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Formulation and analysis of physical properties of Turi leaf extract suspension (*Sesbania grandiflora* L.)

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ABSTRACT

Sesbania grandiflora L. is a type of plant that has so many benefits in the treatment of various kinds diseases, including laxatives, pain relievers (analgesics), fever reducers (antipyretic), laxative urine (diuretic), and others. Almost all parts of this plant belonging to the genus *Sesbania grandiflora* are efficacious as a medicine covering the skin stems, flowers, leaves and roots. *Sesbania grandiflora*.L contains alkaloid compounds, glycosides, flavonoids, saponins, tannins and phenols, which positively react in the phytochemical screening assay. Leaf organs have a higher flavonoid content than other organs such as stems, roots, flowers and seeds. Turi leaf extract needs to be made in pharmaceutical dosage forms for ease of use. One preparation that can be applied is suspension. This study aimed to obtain a suspension formula with the best physical properties according to SNI standards. In this study, Turi leaf extract was used as the active substance. The suspension was made in 3 formulas with different concentrations of turi leaf extract. The finished suspension was tested for physical characteristics, including organoleptic, homogeneity, pH, density and viscosity tests. Based on the results of secondary metabolite tests, Turi leaves contain alkaloids, flavonoids, tannins and saponins. Based on the results of testing the physical properties of the suspension, showed that all formulas met SNI standards based on organoleptic, homogeneity, pH and density tests. While based on the viscosity test, the suspension made does not meet SNI standards.

Keywords:
Turi leaf extract; physical properties; suspension; *Sesbania grandiflora* L. ; Fabaceae

Introduction

Sesbania grandiflora L. (Fabaceae) is widely grown in yards and is better known by the community as Turi plant, used as an ornamental plant, medicinal plant, and vegetable (Budiarti et al., 2020). Turi spread across Indonesia, Malaysia, the Philippines and India. This plant is widely planted in yard gardens, on roadsides, as well as in rice field bunds and dry fields as a limiting plant for land ownership (Baessa et al., 2019). Apart from being a vegetable, parts of the turi plant, such as leaves, flowers and pods, are also a source of raw materials for anemia, cough, and fever reducer, as a stimulation of intelligence, and in Java, they are commonly used as stomach medicine. One of the highest antioxidant content of the turi plant is tannins and flavonoids (Sureka et al., 2021), which in several plants has been widely reported for its pharmacological activities, including effects as an antioxidant (Santillo et al., 2022), anticancer (Muniyandi et al., 2019), antimicrobial (Cano et al., 2021), treatment of cardiovascular disease, antidiabetic, antihepatotoxic, and antiatherosclerotic (Ahmad & Tabassum, 2013).

Turi leaf extract needs to be made in pharmaceutical dosage forms for ease of use. Pharmaceutical dosage forms that can be made are Pulvis (Xia et al., 2020), Tablets (van den Heuvel et al., 2021), Pills (Martínez-Sánchez et al., 2020), Capsule (Reix et al., 2012), Caplet (Ndesendo et al., 2009), Solution (Yu et al., 2020), Suspension (Negrini et al., 2017), and emulation (Garcia-Manero et al., 2016). One preparation that can be applied is a suspension (Thissera et al., 2020). Suspension is a liquid preparation containing insoluble solid particles dispersed in the liquid phase (Amin et al., 2022). Suspensions have several advantages, namely high homogeneity for active ingredients with larger doses, easier absorption than tablets or capsules and can mask the unpleasant taste of the extract (Palak et al., 2023).

Suspension is a preparation that contains solid medicinal ingredients in fine and insoluble, dispersed in a liquid carrier. The dispersed substance should not settle quickly, must be smooth and when shaken slowly the residue must be redispersed immediately (Martha Wijaya & Naufa Lina, 2021). The suspension viscosity should be manageable so that the preparation is easily shaken and poured. Suspension preparations are preferred over solid preparations because they are easy to swallow, given to children and the elderly who have difficulty swallowing. The suspension has better bioavailability and faster absorption than solid dosage forms. The factor that must be considered in the suspension system is settling. Settling speed depends on the physical properties of the suspension, such as viscosity and density (Fukui & Kawaguchi, 2022).

Based on this background, researchers are interested in formulating suspension preparations from turi leaf extract. In this study, suspensions will be made with different extract concentrations. With the difference in concentration, it is hoped that the best formula can be found with the concentration of turi leaf extract.

Methods

Research materials

The material used in This research includes Aquades, aluminium foil, Turi leaves, ethanol 96% (technical), ethanol 96% p.a (Merck), ethanol 70% p.a (Merck), paper filter, propylene glycol (Brataco), CMCNa, sorbitol, sodium benzoate, Triethanolamine.

The tool used is the balance analytics, glassware, ovens, machines pollinators, maceration vessels, water baths, stirrers, funnels, desiccators, mortars and stamper, metal spoon, blender (Philips), glass bottles, homogenizer (Kika Labortechnik), hot plate stirrer (Stuart CB 302), magnetic stirrer, sieve No. 25 (Retsch AS 200), pH-meter (Hanna Instruments), rotary evaporators (Heidolph Laborate 4000 Efficient), stopwatch, spatula, analytical balance (Ohauss), ultrasonic bath (Bandelin Sonorex Digitec), water bath (SMIC).

Turi leaf simplicial

The simplicia used is turi leaves. Leaves are collected, then washed clean and dried. After that, dry back in the oven for 2 hours until simplicia was obtained dry. Then the dried simplicia was powdered and sieved with a sieve number 20 to homogenize the size powder particles (Abebe et al., 2022).

Preparation of leaf extract turi

The method maceration prepared the extract of the leaves. Macerated turi leaf powder with 70% ethanol solvent. Immersion was carried out for 6 hours at a time stirred, Maserate was separated by a filter using a flannel cloth. The remaining residue is macerated again 2 times using 70% ethanol. The entire filtrate obtained was collected and stored for 24 hours o'clock. Then the filtrate was filtered again and evaporated to obtain turi leaf condensed extract (Abebe et al., 2022).

Secondary Metabolite Testing

Secondary metabolite data analysis was carried out descriptively by observing the characteristic changes in turi leaf extract after reacting with the appropriate chemical reagents for each secondary metabolite test. The secondary metabolites tested were alkaloids, tannins, and flavonoids, saponins. Secondary metabolite testing aim to determine the active substance contained in turi leaves, so that it can be used in the manufacture of suspension preparations.

Formulation of extract suspension preparations turi leaves.

The preparation of turi leaf extract suspension begins by dissolving the extract in water and sodium benzoate in propylene glycol. CMC-Na added hot water, this is because CMC will easily dissolve in hot water and then be crushed until homogeneous. Pre-contained propylene glycol sodium benzoate mixed with mucilago CMC-Na and stirred until homogeneous. Function Propylene glycol is one kind of solvent or cosolvent which can be used to increase the solubility of a drug in liquid, semi-solid and transdermal formulations. The extract solution is added gradually into the mixture while still being crushed. The suspension is then added essence or flavor and triethanolamine and stirred until homogeneous.

Evaluation of extract suspension preparations Turi leaves

After the suspension is finished, the next step is to evaluate the physical properties of the suspension. Physical evaluation of the suspension including organoleptic, homogeneity, PH, density and viscosity tests.

Results and Discussions

Research on suspension preparation and physical properties test of turi leaf extract suspension. This study aims to determine differences in the physical properties of the suspension formulation with the active substance of turi leaves.

Secondary metabolite test.

Phytochemical tests were carried out to identify the secondary metabolites' content in plants. The secondary metabolites identified in this study were alkaloids, flavonoids, saponins, tannins and glycosides. The test results showed that turi leaf extract contains alkaloids, flavonoids, saponins, tannins and glycosides as tabulated in Table 1.

Table 1. Turi leaf extract secondary metabolite test results

	Test results
Alkaloids	+
Flavonoids	+
tannins	+
Saponins	+

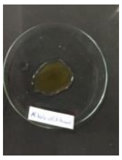
Alkaloid Test

Alkaloid testing is done by using two types of reagents/reagents viz reagent mayer and dragendroff where the results. The result is a positive white precipitate for the Mayer reagent and the orange residue for dragendroff reagent (Kundu et al., 2022).

Alkaloid testing was carried out by adding 1 ml of HCl 2 N and 9 ml of distilled water, heating on a water bath for 2 minutes, cooling, then filtering, 3 drops of the filtrate transferred to the watch glass, then 2 drops of Bouchardat's and Mayer's reagent were added. In addition, HCl in this alhaloid test is because the alkaloid is alkaline, so it is extracted with an acid solvent.

The principle of this analysis method is the precipitation reaction that occurs due to a ligand replacement. Nitrogen atoms with a lone pair of the electron in alkaloids can replace ions in the reagents. Dragendorff reagent Contains bismuth nitrate and potassium iodide in a glacial acetic acid solution (potassium tetraiodobismutat (III)). Alkaloid test results are tabulated in table 2.

Table 2. Alkaloid test results

Compound	Test result		Information
Alkaloids		White precipitate formed	(+)
		Brown precipitate formed	(+)

Alkaloid positive results on the Mayer test indicated the formation of a white residue. The residue is complex potassium-alkaloids. In the manufacture of reagents Mayer, mercury (II) chloride solution is added. Potassium iodide will form a precipitate red mercury mercury (II) iodide. If potassium excess iodide added, Potassium tetraiodomercurate (II) is formed (Kundu et al., 2022).

Alkaloids contain atoms nitrogen has an electron pair free, so it can form a coordinate covalent bond with metal ions. On test alkaloids with Mayer's reagent, nitrogen in alkaloids will react with ions metal K^+ from potassium tetraiodomercurate (II) to form a potassium-alkaloid complex precipitate.

$$HgCl_2 + 2KI \rightarrow Hgl_2 + 2KCl$$

$$Hgl_2 + 2KI \rightarrow K_2\,[HgI_4]$$

Alkaloid positive results in the Dragendorff test indicated by the formation of a precipitate light brown to yellow (orange). Precipitate is a potassium alkaloid. On preparation of Dragendorff reagent, bismuth nitrate dissolved in HCl to prevent reaction hydrolysis due to bismuth salts is easyly hydrolyzed to form bismuth ion (BiO^+).

$$Bi^{3^+} + H_2O \rightarrow BiO^+ + 2H^+$$

For $Bi3^+$ ions to remain in solution, then the the solution was added acid so the equilibrium would shift to the left. Furthermore, $Bi3^+$ ions from bismuth nitrate react with potassium iodide to form a precipitate later black Bismuth (III) iodide dissolves in excess potassium iodide to form potassium tetraiodobismutat. In the alkaloid test with reagents Dragendorff, nitrogen forms a coordinate covalent bond with K^+, a metal ion.

$$Bi(NO_3)_3 + 3KI \rightarrow BiI_3 + 3KNO_3$$

$$BiI_3 + KI \rightarrow K\,[BiI_4]$$

Flavonoid Test

Flavonoid testing is done by taking the extract of 0.5 gram, adding 10 ml of distilled water, heating and filtering, then taking 1 ml of filtrate and adding 1 ml of 96% ethanol and 0.1 gram of magnesium and adding 10 ml of concentrated HCL (Peasari et al., 2018). The results obtained indicated that a yellow solution was formed. They were indicating the presence of flavonoid compounds. The results of the flavonoid test are shown in table 3.

Table 3. Test results for flavonoids

Compound	Test result	Information
Flavonoid	 A yellow solution is formed	(+)

Heating on the testing of flavonoids was carried out due to a large extent flavonoids are soluble in hot water. While the addition of metal Mg and HCl reduces the benzopirone nucleus contained in the structure of flavonoids to form colored flavilium salts red or orange.

Flavonoids contain two aromatic rings with groups of more than one hydroxyl. Phenolic compounds with more hydroxyl groups it has a degree of solubility in water that increases or is polar, so that they can be extracted in polar solvents (Teng et al., 2023). Reactions between compounds flavonoids with HCl and metal Mg can be seen in Figure 1.

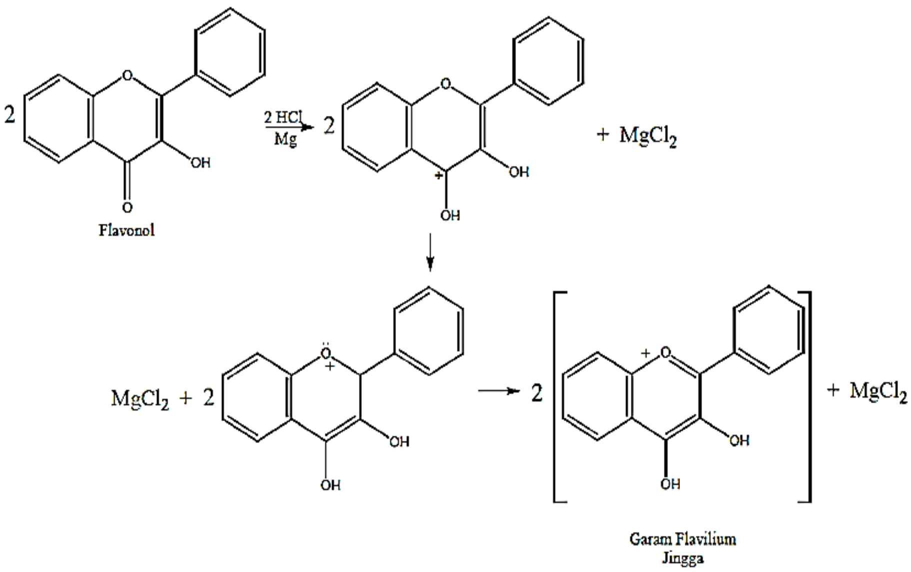


Figure 1. Flavonoid Reaction with Metals Mg and HCl (Rodríguez-Arce & Saldías, 2021)

Tannin Test

Compound testing tannins in turi leaf extract were carried out by taking 0.5 grams of turi leaf extract which was added to 10 ml of distilled water and heated and filtered (Peasari et al., 2018). Transfer 1 ml of the filtrate to 2 test tubes:

- First test tube + $FeCl_3$
- Second test tube + 1% gelatin

The results show that the first test tube showed a color change to blue or green-black and the second test tube showed the presence of a white residue.

Testing of tannin compounds was carried out using $FeCl_3$. $FeCl_3$ is used to determine whether the sample contains a phenol group. There is a phenol group shown in dark green or dark blue after added with $FeCl_3$, so if the phytochemical test with $FeCl_3$ gives positive results, it is possible that the sample contained phenolic compounds and it is possible that one of them is tannins because tannins polyphenolic compounds (Peasari et al., 2018).

Phenolic compounds can be detected by adding the extract to the solution 1% $FeCl_3$ in water, which gives rise to the color strong green, red, purple, blue or black. The formation of a blackish green or blue color ink on the extract after being added with $FeCl_3$ because tannins will form compounds complex with Fe^{3+} ions.

The result of testing for tannin compounds using gelatin is the formation of precipitate white indicates the presence of tannin compounds. It can be explained by the fact that the nature of tannins is to bind and precipitate proteins. Tannins react with gelatin to form a stable copolymer insoluble in water (Peasari et al., 2018).

Table 4. Tannin test results

Compound	test result	Information
Tannins	There is a change in color to black-green	(+)
	There is a white precipitate	(+)

Saponin test

A sample of 0.5 grams of Turi leaf extract was added to 10 ml of hot water, then shaken vigorously for 10 seconds and put into a test tube. A positive result is indicated by the formation of foam stable (Hayat et al., 2020). From the results of saponin testing Turi leaf extract contain saponins. It is visible in the resulting stable foam. Compounds with polar and nonpolar groups are surface active so that saponins can form micelles when shaken with water,. In the micelle structure, the polar group faces outward while the nonpolar group faces inward (Rai et al., 2023). This situation is what appears like foam. The results of the saponin test are shown in table 5.

Table 5. Saponin Test Results

Compound	test result	Information
Saponins	Foam formed which lasted for 10 minutes	(+)

After testing the secondary metabolites on turi leaf extract, the next step is to make a suspension of Turi leaf extract. The suspension was made in 3 formulas with different concentrations of turi leaf extract of *Turi leaf extract suspension.* The selection of 3 formulas was carried out to find the best concentration based on testing the physical properties of the suspension. The preparation formula can be seen in the table 6.

The three suspension formulations that have been made are then tested for the physical properties of the suspension. Testing of these physical properties includes organoleptic, homogeneity, pH, specific gravity and viscosity.

Organoleptic Test

Organoleptic test, commonly called sensory test or sensory test is a method of testing using the human senses as the main tool for measuring the acceptability of products. Organoleptic testing has an important role in the application of quality. The organoleptic examination or test includes an examination of color, smell, taste, and suspension dosage forms (Surya et al., 2020). Organoleptic test results are tabulated in table 7.

Table 6. Turi leaf extract suspension preparation formula

Formulas	Form	Color	Smell	Taste
I	Liquid	Brown	Aromatic	Sweet
II	Liquid	Brown	Aromatic	Sweet
III	Liquid	Brown	Aromatic	Sweet

Table 7. Organoleptic test results

Materials	Formulas (%)		
	1	2	3
Turi leaf extract	5	10	15
Propylene glycol	3	3	3
Sorbitol	30	30	30
CMC-Na	1.5	1.5	1.5
Sodium benzoate	0.4	0.4	0.4
Aquadest	Ad 100 ml	Ad 100 ml	Ad 100 ml

pH Test

The pH test was carried out using a pH stick. This test is important for determining the degree of acidity of a preparation, whether it is following the provisions or not.

The results of the pH test of extract suspension preparations Turi leaves produce pH 6 for all formulas. It shows that the increase in the concentration of turi leaf extract did not affect the suspension preparation's pH. Score the pH of the entire suspension formula complied with Indonesian Pharmacopoeia requirements namely, between 4–7. pH test results of suspension preparations of Turi leaf extract are tabulated in table 8.

Table 8. pH test results

No	Formulas	pH
1	I	6
2	II	6
3	III	6

Homogeneity Test

The suspension homogeneity test aims to see whether all suspension components are mixed with good or not. The results of the homogeneity test of the suspension can be seen in table 9. The results of observations on each preparation of the suspension can be seen that there is a grain of coarse color evenly distributed on the object glass. So this suspension is a homogeneous suspension.

Density test

The purpose of the specific gravity test on suspension preparations is to calculate the viscosity value of preparations because specific gravity is one of the factors that affect viscosity. (Rosida et al., 2016). The results measurement of the weight of the type of preparation can be seen in table 10.

Table 9. Homogeneity test results

No	Formulas	Results
1	I	Homogeneous
2	II	Homogeneous
3	III	Homogeneous

Table 10. Density test results

No	Formulas	Density (gr/ml)
1	I	1.062
2	II	1.069
3	III	1.071

The results of mass measurements type indicate a difference in the density value in each formula. The greater the extract concentration, the greater the density. All formulas have a density that meets the specific gravity requirements suspension is > 1.00 g/ml (Selin et al., 2018).

Viscosity test

A viscosity test was carried out to determine the thickness of a suspension preparation. A good suspension is easy to flow but has a high viscosity to improve physical stability. The viscosity of the suspension is known by comparison with known viscosities of water (Kamińska-Dwórznicka et al., 2022). Viscosity testing is carried out to find out how much the consistency of the preparation and indicates the thickness of a preparation. The results of the preparation viscosity measurements can be seen in table 11.

Table 11. Viscosity test results

No	Formulas	viscosity (cP)
1	I	23.83
2	II	25.05
3	III	25.11

Based on the results of viscosity measurements show that the viscosity of the suspension increases with increasing Turi leaf extract concentration. According to SNI, the viscosity value of the suspension is 37cP-396 cP. All formulas do not meet SNI standards (Martha Wijaya & Naufa Lina, 2021).

Conclusion

Turi leaf extract suspension has been successfully made. Turi leaf extract was used as the active substance. The suspension was made in 3 formulas with different concentrations of turi leaf extract. The finished suspension was tested for physical characteristics, including organoleptic, homogeneity, pH, density and viscosity tests. Based on the results of secondary metabolite tests, Turi leaves contain alkaloids, flavonoids, tannins and saponins. Based on the results of testing the physical properties of the suspension, showed that all formulas met SNI standards based on organoleptic, homogeneity, pH and density tests. While based on the viscosity test the suspension does not meet SNI standards.

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Conflicts of interest
The authors declare that there are no conflicts of interest.

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