JURNAL RISET KEFARMASIAN INDONESIA
Ilmu Kefarmasian & Ilmu Kesehatan

Vol.8 Issue.1 (January 2026)
page 73-83
https://doi.org/10.33759/jrki.v8i1.908
e-ISSN: 2655-8289

Original Article

Antioxidant Activity Test of Tampoi Fruit Peel Extract (Baccaurea pyriformis Gage) using the DPPH (2,2-Difenil-1-Pkrihidrazil) Method

Uji Aktivitas Antioksidan Ekstrak Kulit Buah Tampoi (*Baccaurea pyriformis* Gage) Menggunakan Metode DPPH (2,2-Difenil-1-Pikrilhidrazil)

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Submitted : 2025-12-08
Revised : 2026-01-19
Accepted : 2026-01-31

Keywords: Antioxidants, Baccaurea pyriformis Gage, IC50, DPPH

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Abstract

Excessive oxidation reactions in the body can cause various harmful effects, mainly due to the uncontrolled production of free radicals. Antioxidant compounds are needed to protect the body from free radical attacks. One natural source of antioxidants is the tampoi fruit (*Baccaurea pyriformis* Gage). This fruit is known to contain metabolites such as flavonoids, phenolics, tannins, and saponins, which act as natural antioxidants. The purpose of this study was to determine the antioxidant activity of tampoi fruit peel (*Baccaurea pyriformis* Gage) using the DPPH method. This was an experimental study with the independent variable being ethanol extract of tampoi fruit peel and the dependent variable being antioxidant activity. The research stages included plant determination, dried fruit peel preparation, maceration extraction, phytochemical screening, determination of extract moisture content, and antioxidant activity testing with DPPH. The results showed a drying shrinkage of 5,6%, an extract yield of 13%, and an extract moisture content of 14,77%, which is classified as a thick extract. Phytochemical screening showed the presence of alkaloids, flavonoids, tannins, and saponins. Antioxidant test results showed that tampoi fruit peel ethanol extract had an average IC_{50} value of 11,8165 ppm (very strong category), and vitamin C as a comparison had an IC_{50} value of 7,5019 ppm. Thus, tampoi fruit peel ethanol extract has strong antioxidant activity.

Abstrak

Reaksi oksidasi yang berlebihan di dalam tubuh dapat menimbulkan berbagai efek merugikan, terutama akibat produksi radikal bebas yang tidak terkendali. Senyawa antioksidan diperlukan untuk melindungi tubuh dari serangan radikal bebas. Salah satu sumber antioksidan alami adalah buah tampoi (Baccaurea pyriformis Gage). Buah ini diketahui mengandung metabolit sekunder seperti flavonoid, fenolik, tanin, dan saponin yang berperan sebagai antioksidan alami. Penelitian ini bertujuan untuk mengetahui aktivitas antioksidan ekstrak kulit buah tampoi (Baccaurea pyriformis Gage) menggunakan metode DPPH. Penelitian ini merupakan penelitian eksperimental dengan variabel bebas berupa ekstrak etanol kulit buah tampoi dan variabel terikat berupa aktivitas antioksidan. Tahapan penelitian meliputi determinasi tanaman, pembuatan simplisia kulit buah, ekstraksi dengan metode maserasi, skrining fitokimia, penetapan kadar air ekstrak, serta pengujian aktivitas antioksidan dengan metode DPPH. Hasil penelitian menunjukkan susut pengeringan sebesar 5,6%, rendemen ekstrak sebesar 13%, dan kadar air ekstrak sebesar 14,77% yang diklasifikasikan sebagai ekstrak kental. Skrining fitokimia menunjukkan adanya senyawa alkaloid, flavonoid, tanin, dan saponin. Hasil uji aktivitas antioksidan menunjukkan bahwa ekstrak etanol kulit buah tampoi memiliki nilai IC_{50} rata-rata sebesar 11,8165 ppm yang termasuk dalam kategori sangat kuat, sedangkan vitamin C sebagai pembanding memiliki nilai IC_{50} sebesar 7,5019 ppm. Dengan demikian, ekstrak etanol kulit buah tampoi memiliki aktivitas antioksidan yang sangat kuat.

How to Cite: (*citation style* AMA 11th Ed.)
Milasari N, Sundu R, Sa'adah H, Olivia S, Adhila G, Fatimah N. Antioxidant activity test of tampoi fruit peel extract (Baccaurea pyriformis Gage) using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method. *Jurnal Riset Kefarmasian Indonesia.* 2026;8(1):73-83. doi:10.33759/jrki.v8i1.908

INTRODUCTION

Free radicals are molecules or compounds that have one or more unpaired electrons. Due to the presence of unpaired electrons, these compounds are highly reactive in attacking and binding electrons from surrounding molecules. This results in cellular dysfunction, which can lead to degenerative diseases such as coronary heart disease, rheumatism, cataracts, stroke, heart disease, ischaemia, and cancer. Therefore, the body needs antioxidants, which can protect the body from free radical attacks and reduce their adverse effects[1]

Antioxidants can be synthetic or natural[2]. Synthetic antioxidants are generally used to prevent oxidation, but there are indications that these compounds are associated with the onset of several diseases and have adverse side effects[3]. This has led to natural antioxidants, especially those sourced from plants such as fruits and vegetables, becoming a potential alternative as antioxidant compounds because they are easily obtained and have relatively fewer side effects[4]

One plant that has the potential to be developed as a source of antioxidants is the Tampoi fruit (*Baccaurea pyriformis* Gage). The Tampoi fruit is a member of the Phyllanthaceae family. The use of the Tampoi fruit by the Dayak tribe of Kalimantan is still limited, being used for fruit consumption and as an ingredient in the production of tuak (palm wine). This antioxidant activity is significantly correlated with the total phenolic and flavonoid content, but does not show a strong relationship with the carotenoid content. Flavonoids, as one of the active compounds in the extract, play an important role in antioxidant activity that is beneficial to health[5]

The main uniqueness of this study lies in the utilisation of tampoi fruit peel, which has been considered agro-industrial waste, but has high potential to contain bioactive compounds such as flavonoids, phenolic compounds, and tannins. Various studies have reported that fruit peels generally contain higher levels of phenolic compounds than fruit flesh, giving them strong antioxidant activity[6]. This approach is in line with the concept of agricultural waste valorization, which involves converting waste materials into sources of compounds with pharmacological and economic value.

Furthermore, to date, scientific data on the antioxidant activity of tampoi fruit peel extract is still very limited, especially when tested using the DPPH (2,2-diphenyl-1-picrylhydrazil) method. The DPPH method is simple, fast, easy to screen for radical scavenging activity of several compounds, effective, practical, and has a fast processing time, and is stable in polar solvents[7]. The type of solvent and the degree of polarity of the solvent also greatly influence the antioxidant activity obtained[8]. Therefore, careful consideration in determining the solvent is also very important in antioxidant activity testing. The DPPH method is used to measure the antioxidant's ability to scavenge free radicals. Compounds such as flavonoids and phenolics, which are highly soluble in 70% ethanol, play an important role in antioxidant activity because they can donate hydrogen atoms to neutralise free radicals. Therefore, the use of 70% ethanol supports more accurate testing of antioxidant activity[9]

Another unique feature of this study is its contribution to the development of a phytochemical database of local Indonesian plants, especially endemic species that have not been extensively explored scientifically. Research on local plants plays an important role in enriching the global literature on natural materials and their potential use as sources of natural antioxidants[10]

According to research conducted[11], one species of the genus Baccaurea (Family Phyllanthaceae) has shown that the peel of the tampoi fruit (*Baccaurea pyriformis* Gage) contains various important secondary metabolites such

as alkaloids, flavonoids, phenols, tannins, and saponins. In addition, methanol extracts of the fruit peel also positively contained polyphenols and showed significant antibacterial activity, especially in the ethyl acetate fraction[12].

Based on the above description, researchers were interested in conducting research on the antioxidant activity of Tampoi fruit peel (*Baccaurea pyriformis* Gage) using the DPPH (1,2-diphenyl-2-picrylhydrazyl) method.

METHODS

Tools and Materials

Tools. The tools used included a blender (Philips®), laboratory glassware (Pryrex/Iwaki®), analytical balance (Ohaus®), micropipette (Vitlab®), cuvette (Hellma Analitik®), maserator (IKA RV 10®), rotary evaporator (RV 10 digital V®), a UV-VIS spectrophotometer (Shimidzu®), an oven, a water bath, a stirring rod, porcelain dishes, test tube clamps, test tubes, droppers, test tube racks, spirit lamps, horn spoons, brown vials, blue tips, and yellow tips.

Materials. The materials used were tampoi fruit peel (*Baccaurea pyriformis* Gage), 70% ethanol, vitamin C, DPPH solution (2,2-diphenyl-1-picryhydrazil), concentrated ammonia, Bouchardat, Mayer, Dragendorf, chloroform, magnesium powder, distilled water, iron (III) chloride ($FeCl_3$) 1%, concentrated HCl, 2N HCl, aluminium foil, filter paper, and tissue paper.

Research Procedure

This study is an experimental study to determine the antioxidant activity of tampoi fruit peel ethanol extract using the DPPH method. Experimental research is research that examines the effect of treatment on behaviour resulting from the treatment[13]. The research stages included plant determination, slimpisia preparation, maceration extraction, phytochemical screening, determination of extract moisture content, and antioxidant activity testing using DPPH.

1. Plant Identification

   Plant identification was carried out at the Laboratory of Ecology and Tropical Forest Biodiversity Conservation, Faculty of Forestry, Mulawarman University, Samarinda.

2. Tampoi Fruit Peel Production

   The first step in producing tampoi fruit peel was to prepare fresh materials, namely tampoi fruit peel that had been harvested at optimal maturity. The fruit then undergoes peeling, slicing, and drying. This process is carried out naturally by airing in a place with good air circulation, but still protected from direct sunlight. Drying using this method is chosen so that the active compounds in the fruit are not damaged by exposure to UV rays. The dried fruit peel is stored in tightly sealed containers, such as dark glass bottles or airtight plastic containers, and placed in a cool, dry place to maintain the quality of the ingredients before they are used in the extraction process[14].

3. Extract Production

   The method used is maceration with 70% ethanol solvent. After the ingredients and containers are prepared, 70% ethanol solvent is added until all the dried fruit is completely submerged. Soaking is carried out at room temperature for three days (3x24 hours), during which time the mixture must be shaken or stirred occasionally to accelerate the dissolution of the active substances. This maceration process was repeated three times using fresh solvent in each repetition so that all active ingredients could be extracted to the maximum extent possible. After the soaking process is complete, the mixture is filtered using filter paper to separate the solid part (pulp) and the extracted liquid (macerate). To obtain a thick extract, the filtrate is then evaporated using a special device called a

rotary evaporator. This process will produce a dark-coloured thick liquid which is a pure ethanol extract from tampoi fruit.

4. Moisture Content Test

   The moisture content is determined by placing 1 gram of the crude drug in a porcelain dish, heating it in an oven at 105°C for 30 minutes and drying it to a constant weight. The moisture content requirement according to the applicable standard parameters is no more than 10%, and the drying shrinkage is calculated using the following formula[15].

5. Phytochemical Screening

   a. Flavonoid

      Tampoi fruit peel extract was placed in a test tube, then Mg stearate powder and concentrated HCl were added. Flavonoid content was positive if a colour change to yellow, orange, and red occurred[16].

   b. Alkaloid

      0.5 grams of tampoi fruit peel extract was placed in a test tube, added with 1 mL of 2 N hydrochloric acid and 9 mL of distilled water, heated on a water bath for 2 minutes, cooled, and filtered. The filtrate is used for the alkaloid test. Take 3 test tubes and add 0.5 mL of filtrate to each test tube. The alkaloid test is carried out using three reagents, namely Mayer, Dragendorff, and Bouchardt. For the Mayer reagent, add 0.5 mL of filtrate to a test tube and then add 2 drops of Mayer reagent. The Mayer reagent produces a white to yellowish precipitate. This indicates that the extract is positive for alkaloid compounds. For the Dragendorff reagent, 0.5 mL of filtrate is placed in a tube and 2 drops of Dragendorff reagent are added. The Dragendorff reagent test is indicated by the formation of a brown-orange or orange precipitate. This indicates that the extract is positive for alkaloid compounds. Bouchardat reagent: 0.5 mL of filtrate is placed in a tube and 2 drops of Bouchardat reagent are added. The Bouchardat reagent test is indicated by the formation of a brown precipitate. This indicates that the extract is positive for alkaloid compounds.

   c. Tannin

      Add 0.5 g of tampoi fruit peel extract and 20 mL of distilled water to a test tube and heat. Then filter and add a few drops of 0.1% $FeCl_3$ until a colour change occurs. If a brownish green or blue black colour appears, the extract clearly contains tannin.

   d. Saponin

      Place 0.5 g of tampoi fruit peel extract into a test tube, add 5 mL of distilled water, and shake vigorously. A positive saponin content is indicated by the formation of foam or bubbles.

   e. Steroid

      The tampoi fruit peel extract is placed in a test tube. Then add 1 drop of anhydrous acetate and 2 drops of concentrated sulphuric acid. The appearance of a blue or green colour indicates the presence of steroids. If a purple or orange colour forms, this indicates the presence of triterpenoids[16].

6. Tampoi Fruit Extract Antioxidant Activity Test

   Antioxidant activity testing was carried out using the DPPH method and the absorbance was measured with a UV-Vis Spectrophotometer.

   a. Preparation of 40 ppm DPPH Solution

      A 40 ppm DPPH solution was prepared by weighing 4 mg of DPPH, then dissolving it with sufficient ethanol solvent, stirring until dissolved, then placing it in a 100 mL measuring flask and filling it with ethanol to the

mark, shaking until the solution was homogeneous. The DPPH solution was then stored in a brown bottle because the DPPH solution reacts easily with light and oxygen, causing degradation (Mendra *et al*., 2022).

b. Determination of the Maximum Wavelength of 40 ppm DPPH

The determination of the maximum wavelength of DPPH for the antioxidant activity test was determined by placing 2 mL of 40 ppm DPPH solution into a 10 mL measuring flask, covering the entire flask with aluminium foil, then adding ethanol up to the mark and homogenising. Measure the wavelength at 522 nm using UV-VIS spectrophotometry and ethanol blank.

c. Preparation of 100 ppm Vitamin C Stock Solution

The stock solution was prepared by weighing 10 mg of vitamin C, placing it in a beaker, and dissolving it with sufficient ethanol. The solution was then transferred to a 100 mL volumetric flask and ethanol was added up to the mark to obtain a 100 ppm vitamin C stock solution (Supringrum and Jubaidah, 2019). 4. Determination of the Standard Solution Curve The standard curve for the 100 ppm vitamin C stock solution was determined by pipetted into 10 mL volumetric flasks at concentrations of 2, 4, 6, 8, and 10 ppm as standard series solutions, then the volume was adjusted with ethanol to the 10 mL mark, and the absorbance of each standard series solution was measured at the maximum wavelength obtained.

d. Determination of Vitamin C Absorption plus DPPH

Each solution in the vitamin C series of 2, 4, 6, 8, 10 ppm was pipetted 1 ml, then 2 mL of 40 ppm DPPH solution was added, followed by incubation for 30 minutes in a dark room. The solution absorption was then measured at the wavelength obtained with 1 mL of ethanol blank plus 2 mL of DPPH solution using UV-Vis spectrophotometry.

e. Preparation of Extract Stock Solution

An ethanol extract stock solution with a concentration of 1000 ppm was prepared by weighing 0.1 g of ethanol extract and dissolving it in sufficient ethanol, then transferring it to a 100 mL volumetric flask and filling the volume with ethanol up to the mark. A series of ethanol extract solutions was prepared by placing 2, 4, 6, 8, and 10 ppm into a 10 mL measuring flask and filling the volume with ethanol to the mark. The absorbance of each solution was measured at the maximum wavelength obtained.

The absorbance of each sample was measured, then the inhibition value was calculated based on the percentage reduction in DPPH absorbance using the following equation:

$$\% \text{ Inhibition} = \frac{Absorbansi\ Blanko - Absorbansi\ Sampel}{Absorbansi\ Blanko}\ x\ 100\%$$

f. Inhibition Percentage (Inhibitory Concentration 50)

The determination of IC_{50} is a number that indicates the concentration of a sample capable of inhibiting the activity of a free radical by 50%, which can be calculated using the linear regression equation obtained. The value for determining IC_{50} is found by entering 50 as the y-axis and the concentration of the antioxidant extract as the x-axis. This ultimately yields the 50% inhibitory concentration value (x = IC_{50}). A smaller IC_{50} value indicates stronger antioxidant activity[17].

RESULT AND DISCUSSION

1. Plant Identification

Plant identification was carried out at the Laboratory of Ecology and Tropical Forest Biodiversity Conservation, Faculty of Forestry, Mulawarman University, Samarinda, which showed that the sample used was the species *Baccaurea pyriformis* Gage, known in Indonesia as the Tampoi fruit, with the number 200/UN17.4.08/LL/2025.

2. Production of Tampoi Fruit Peel

This fruit was obtained from Murung Raya Regency, Central Kalimantan. The fruit used was harvested based on the criteria of yellow to brownish peel colour. The Tampoi fruit peel obtained was split and separated from the fruit, then the fruit peel was wet sorted, washed with clean running water, drained, chopped, and dried by airing for 7 days. The dried fruit peel is then dry-sorted to ensure its quality. It is pulverised using a blender to increase the contact surface with the solvent. The fruit peel powder is then sieved using a 40-mesh sieve to obtain uniform particle sizes.

3. Determination of Drying Shrinkage

Drying shrinkage is determined by heating a crucible containing the extract at 105°C for 30 minutes and repeating until the weight is constant. The decrease in weight indicates that the water content in the extract has been successfully removed, signifying that the material is sufficiently dry, expressed as a percentage. This aims to provide a maximum limit (range) on the amount of compounds lost during the drying process[18].

Based on the research results, the water content of tampoi fruit peel was found to be 5.6%. The Indonesian Herbal Pharmacopoeia (2017) does not set a general limit for all crude drugs or extracts but lists the maximum moisture content, which varies in each monograph. However, the moisture content of plant extracts or crude drugs is generally required to be low, i.e., no more than 10%, to ensure stability during storage. Therefore, the result of 5.6% can be categorised as good because it is below the generally required range and indicates low moisture content, thereby minimising the risk of microbial growth and damage.

4. Tampoi Fruit Peel Extract

Tampoi fruit peel that has been processed into fruit peel is processed into tampoi fruit peel extract. Extraction is carried out using the maceration method with 70% ethanol as the solvent for 1×24 hours. This is a simple extraction method used to extract fruit peel containing active substances that are easily soluble in the extraction fluid. The resulting filtrate is filtered and evaporated using a rotary evaporator to obtain a thick extract. Organoleptic examination shows that the extract is dark brown, thick, and has a distinctive tampoi fruit aroma.

Dried tampoi fruit peel is weighed at 500 grams, then maceration extraction is carried out using 5.000 mL of ethanol solvent (1:10). The solvent used in maceration is 70% ethanol, which aims to extract all chemical components in the tampoi fruit peel, as ethanol solvent is effective in extracting all chemical components in the tampoi fruit peel.

5.000 mL (1:10). The solvent used in maceration is 70% ethanol, which aims to extract all chemical components in the tampoi fruit peel, as ethanol is a universal solvent that can extract compounds soluble in non-polar to polar solvents. The maceration process was carried out by stirring the macerator for 2 hours and then left to stand for 22 hours, then filtered to separate the filtrate from the pulp. The extract production process was carried out twice to optimise the extraction of compounds contained in the tampoi fruit peel. The filtrate obtained is

evaporated using a rotary evaporator at a temperature of 60°C, then concentrated in a water bath at a temperature of 60°C until a thick extract is obtained. The thick extract obtained is then used to calculate the extract yield. The yield of a sample is very important because it shows the amount of extract obtained during the extraction process. Yield is the ratio of the amount of metabolites obtained after the extraction process to the weight of the sample used. According to the Indonesian Herbal Pharmacopoeia (2017), the yield is considered good if the value is more than 10%. Based on the yield calculation in the appendix, the yield of the ethanol extract of tampoi fruit peel is considered good because the yield obtained is more than 10%, namely 13%.

5. Determination of Water Content

The determination of water content is carried out to determine the water residue after the thickening and drying processes. The aim is to provide a maximum limit or range for the water content in the extract. One gram of the crude drug is heated in an oven at 105°C for 30 minutes until the weight remains constant. The determination of water content is important to ensure the stability of the material before the extraction process. Water content determination in this study used oven heating. An extract is considered a liquid extract if it has a water content of more than 30%, a thick extract if it has a water content between 5-30%, and a dry extract if it has a water content of less than 5% [19]. Based on the results of this study, it can be concluded that tampoi fruit peel falls into the viscous extract category because it has a moisture content between 5-30%.

6. Phytochemical Screening

Phytochemical screening was conducted to identify the content of certain chemical compounds contained in the ethanol extract of tampoi fruit peel. The test results showed that the extract contained flavonoids, saponins, tannins, phenolics, and alkaloids, which were indicated by the formation of characteristic colours or precipitates in each test reagent[1].

Table 1. Results of Phytochemical Screening of Tampoi Fruit Peel Extract

No	Compound Group	Reagent	Result	Description
1	Alkaloid	Mayer	+	Yellow deposits formed
		Bouchardat	+	Brown deposits present
		Dragendorf	+	Red brick deposits formed
2	Flavonoid	Powder Mg + HCl pekat + amil alkohol	+	Yellow colour in the amyl alcohol layer
3	Saponin	Sample+ aquades, shaken vigorously 10 second + HCl 2N	+	Foam formed
4	Tanin	Sample + aquades + FeCl3 5%	+	Blackish green solution
5	Steroid/Triterpenoid	Residu + n-heksan + asam asetat + H2SO4	-	No positive signs steroids/triterpenoids

In Table 1. In this study, ethanol extracts of tampoi fruit peel from the table above contained secondary metabolite compounds of alkaloids, flavonoids, tannins, and saponins. The alkaloid phytochemical test was carried out using three reagents, namely Mayer, Dragendorf, and Bouchardat. The alkaloid screening produced precipitates from the three reagents, thus it can be concluded that the tampoi fruit peel ethanol extract sample was positive for alkaloids. Alkaloids are a group of compounds that are generally basic with one or more nitrogen atoms, which are usually found in a cyclic system. The mechanism of these alkaloids shows that they act as primary antioxidants[16].

Flavonoids can be tested using Mg powder, concentrated HC1, and amyl alcohol. Flavonoids can produce red, yellow, or orange colours. The ethanol extract of tampoi fruit peel tested positive for flavonoids because it produced a red colour on the amyl alcohol layer. Flavonoids are found in all green plants and can therefore be found in every plant extract. The mechanism of flavonoids as antioxidants occurs directly by donating hydrogen ions to neutralise the toxic effects of free radicals, while the indirect mechanism is by increasing the expression of endogenous antioxidant genes through several mechanisms.

Tannin compounds, namely extract solutions, will turn blue-black or green-black when dripped with FeC13. In addition, phenols can also be tested by adding 1% FeC1, which produces a colour change from blue to black. The results of the tannin and phenol tests produced a blue-black or green-black colour, so it can be concluded that the ethanol extract of tampoi fruit peel is positive for tannin and phenol compounds.

Saponins are plant compounds that belong to the terpenoid group. Saponins can be detected because they behave like soap and form foam when shaken, and permanent foam forms after adding 2N hydrochloric acid. The foam produced in the saponin test is caused by the presence of glycosides that can form foam in water and hydrolyse into glucose and other compounds[20]. The results of the saponin test on this sample produced foam and bubbles, so it can be concluded that the ethanol extract of tampoi fruit peel is positive for saponin compounds.

70% ethanol triterpenoids are effective solvents for extracting steroid compounds from plant materials. The phytochemical screening results showed that the ethanol extract of tampoi fruit peel did not produce red or purple rings, indicating that it was positive for steroid compounds. Steroids are compounds that act as antioxidants. Based on the above, it can be concluded that the antioxidant activity of ethanol extract from tampoi fruit peel is influenced by the secondary metabolites contained within it, namely alkaloids, flavonoids, tannins, and saponins.

7. Antioxidant Activity Test of Ethanol Extract of Tampoi Fruit Peel

The antioxidant activity test on tampoi fruit peel in this study was conducted using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method. The mechanism of action of DPPH is the donation of hydrogen atoms, which causes the purple colour of DPPH to fade to yellow .The parameter of the DPPH method is the 50% inhibition concentration (IC50) or the concentration that can reduce free radical activity by 50%.

The maximum wavelength was determined so that the absorbance of the sample was at the maximum wavelength to obtain maximum results. In this study, the maximum wavelength of DPPH free radicals was measured in the range of 450-600 nm using a UV-Vis spectrophotometer. The maximum wavelength of DPPH obtained was 522 nm. The determination of the maximum wavelength aims to find out the wavelength required for the solution to reach maximum absorption.

Tampoi fruit peel extract was made into several concentrations and tested using DPPH radicals. As free radicals, the purpose of making this concentration series was to find the IC50 value using a mathematical equation obtained through the correlation between inhibition and extract concentration. Inhibition is the presentation of purple colour decay and can be calculated from its absorbance. Each extract concentration was given free radicals and allowed to react for 30 minutes, which is the effective time between the test sample and DPPH. In addition, the DPPH method is known as a fast, simple, and sensitive method for assessing antioxidant capacity.

Table 2. Results of Antioxidant Activity Tests on Ethanol Extracts of Tampoi Fruit Peels

Sample	IC50 (ppm)	Average IC50 (ppm)	Category
Vitamin C	7,3520	7,5019	Very Strong
	6,6863		
	8,4675		
Tampoi Fruit Peel Extract	12,1584	11,8165	Very Strong
	10,6197		
	12,6714		

Antioxidant activity testing showed that ethanol extracts of tampoi fruit peel have antioxidant activity, as indicated by a colour change from purple to yellow. The results showed that the higher the concentration of ethanol extract of tampoi fruit, the higher the percentage of inhibition of DPPH free radicals. The antioxidant activity test results of the ethanol extract of tampoi fruit peel had an average IC_{50} value of 11,81 ppm, which is classified as very strong (IC_{50} < 50 ppm), indicating that the extract is capable of effectively reducing DPPH free radicals.

In this study, vitamin C (ascorbic acid) was used as a positive control in the antioxidant activity test because it has been widely proven to be a strong antioxidant capable of reducing free radicals. Vitamin C is a water-soluble vitamin, and its main function is as a coenzyme or cofactor. Thus, the use of vitamin C in this study served as a comparison to assess the antioxidant capacity of tampoi fruit ethanol extract more objectively and measurably.

The results of the antioxidant activity test of ethanol extract of tampoi fruit peel showed an average IC_{50} value of 11,81 ppm, which is classified as very strong (IC_{50} < 50 ppm), indicating that the extract is effective in reducing DPPH free radicals. This is in line with research conducted by Dani in 2024 entitled Antioxidant Activity of Ethanol Exctract of Tampoi Fruit Peel (*Baccaurea macrocarpa*) Using the DPPH (2,2-diphenyl-1-picrylhydrazyl) Method, which states that the antioxidant activity test results of the tampoi fruit peel extract had an average IC50 value of 14.5785 ppm (very strong), thus it can be concluded that the ethanol extract of tampoi fruit peel has very strong antioxidant activity when compared to vitamin C, which has an average IC_{50} value of 5.9613 ppm.

These results are also in line with research conducted by Zharifah and Sunarwati in 2024 entitled Phytochemical Testing and Antioxidant Activity of Tampoi Leaves (*Baccaurea macrocarpa* (Miq.) Mull.Arg) From the Ghimbo Potai Traditional Forest Based on Location and Age of Leaves stated that the phytochemical test results showed that tampoi leaf extract contained alkaloids, flavonoids, saponins, triterpenoids and tannins. The antioxidant activity test showed that tampoi leaf extract from location 2 old leaves had the strongest IC_{50} value at 5,95 µg/mL.

Limitation

The antioxidant activity test results of the ethanol extract of tampoi fruit peel had an average IC_{50} value of 11,81 ppm, which is classified as very strong (IC_{50} < 50 ppm), indicating that the extract is capable of effectively reducing DPPH free radicals. This antioxidant activity is thought to be closely related to the presence of secondary metabolites contained in the tampoi fruit peel extract. Based on the results of phytochemical screening, the extract was found to contain flavonoids, alkaloids, tannins/phenols, and saponins, which are known to have potential as natural antioxidants . These compounds are known to have antioxidant activity. Flavonoids are able to capture free radicals and prevent oxidative stress. Alkaloids can inhibit the formation of radicals through active nitrogen groups that act as pro-oxidant metal binders and oxidase inhibitors, while saponins are known to provide protection against oxidative damage.

CONCLUSION

The conclusion of this study is that ethanol extract of tampoi fruit peel has an average IC_{50} value of 11,8165 ppm, which is classified as a very strong antioxidant, while vitamin C, as a comparison, has an IC_{50} value of 7,5019 ppm.

FUNDING

This research was supported by the Ministry of Higher Education, Science, and Technology through a Research Grant for Early Career Lecturers with the main contract number 132/C3/DT.05.00/PL/2025.

ACKNOWLEDGMENTS

On this occasion, the researchers would like to express their gratitude to various parties who have contributed to the realisation of this research:

1. Kementerian Pendidikan Tinggi, Sains, dan Teknologi through the Research Grant for Early Career Lecturers.
2. The Head of the Sekolah Tinggi Ilmu Kesehatan Samarinda.
3. The Head of the LPPM Sekolah Tinggi Ilmu Kesehatan Samarinda.

AUTHOR CONTRIBUTION STATEMENT

NM : Conceptualization, Methodology, Investigation, Writing—Original Draft Preparation; **RS** : Investigation, Data curation, Formal analysis; **HS** : Methodology, Validation, Visualization; **SO** : Resources, Investigation, Data curation; **GA** : Writing—Reviewing and Editing, Validation; and **NF** : Supervision, Project administration, Funding acquisition.

CONFLICT OF INTEREST DECLARATION

The authors declare that there are no conflicts of interest.

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