



# **Antibacterial Activity of Star Fruit Extract against *Vibrio cholera* Isolated from Tuna Fish**

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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**

**Aims:** This study aims to determine the effect of ethanol concentration and extraction temperature on the characteristics of star fruit extract, that content of bio active, compounds (polyphenol, flavonoid, alkaloids, saponin, and tannin of star fruit) can inhibit bacterial activity as a preservative for tuna.

**Study Design:** This research was carried out in 2 stages, namely: (1) determine the ethanol concentration and temperature to produce the best extract and (2) determine the antibacterial power of the extract against *Vibrio cholera* - BSFIL Randomized block design (RBD) with two factors, namely 1 (ethanol concentration 96% and 70%) and 2 (temperature extraction 30°C, 40°C and 50°C. and analysis of variance with Tukey's honestly significant difference was used to analyze the data.

**Place and Duration of Study:** This research was conducted at Food Technology laboratory, Faculty of Agriculture Technology, Udayana University on November – April 2022.

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**Results:** The best quality ( $P=0.05$ ) of star fruit extract by 96% ethanol at 30°C, such as: yield (77%), total flavonoid (7.10%), total tannin (0.914 mg QE /g), total acids (34.24%). and with a concentration of 80% the extract was able to inhibit the growth of *Vibrio cholera* (VC-BSFIL) with very strong criteria (inhibition zone diameter: 20.78 mm).

**Keywords:** Star fruit extract; tuna; *Vibrio cholera*.

## ABBREVIATIONS

LB : Lactose Broth.  
NA : Nutrient Agar  
PW : Pepton Water.  
RBD : Randomized block design  
TCBS : Thiosulfat Cytrat Bile Salts Sucrose,  
TPC : Total Plate count  
VC BSFIL : *Vibrio cholera* Bali Sea Food  
Inspection Laboratory '



**Fig. 1. Star fruit**

## 1. INTRODUCTION

Fish is a food commodity that supplies animal protein rich in saturated and unsaturated fatty acids. Conducive marketing of fish, lack of sanitation, causes quality to decline, consumer health problems and financial losses increase. This poisoning is caused by contamination of pathogenic bacteria such as *Vibrio cholera*, *Escherichia coli*, *Salmonella* and *Enterobacteriaceae* [1].

Prolonged use of antibiotics will increase the resistance of contaminant bacteria which will endanger consumer health. Therefore, it is necessary to apply an alternative solution by soaking fish in star fruit juice (*Averrhoa bilimbi* L) before being marketed. This effort can inhibit the activity of contaminant bacteria, especially *Escherichia coli*, *Staphylococcus aureus* [2].

Star fruit (Fig. 1) is the result of the plants that are often found in people's yards, maximum height of 10-15 m, grows naturally and is rarely commercialized. Flavonoid and saponin compounds are antimicrobial compounds that are very effective in inhibiting the growth of viruses, bacteria and fungi as well as easily soluble in polar solvents such as ethanol, butanol, and acetone. Likewise, alkaloids have the ability as an antibacterial by interfering with the constituent components of peptidoglycan in bacterial cells, while tannin are polyphenolic compounds (C6-C3-C6) that precipitate proteins and form complexes with polysaccharide, resulting in microbial cell walls lysis.

This study aims to determine the effect of ethanol solvent concentration and extraction temperature on the characteristics of star fruit extract, which has the best antibacterial activity against *Vibrio cholera*.

## 2. MATERIALS AND METHODS

### 2.1 Materials and Tools

The material used in the study consisted of star fruit (green color, size 3-5 cm), with the criteria of green fruit skin, obtained from Jimbaran Village, Badung Regency. The chemical used as a solvent is ethanol (Merck brata chem) with a concentration of 96% and 70%. Aquades,  $\text{NaNO}_2$ ,  $\text{AlCl}_3$ ,  $\text{NaOH}$ . *Vibrio cholera* isolate was obtained from the Bali Sea food Inspection Laboratory (BSFIL VC Isolate) as a result of identification of Bali tuna poisoning in Tabanan, TCBS (Thiosulfat Cytrat Bile Salts Sucrose), LB (Lactose Broth), NA (Nutrient Agar), PW (Pepton Water), 95% alcohol.

The equipment used is: for the extraction process blender (Phillips), extraction flask, hot plate, magnetic stirrer, stainless steel knife, oven (Blue M, USA), rotary evaporator (Janke & Kunkel RV 06 – ML, Switzerland), UV-spectrophotometer Vis (Thermo scientific, USA), calorimeter (PCE-CSM4, Spain), analytical balance (Mettler Toledo AB 204 and Shimadzu, Japan), 60 mesh sieve (Retch, Germany), pH meter (Hanna HI98107) and glassware (Pyrex).

## 2.2 Research Design

This research was done in 2 stages. Stage 1 aims to determine the best ethanol solvent concentration and extraction temperature to produce star fruit extract, using a Randomized Block Design (RBD). Factorial pattern: the first factor is solvent concentration (P) which consists of 2 levels, namely: P1 (Ethanol 96 %), P2 (70% ethanol); and the second factor is the extraction temperature (T) which consists of 3 levels, namely T1(30°C), T2(40°C), T3(50°C) with 3 repetitions. The data were analyzed using analysis of variance and a follow-up test was carried out for Tukey's Honestly significant Difference.

Stage 2, aims to test the antibacterial activity using the best percent extract in the Phase I study (20%, 40%, 60%, 80% and 100%) on VC BSFIL isolates, with tetracycline as a positive control and distilled water as a negative control. Completely randomized design (CRD) with 3 times and observed variables: yield [3], total flavonoid, total tannin and total acids [4] followed by the best treatment effectiveness test [5]; while for the best extract antibacterial activity test against *Vibrio cholera* [6]; data were analyzed using analysis of variance and follow-up tests with significant difference tests honest and determine the best treatment (effectiveness index test [5]).

## 2.3 Making Star Fruit Extract

Star fruit (*Averrhoa bilimbi* L) is cleaned using running water, then sliced thinly and then dried in an oven at 50°C until it is easily broken, then blended and then sieved with a 60 mesh sieve to obtain dried star fruit powder. Star fruit extract is made by maceration process [7]. A sample of 10 g was put into a 1000 ml Erlenmeyer then added 200 ml of solvent, then macerated for 24 hours. During the extraction, stirring was carried out using a magnetic stirrer at a speed of 300 rpm, the filtered using coarse filter paper. Filtrate I is collected while the dregs are added with solvent to a volume of 100 ml, shaken and filtered again with coarse filter paper, and filtrate II combined with filtrate I is filtered with What man filter paper No. 1. Filtrate III was evaporated with a rotary vacuum evaporator at a temperature of 40°C, a pressure of 110 m bar at a speed of 100 rpm until all the solvent had evaporated and a viscous extract was obtained. This thick extract was analyzed according to the research variables: yield, total flavonoid, total tannin, total acids) and

its data were analyzed using analysis of variance and carried out a follow-up test of Tukey's Honestly significant difference).

## 2.4 Confirmatory *Vibrio cholera* Test

In this confirmation test by observing the shape of the colony, gram staining and cell observation. Bacterial isolates that had been refreshed were then cultured on TCBS media to obtain single colonies and incubated for 48 hours at 37°C. Then the shape and color of the bacterial colonies were observed [8,9].

## 2.5 Preparation of *Vibrio cholera* Culture Stock

For the preparation of bacterial culture stock, a colony of *Vibrio cholera* bacteria was taken using an ose needle, then instilled in a slanted Nutrien Agar medium by scraping, after which it was incubated in an incubator at 37°C for 24 hours.

## 2.6 Antibacterial Activity

The sterile disc paper with a diameter of 6 mm is dripped with the best extract which has been diluted with a concentration of 20, 40, 60, 80 and 100% until completely whetted, let stand until the extract is completely absorbed. The control solution used in this experiment was distilled water as a negative control and tetracycline as a positive control. Tetracycline was chosen as the positive control in this study because this antibiotic is a selective antibiotic for the test bacteria. The disc paper was then placed on the surface of the media according to the specified position, each treatment was repeated 3 times. The media was incubated at 37°C for 1x24 hours. Furthermore, the inhibition zone formed (clear zone around the disc) was observed which showed no bacterial growth [6]. This shows that star fruit extract has bio active compounds that act as antibacterial inhibiting the growth of *Vibrio cholera* [10].

## 3. RESULTS AND DISCUSSION

### 3.1 Yield

The results of the analysis of variance showed that the treatment interaction effect of ethanol concentration and extraction temperature had a significant effect ( $P = 0.05$ ) on the yield of starfruit extract (Table 1).

An decrease in the concentration of ethanol (96-70%) resulted in a lower yield ( $P=0.05$ ), as well

as an increase in the extraction temperature (Table 1), but at temperatures of 30°C and 40°C with an ethanol concentration of 96% had no significant effect. This is due to the compounds in star fruit have the polarity most similar to that of 96% ethanol. The more compound components dissolved in the solvent will produce a higher yield [4].

### 3.2 Total Flavonoid

Ethanol concentration and extraction temperature had a highly significant effect ( $P < 0.01$ ) and the interaction of the two treatments had a significant effect ( $P = 0.05$ ) on the total flavonoids of star fruit extract (Table 2).

**Table 1. The average yield (%) of star fruit extract in the treatment of ethanol concentration and extraction temperature**

Ethanol concentration	Extraction temperature		
	30°C	40°C	50°C
96%	77 <sup>a</sup>	73 <sup>a</sup>	61 <sup>b</sup>
70%	65 <sup>b</sup>	52 <sup>c</sup>	47 <sup>d</sup>

*Description: Different letters behind the mean value indicate real difference (Tukey's Honestly significant difference)*

The highest average value of total flavonoid (7.10%) was obtained from the combination treatment of 96% ethanol concentration at 30°C and the lowest average value of total flavonoid (4.38%) was obtained from the combination treatment of 96% at 50°C. Based on Table 2, the total flavonoid treated at 70% at 30°C, 40°C and 50°C were no significant lower, but at 96% ethanol concentration the different value were significant ( $P = 0.05$ ). This is due to the difference caused by the concentration of ethanol can result in a change in the polarity of the solvent which affects the solubility of the flavonoid. Each type of flavonoid has a different polarity depending on the number and position of the hydroxyl groups of each type of flavonoid. The polarity of the ethanol solvent decreases at higher temperatures, so that the binding of flavonoid compounds in star fruit extract is not optimal.

### 3.3 Total Tannin

The results of the analysis of variance showed that the interaction of the extraction temperature and ethanol concentration had a significant effect

( $P = 0.05$ ) on the total tannins yield of star fruit extract (Table 3).

**Table 2. The average value of total flavonoids (%) of star fruit extract in the treatment of ethanol concentration and extraction temperature**

Ethanol Concentration	Extraction temperature		
	30°C	40°C	50°C
96%	7.10 <sup>a</sup>	4.96 <sup>c</sup>	4.38 <sup>d</sup>
70%	6.60 <sup>b</sup>	6.48 <sup>b</sup>	6.47 <sup>b</sup>

*Description: Different letters behind the mean value indicate real difference (Tukey's Honestly significant difference)*

The highest the total tannin-average (0.914 mg QE/g) was obtained from the combination treatment of 96% ethanol concentration at 30°C and the lowest the total tannin- average (0.434 mg QE/g) was obtained from the combination treatment with 96% ethanol concentration at temperature 50°C. Increasing solvent concentration and extraction temperature caused a significant decrease in total tannin ( $P = 0.05$ ) due to decreasing solvent polarity. The polarity of the ethanol solvent for each concentration also affects the level of solubility of tannin compounds so that the total tannin produced are reduced [11].

**Table 3. The average value of total tannin (mg QE/g) of star fruit extract in the treatment of ethanol concentration and extraction temperature**

Ethanol concentration	Extraction temperature		
	30°C	40°C	50°C
96%	0.914 <sup>a</sup>	0.646 <sup>d</sup>	0.434 <sup>e</sup>
70%	0.802 <sup>b</sup>	0.794 <sup>c</sup>	0.683 <sup>d</sup>

*Description: Different letters behind the mean value indicate real difference (Tukey's Honestly significant difference)*

### 3.4 Total Acid

The results of the analysis of variance showed that the effect of solvent concentration and extraction temperature on the total acid of the star fruit extract and its interaction was significantly different ( $P = 0.05$ ), (Table 4). The treatment of ethanol solvent concentration and extraction temperature had a significant effect ( $P = 0.05$ ) on total acid, the highest (34.24%) was produced in the process with 96% ethanol. and the lowest total acid was produced with 70% ethanol at 30°C. Table 4 shows that increasing the concentration of ethanol solvent and

extraction temperature will increase the total acid in general. This is due to the increase in extraction temperature triggering the evaporation of water intracellular which will produce pressure inside the cell [12]. This pressure will cause the cell wall to rupture, so that it can increase the compound diffused into the solvent. However, the extraction temperature that exceeds the optimal time results in the degradation of the active compound by heat [9]. The total acid in star fruit extract tends to be extracted more effectively in solvents with lower polarity [13,14].

### 3.5 Best Treatment

In this study, 96% ethanol concentration at 30°C obtained the highest value of all treatments (used for Phase 2 research). This treatment is the best to produce star fruit extract which has the potential for antibacterial to *Vibrio cholera*.

**Table 4. Average total acid value (%) of starfruit extract at ethanol concentration and extraction temperature**

Ethanol Concentration	Extraction temperature		
	30°C	40°C	50°C
96%	34.24 <sup>a</sup>	30.08 <sup>b</sup>	32.96 <sup>a</sup>
70%	10.88 <sup>d</sup>	13.44 <sup>c</sup>	14.40 <sup>c</sup>

Description: Different letters behind the mean value indicate real difference (Tukey's Honestly significant difference)

#### 3.5.1 Confirmation test

Confirmatory tests on *Vibrio cholera* include color and colony shape as well as gram staining and cell shape. Prior to testing the antibacterial activity, the colony count was first performed using the TPC method. *Vibrio cholera* grows well on TCBS media agar. The color of *Vibrio cholera* colonies will change the green selective TCBS media to yellow. Large colony morphology with

diameter <3 mm, smooth surface, rather flat, opaque center and bright edges, yellow in color (Fig. 2). The shape of the cell in *Vibrio cholera* shows the form of bacilli, gram negative, with a length of 2-4 µm and a crooked rod-shaped like a comma.

### 3.6 Antibacterial Activity

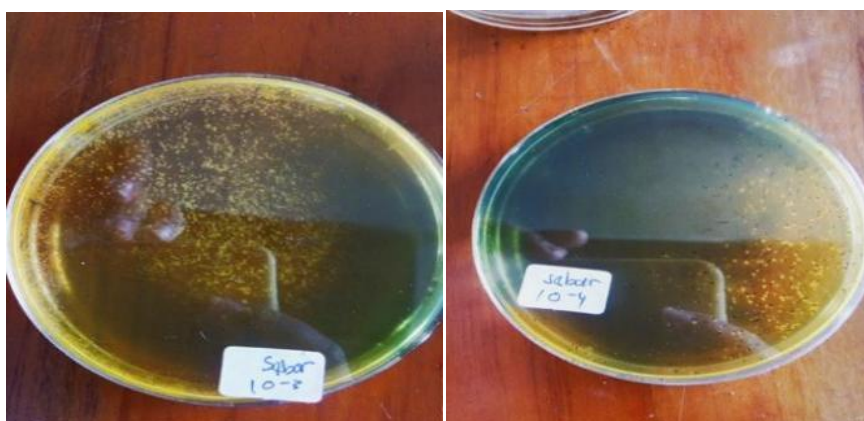
The results of the variance analysis showed that the concentration treatment had a very significant effect ( $P=0.05$ ) on the antibacterial activity of star fruit extract (Table 5). The highest average of inhibition diameter (20.78 mm) was obtained from the 80% concentration extract, while it was not significantly different with 100% concentration extract. Antibacterial activity test against *Vibrio cholera* was carried out using the disc diffusion method. Based on Table 5, star fruit extract was able to inhibit the growth of *Vibrio cholera* [5].

The total *Vibrio cholera* used in this study was  $2.24 \times 10^7$  CFU/ml. The inhibition zone on TCBS media appeared after 24 hours of storage. The formation of an inhibition zone indicates that star fruit extract has bio active compounds that act as antibacterial activity, so that they can inhibit the growth of *Vibrio cholera* (Fig. 3).

The wider the diameter of the inhibition zone formed, the stronger the bio-active compound inhibits the growth of bacteria [10] which are categorized as very strong. Table 5 shows the diameter of the barriers continued to increase from up to 20.78 mm at concentrations 20% - 80% but decreased at 100% concentration. The decrease in inhibition diameter at 100% concentration was due to the fact that the extract was unable to diffuse properly, because the concentration of the extract was too concentrated so that the active component of the star fruit had difficulty interacting with *Vibrio cholera*.

**Table 5. The average diameter of the inhibition of star fruit extract on the growth of *Vibrio cholera***

Concentration (Treatment)	The Inhibition Diameter (mm)	Inhibition Category
20%	12.63 <sup>c</sup>	Strong
40%	13.43 <sup>b</sup>	Strong
60%	14.21 <sup>b</sup>	Strong
80%	20.78 <sup>a</sup>	Very strong
100%	19.01 <sup>a</sup>	Strong



**Fig. 2. Form and color of *Vibrio cholera* colonies**



**Fig. 3. Inhibition zone of star fruit extract against *Vibrio cholera***

The content of secondary metabolite compounds (flavonoid, tannin) in star fruit extract is able to inhibit the growth of *Vibrio cholera* through inhibiting cytochrome c-reductase, so that the metabolism of microbial cells is disrupted [5]. The inhibition of this metabolic activity will result in the death of bacterial cells. Flavonoid also play a role in reducing energy metabolism by inhibiting the use of oxygen by bacteria, thus preventing the formation of energy in the cytoplasmic membrane and inhibiting bacterial motility which plays a role in antimicrobial activity.

Tannin work by inhibiting the enzymes reverse transcriptase and DNA topoisomerase, so that bacterial cells are not formed [6]. Tannin activity as an antibacterial with its ability to inactivate microbial cell adhesion (molecules attached to host cells) found on the surface of the cell which will cause damage to the cell wall, so that the membrane will leak (disturbing permeability) resulting in liquid metabolites coming out and bacterial metabolism disrupted

so that growth inhibited bacteria can even experience death.

The cell wall plays a role in the survival of bacteria, regulates the entry and exit of secondary metabolites such as flavonoid and tannin into the bacterial cell, there by disrupting the permeability of the cell membrane. Apart from the secondary metabolites of starfruit extract, acids play a role in inhibiting bacterial growth. Almost all types of acids have strong antibacterial activity, which work by dissociating and producing hydrogen ions. If the amount of acid that is not dissociated is large, it will produce hydrogen ions in large quantities, resulting in acidification of cells in the cytoplasm which causes membrane damage and the bacteria will die.

#### **4. CONCLUSION**

Based on the results of the study, several things were concluded as follows: The best characteristics of star fruit extract made with 96%

ethanol solvent at 30°C consists of: yield 77 %, total flavonoid 7.10%, total tannin 0.914 mg QE/g, and total acids 34.24%. Star fruit extract is able to inhibit the maximum growth of *Vibrio cholera* (20.78 mm) in the very strong category at a concentration of 80%.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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