health which is obtained upon plants decomposition process. Tannins affect the sense of taste, odor of water and can make a yellow cast in water which is difficult to remove. Tannins are polyphenols that shrink, bind or precipitate proteins. In addition, tannins act as defiance system and protection of trees against pest and minute organisms. It is commercially used in tanning, refining beer and wine, dyeing, photography and astringent in medicines [16].

Further, rotenone is present in the Cube plant crude extracts that can poison fish and insect. It is isolated from tropical and subtropical members of pea family which grow in Southeast Asia and South America. In addition, rotenone has a great potential commercial value as insecticides and pesticides on food crops or fish poison [17]. The leaves, roots, stem barks, flowers, or their combinations, essential oils of cube plants have been practices in the treating infection cause by pathogen and microbial diseases due to its diverse phytochemicals [18].

2.2 Economic Importance of Tubli

“Tubli (*Derris elliptica*) is a rambling climber, with branches covered with brown hairs and pinnate leaves which measure 30 to 50 cm long. The leaflets are usually oblong which range from 9 cm to 13 cm and when grown matured the upper part measures up to 10-15 cm long. The lax racemes can reach 15 to 30 centimeters in length and blossoms reddish flower. The pods reach up to 5 to 8 centimeters long and contain seeds which are flat and reniform with brown or black color” [4] When it reaches 18 months of age it begins to flower and fruit normally. After fertilization, its pods start to ripe for about 4 months. In cultivation, the fruiting of *Derris* is rare (Orwa, et al., 2009).

2.3 Morphology of *Escherichia coli*

“*Escherichia coli* is a Gram-negative rod (bacillus) in the family Enterobacteriaceae. Most *E. coli* are normal commensals found in the intestinal tract. Pathogenic strains of this organism are distinguished from normal flora by their possession of virulence factors such as adhesins, toxins, and biofilm formation. The specific virulence factors can be used, together with the type of disease, to separate these organisms into pathotypes” [19].

“Enterohemorrhagic *Escherichia coli* (EHEC) strains are a highly pathogenic subgroup of Shiga toxin—producing *E. coli* (STEC) that cause severe human diseases, including bloody diarrhea and hemolytic uremic syndrome (HUS)” (Karch, et al., 2005). “The ability to cause severe human disease differentiates EHEC from other STEC found in the environment that is less pathogenic or nonpathogenic. *E. coli* 0157:H7 is the most frequent EHEC implicated as a cause of HUS but non—0157:H7 EHEC are variably present as the only pathogens in stools from HUS patients” (Karch, et al. 2005).

“EHECs are transmitted by the fecal—oral route. They can be spread between animals by direct contact or via water troughs, shared feed, contaminated pastures or other environmental sources. Birds and flies are potential vectors. In one experiment, EHEC 0157:H7 was transmitted in aerosols when the distance between pigs was at least 10 feet. The organism was thought to have become aerosolized during high pressure washing of pens, but normal feeding and rooting behavior may have also contributed” [19].

“The reservoir hosts and epidemiology may vary with the organism. Ruminants, particularly cattle and sheep, are the most important reservoir hosts for EHEC 0157:H7. A small proportion of the cattle in a herd can be responsible for shedding more than 95% of the organisms. These animals, which are called super-shedders, are colonized at the terminal rectum, and can remain infected much longer than other cattle. Super-shedders might also occur among sheep” [20].

“*E. coli* can be killed by numerous disinfectants including 1% sodium hypochlorite, 70% ethanol, phenolic or iodine—based disinfectants, glutaraldehyde and formaldehyde. This organism can also be inactivated by moist heat (121°C [250°F] for at least 15 min) or dry heat (160—170°C [320-338°F] for at least 1 hour). Foods can be made safe by subjecting them to a minimum temperature of 160°F/ 71°C. Ionizing radiation or chemical treatment with a sodium hypochlorite solution may reduce or eliminate bacteria on produce” (Seto, et al. 2007).

2.4 Morphology of *Staphylococcus aureus*

“*Staphylococcus aureus* is a gram-positive coccus pathogen. *S. aureus* is one of the main causes of hospital- and community-acquired

infections which can result in serious consequences" [21]. "Nosocomial *S. aureus* infections affect the bloodstream, skin, soft tissues and lower respiratory tracts. *S. aureus* can be a cause of central venous catheter-associated bacteremia and ventilator-assisted pneumonia. It also causes serious deep-seated infections, such as endocarditis and osteomyelitis" [22]. "In addition to the infections listed above, *S. aureus* is often responsible for toxin-mediated diseases, such as toxic shock syndrome, scalded skin syndrome and staphylococcal foodborne diseases (SFD). Hospitalized patients are particularly exposed to *S. aureus* infections due to their compromised immune system and frequent catheter insertions and injections" [23].

"Penicillin was used in order to combat this organism in the year 1940, and all isolates were sensitive to penicillin during that period. With this antibiotic, the mortality rate of bacteremia caused by *aureus* decreased from a striking 80% to 25%" [24]. "While In 1944, the first penicillin-resistant strain of *S. aureus* was discovered. As clinicians used more and more penicillin's as the primary treatment for *S. aureus* infection, the prevalence of penicillin-resistant strains increased in the 1960s. It was during this time that a new class of antibiotics was developed to target this pathogen specifically. This class of antibiotics is known as the penicillinase-resistant penicillin's, which includes nafcillin, dicloxacillin, and oxacillin. One year after this class of antibiotic was developed, a resistant strain known as Methicillin-resistant *Staphylococcus aureus* (MRSA) was discovered in both the United States and the United Kingdom" [25].

"Methicillin-resistant *Staphylococcus aureus* (MRSA) became increasingly prevalent, especially in larger hospitals, in the 1970s. From the late 1970s to the early 1990s, Methicillin-resistant *Staphylococcus aureus* (MRSA) was usually a hospital-acquired pathogen. It was not until 1998 that the first case of CAMRSA in children was identified, since then CA-MRSA has become more prevalent in children throughout the United States" [25].

3. METHODOLOGY

3.1 Research Design

The experiments conducted used the Completely Randomized Designed (CRD) strategy. Completely randomized designs are the simplest in which the treatments are assigned to the

experimental units completely at random. This allows every experimental unit, i.e., plot, animal, soil sample, etc., to have an equal probability of receiving a treatment. The test subjects are assigned to treatment levels of the primary factor at random. Levels of significance between treatments were measured using T-Test on CRD Experiment on inhibitory property of *Derris elliptica* on growth of *Staphylococcus aureus* and *Escherichia coli* were conducted using CRD.

3.2 Treatments

Treatment 1 is composed of the agar growth media (*Staphylococcus aureus*) + *Derris elliptica* root extract. While the treatment 2 consists of the agar growth media (*Escherichia coli*) + *Derris elliptica* root extract. There were 3 replicates in each treatment.

3.3 Collection and Drying of *Derris Elliptica* Roots

Roots of Tubli (*D. elliptica* Benth) were gathered and weighed 253.41 g. The collected tubli roots were washed under running tap water and air dried at room temperature for 20 days.

3.4 Extraction of Fresh Roots Materials

The dried roots weighed 253.41 g in an Erlenmeyer flask and were treated with sufficient 80% ethyl alcohol to completely submerge the material. The flask was then covered and the material was kept and soaked for 48 hours. After soaking, the roots were filtered through Buchner funnel with gentle suction. The flask and dried roots material were rinsed with fresh portions of alcohol. Then the dried roots and washing material were transferred to the funnel and the washings with the first filtrate. Gentle suction was applied to complete the collection of the roots extract and the roots residues were discarded. The filtrate was concentrated under the vacuo at 40 ° C. Then the extract volume of the concentrated extract was measured. Rotary evaporator machine was used to test and evaluate the phytochemicals present in the root extracts.

3.5 Preparation of the Test Organisms or Inoculum

The recommended set of assay organisms for the antimicrobial screening program were represented the major group of microbial flora:

Staphylococcus aureus - gram positive cocci and *Escherichia coli*- gram-negative short rods. The 0.5 M McFarland standard was used to adjust the turbidity of the inoculums prior to the cotton swabbing of the agar plates for the antimicrobial assays. The standard was prepared and subjected to quality control prior to use. The standard contained approximately 1.5×10^8 CFU/ml of the test organism.

3.6 Preparation of 0.5 Mcfarland Standard

The 0.5 ml of 0.048 M BaC12 (1.175%w/v BaC12.2H2O) was mixed to 99.5 ml of 0.36NH2S04 (1%v/v). 5 ml was distributed into screw-cap tubes of the same dimension as those were used in preparing the culture suspension. The tubes were then tightly sealed and stored in the dark room temperature. Before used, the turbidity standard was shaken vigorously on a mechanical vortex mixer.

3.7 The Broth Culture

1. Preparation of the nutrient broth

Preparation of 1000ml solution was referred to label. A loop full of bacteria (g-am positive) was taken from the culture slant and inoculated in 500ml nutrient broth. The culture broth was then inoculated for 24hours at 350C and it was observed for turbidity which was the indicative of microbial growth.

2. Adjusting the turbidity of the inoculum

The adjusted turbidity served as the inoculums for the microbial assay and served as the inoculums which were swabbed onto agar plates. The 5 ml of the culture broth was aseptically transferred in sterile screw-capped tubes. The bacterial suspension was agitated on a vortex mixer and immediately compared against the 0.5 Mcfarland standard preparations.

3.8 Preparation of Treatment Agar

A. *Staphylococcus aureus*

15ml of melted nutrient agar was poured into dry and sterile petri dishes and they were allowed them to solidify. A sterile cotton swab was moistened into the *Staphylococcus aureus* (inoculum) suspension. The cotton swab with wooden applicator handles was used. Then a sterile cotton swab was dipped into a suspension of the *Staphylococcus aureus*

/inoculum. The moistened swab was then pressed and rotated firmly against the inside wall of the tube just above the fluid level to remove the excess liquid.

B. *Escherichia coli*

15ml of melted nutrient agar was poured into dry and sterile Petri dishes and allowed them to solidify. A sterile cotton swab was moistened into the *Escherichia coli* (inoculum) suspension. The cotton swab with wooden applicator handles was used. Then a sterile cotton swab was dipped into a suspension of the *Escherichia coli*/inoculum. The moistened swab was then pressed and rotated firmly against the inside wall of the tube just above the fluid level to remove the excess liquid.

3.9 Cotton Swabbing

A. *Staphylococcus aureus*

The *Staphylococcus aureus* was aseptically swabbed into a solidified nutrient agar by streaking the swab over the entire surface of the agar plate 3x, and rotated the plate 60 after each application to ensure an even distribution of the inoculum on the surface of the medium and the swabbed plates stand for 5 minutes.

B. *Escherichia coli*

The *Escherichia coli* was aseptically swabbed into a solidified nutrient agar by streaking the swab over the entire surface of the agar plate 3x, and rotated the plate 60 degrees after each application to ensure an even distribution of the inoculum on the surface of the medium and the swabbed plates stand for 5 minutes.

3.10 Disposal of Laboratory Waste

Wastes that accumulated during the experiment were properly disposed according to standard laboratory waste disposal procedures.

3.11 Data Gathering (Zone of Inhibition)

3.11.1 The plates

The "HALO" or "Clearing" was looked around the disc which was known as the zone of inhibition. The plates were inverted and using a ruler, the diameter of each inhibition zone was measured in millimeters and the result was expressed as

mm diameter zone of inhibition. The diameter of the paper disc used in the assay was recorded in mm.

3.11.2 Analyzing the results

< 10 mm of the diameter of zone of inhibition may be expressed as inactive, 10-13 mm means partially active, 14-19 mm is active while > 19 mm is very active.

3.11.3 Statistical treatment

Level of significance between treatments was measured using T-Test on CRD Experiment on inhibitory property of *Derris elliptica* on growth of *Staphylococcus aureus* and *Escherichia coli*.

4. RESULTS AND DISCUSSION

Table 1 shows the ethanolic root extract of *Derris elliptica* Benth is a promising medicinal plant because of its variety of phytochemicals which were reported to have some key bioactivities. Tannins are very much astringent in nature and has high potential treating intestinal disorders such as diarrhea and dysentery [26]. Its presence also aids in wound healing [27]. *Derris elliptica* roots also prevent damage caused by free radicals in the body by neutralizing them. This can be explained by the presence of flavonoids in the plant, as flavonoids are known to act as antioxidant [28]. It also functions to other health promoting properties such as anti-allergic, anti-inflammatory, antimicrobial and anticancer properties (Aiyelaagbe and Osamudiamen, 2009). The ++ symbols in ethanolic extract indicates the presence of secondary alkaloids. Alkaloids have been reported to possess analgesic, antispasmodic and bactericidal, antimalarial and analgesic activities, (Okwu and Okwu, 2004; [29]. Saponins prevent the excessive intestinal absorption of cholesterol and thus reduce the risk of cardiovascular diseases such as hypertension [26] and steroids showed the analgesic properties and central nervous system activities [30].

Table 2 depicts the average zone of inhibition of bacteria tested on the three replicates with 30 ml of *Derris elliptica* ethanolic extract. It is reflected on the table that the *Derris elliptica* was more active against *Staphylococcus aureus* having the total average zone of inhibition of 24.66mm than *Escherichia coli* having the total average zone of inhibition of 20mm. "This is because cell wall of gram-negative bacteria is more complex than gram positive bacteria which make it more susceptible and impermeable" [31], Zaidan, et al., 2005). "Therefore, this explains why the gram-negative bacteria were more resistant to antimicrobial compounds with its effective diffusion barrier. It is not surprising to note that *E. coli* in the study was the most resistant microorganism between the bacterial strains, despite the fact that *E. coli* developed multi drug resistance toward different kinds of antimicrobial agents" [32]. "On the other hand, *S. aureus* was more susceptible bacteria of the two bacterial strains tested. Several reports suggest that *S. aureus* is the most common pathogen to cause skin infections" (Jones, et al., 2003). The zone of inhibition of the extract from Tubli applied to the bacterial species were also higher compared to the Erythromycin, an antibacterial drug which was used in several studies to fight these microorganisms [33]. Thus, *Derris elliptica* Benth root extract has the potential to be used in pharmaceutical to combat against *S. aureus* and *E. coli*.

Fig. 2 Shows the Zone of Inhibition of the Growth of *Staphylococcus aureus* and *Escherichia coli* under *Derris elliptica* Root Extract.

Table 3 depicts the test of significance difference in the mean average of zone of inhibition between *E. coli* and *S. aureus*. The results revealed that the p-value is 0.000 which is lesser than the significant level which is 0.05. This implies that there is a significant difference between the mean average of zone of inhibition between *E. coli* and *S. aureus*.

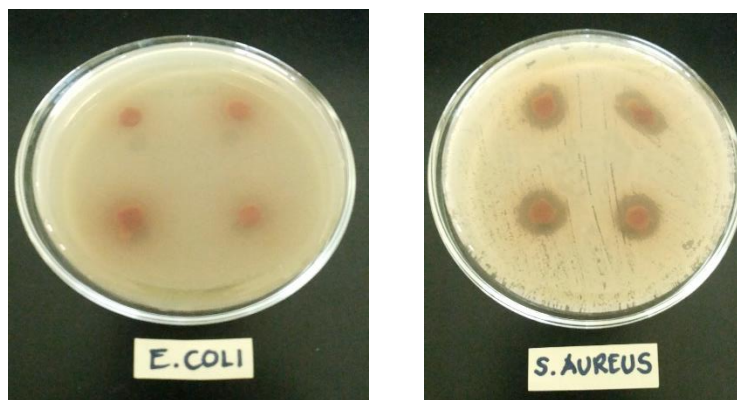
Table 1. The biochemical compounds of *Derris elliptica* benth

Phytochemicals Tested	Ethanolic Extract
Tannins	+
Flavonoids	+
Alkaloids	++
Saponins	+
Steroids	+

Present (+); Absent (-)

Table 2. Zone of Inhibition (mm) of the Growth of *Staphylococcus aureus* and *Escherichia coli* under *Derris elliptica* Root Extract

Bacterial Species	Replication			Total	Mean
	R1	R2	R3		
<i>Staphylococcus aureus</i>	25	25	24	74	24.66
<i>Escherichia coli</i>	20	20	20	60	20

**Fig. 2. Zone of Inhibition of the Growth of *Staphylococcus aureus* and *Escherichia coli* under *Derris elliptica* Root Extract****Table 3. Test of Significant Difference of the Average between *Escherichia coli* and *Staphylococcus aureus***

Source	Type III Sum of Squares	df	MS	F	P-Value	Interpretation
Model	3025.333 ^a	2	1512.667	9076.000	.000	Significant
Treatment	3025.333	2	1512.667	9076.000	.000	Significant
Error	.667	4	.167			
Total	3026.000	6				

5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This section presents a summary of findings, conclusions, and recommendations generated from the results of the study.

5.1 Summary

The main purpose of the study was to analyze the bioactive compounds present in Tubli (*Derris elliptica* Benth) root extract, determine the result of the mean average of zone of inhibition between *Escherichia coli* and *Staphylococcus aureus* and differentiate the mean average of zone of inhibition between *Escherichia coli* and *Staphylococcus aureus*. The study used experimental method of research.

Phytochemical analysis of Tubli (*D. elliptica* Benth) revealed the presence of tannins, flavonoids, alkaloids, saponins, and steroids which contributed to the antimicrobial ability of the root extract. Results of the mean average of

zone inhibition showed that Tubli (*D. elliptica* Benth) root extract has 24.66 mm of the growth of *Staphylococcus aureus* and 20 mm of the growth of *Escherichia coli*. The tests revealed that Tubli (*D. elliptica* Benth) was found to be very active against the bacterial species because it has a big zone of inhibition which shows its potential to kill or inhibit the of bacteria.

Based on the findings, there is a significant difference between the mean average of zone of inhibition between *Escherichia coli* and *Staphylococcus aureus*.

5.2 Conclusions

Based on the results of the study, the following were drawn:

1. The bioactive compounds present in Tubli (*D. elliptica*) which contributed to its antimicrobial property are tannins, flavonoids, alkaloids, saponins, and

- steroids against *Escherichia coli* and *Staphylococcus aureus*.
- The mean average of zone of inhibition of *D. elliptica* Benth root extract on *Staphylococcus aureus* is higher than the mean average of zone of inhibition of *Escherichia coli*.
 - There is significant difference in the mean average of zone of inhibition between *Escherichia coli* and *Staphylococcus aureus*.

5.3 Recommendations

Based on the outcome of the study, the following are recommended for further studies:

- Develop research regarding antimicrobial property of other parts of the plant.
- Thus, further research must be done to determine the efficacy of these extracts against various other pathogenic bacterial and fungal species.
- Higher the research of this species that can make an antibiotic drug.
- Research on other uses of *Derris elliptica* Benth.
- Use different amounts of concentration in applying the extracts of tubli to the bacterial species.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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