International Journal of Applied Pharmaceutics

ISSN- 0975-7058 Vol 16, Special Issue 6, 2024

Original Article

FORMULATIONS AND CHARACTERIZATIONS OF TELANG FLOWER EXTRACT (*CLITORIA TERNATEA* L.) GEL USING HYDROXY PROPYL METHYL CELLULOSE (HPMC) AS GELLING AGENT AND ITS ANTIOXIDANT ACTIVITY

SETYO NURWAINI*, ARUNIYAL ALIMATUS SADIAH, RIZA MAULANA, TEGUH IMANTO

Pharmaceutic and Pharmaceutical Technology Laboratory, Faculty of Pharmacy Universitas Muhammadiyah Surakarta Jl Ahmad Yani Kartasura, Surakarta, Indonesia

***Corresponding author: Setyo Nurwaini; *Email: sn164@ums.ac.id**

Received: 22 Apr 2024, Revised and Accepted: 12 Sep 2024

ABSTRACT

Objective: Telang flowers (*Clitoria ternatea* L.) are plants that contain a natural source of antioxidants that can be formulated in gel preparation with a variation of concentration of gelling agent Hydroxy Propyl Methyl Cellulose (HPMC). The purpose of this research was to know the difference in the levels of HPMC as a gelling agent against the physical properties and antioxidant activity of preparation of telang flower extract gel.

Methods: The extraction of telang flowers is done by a maceration method with a 96% ethanol solvent. The gel was formulated with HPMC concentration variations of 2%, 2.5% and 3% respectively. The physical properties of the gel that were determined were organoleptic, pH, stickiness, spreadability, viscosity, and homogeneity. Antioxidant activity was determined using DPPH (2,2-diphenyl-1-picrylhydrazyl). Data was analyzed statistically using a one-way ANOVA test with a 95% confidence level.

Results: The results of the research showed that the best formula was formula II with a concentration of HPMC of 2.5%. The gel of extract telang flower has characteristics with a typical scent of the telang flower, the blue-purple color, homogeneous, pH was 6.393±0.01, stickiness was 1.203±0.7 s, spreadability was 4.17±0.1 cm, and viscosity was 3000±100 cP. The antioxidant activity (IC_{50}) the gel was 101.42 ppm belongs to the category of moderate antioxidants.

Conclusion: Gel extract of telang flowers with concentration gelling agent HPMC concentration of 2.5% had the best physical properties.

Keywords: Telang flowers extract, HPMC, Antioxidant

DOI: https://dx.doi.org/10.22159/ijap.2024.v16s6.SE2030 Journal homepage: https://innovareacademics.in/journals/index.php/ijap

INTRODUCTION

Ultraviolet rays can expose the human body to free radicals [1]. The effects of free radicals can trigger diseases such as skin redness, pigmentation, and even cancer [2]. One of the natural ingredients that contains antioxidant activity is telang flower (*Clitoria ternatea* L.). Telang flower is rich in antioxidants that scavenge free radicals caused by ultraviolet rays [3]. According to Oguis (2019), the purple-blue color is characteristic of the telang flowers due to the presence of an anthocyanin compound, a color pigment known to have antioxidant properties [4]. Specifically, the type of antocyanine contained in the telang flower is a saturated 3-o-glycoside delpinidine compounds. Jeyaraj (2021) have revealed that telang flowers contain bioactive compounds such as kaempferol, quercetin, and myricetin [5].

In this study, telang flowers were made into a gel, which is a preparation in the form of semipadate or thick, made by mixing the active substance with the appropriate base. The water base in the gel provides a cooling, moisturizing, and softening effect [6]. The gel preparation also has good resistance, does not clog pores, is easy to wash with water and has excellent drug release [7].

Hydroxy Propyl Methyl Cellulose (HPMC) is a gelling agent that is capable of forming a gel at low concentrations. HPMC is a cellulose derivative that has the advantages of, among other things, producing a gel that is neutral, clear, and colorless, producing a gel with good viscosity in long storage, being non-toxic, not irritating, stable at pH 3–11, and having good resistance to microbes [8].

According to Setiyadi (2023) the concentration of gelling agent 2.3% and glycerol 7.7% as humectan in gel extract of carrots (*Daucus carota* L.) provided physical properties such as viscosity, uniformity, adhesion, and optimum pH values, as well as IC_{50} [9]. Gel of pandan leaf (*Pandanus amaryllifolius* Roxb.) and ethanol extracts of kelor leaf (*Moringa oleifera*) using concentration HPMC 2% had good physical quality compared to concentration 3% and 4% [10, 11]. According to research by Seru *et al.* (2021), the gel of ethanol extract of *Clerodendrum minahassae* with a concentration of 3% HPMC has good gel properties and has an antioxidant activity value compared to HPMC concentrations of 5% and 7% [12]. The addition of gel-forming ingredients will affect the physical stability of the preparation produced [13]. This research determined the difference in the levels of HPMC as a gelling agent against the physical properties and antioxidant activity of telang flower extract gel.

MATERIALS AND METHODS

Materials

The material used was dried telang flower (*Clitoria ternatea* L.) from the marketplace distributor of telang flower (Surakarta, Indonesia). The identity of telang flowers has been determined at the UPT Laboratory of the University of Setia Budi, Indonesia (No. 76E/DET/UPT-LAB/18.08/2023). Other reagents are ethanol 96% (Cipta Kimia, Indonesia), HPMC (Griya Mandiri, Indonesia), propylene glycol, methylparaben, DPPH (E-Merk), magnesium (Mg), chloric acid (HCl), sulfate acid (H_2SO4), and $FeCl_3$ 5%. All of these materials were from the Laboratory Faculty of Pharmacy at UMS.

Extraction telang flower (*Clitoria ternatea* L.)

The method used to make telang flower extract was maceration. The dried telang flowers were powdered using a blender (Miyako), then weighed as much as 500 g. The telang flower powder was placed in the bottle, and then 96% ethanol solvent was added as much as 5 l (proportion 1:10). The mixture was soaked for 4 d and stirred every 8 h. The immersion result was filtered using Whatman filter paper until the filtrate was obtained. The residues obtained were remacerated with ethanol (96%, 3.5 l). The filtrate was obtained using a rotary evaporator (Heidolph) at 60 °C and thickened using a water bath (Memmert) at a temperature of 60 °C until a thick extract was obtained.

Phytochemical screening telang flower (*Clitoria ternatea* L.) extract

Flavonoid test

As much as 40 g of telang flower extract was added to 100 ml of hot water, then heated for 5 min and filtered. The filtrate was taken and added to 0.1 g of magnesium powder (Mg) and 1 ml of concentrated chloric acid (HCl), then boiled. Positive results were marked by the formation of red, yellow, or orange colors [14].

Terpenoid test

As much as 100 mg of telang flower extract was dissolved in 10 ml of water. The 2 ml of filtrate was taken and 3 drops of chloric acid (HCl) and 1 drop of H_2SO4 were added. The positive result was marked by the formation of a red or purple color [14].

Saponin test

Extract telang flower of 0.5 g was added to 10 ml of aquadest and moisturized for 10 s. The positive result of saponins formed a stable foam for no less than 10 min with a foam height of 1-10 cm. When 1 ml of 2N HCl was added, the foam would not disappear [15].

Tanin test

A sample of telang flower extract was (0.5 g) was placed in the tube, and 1 ml of $FeCl_3$ 5% was added. Positive tannins were formed by the color of dark blue, green blue or back greenery [15].

Table 1: Formula of gel of telang flower (*Clitoria ternatea* L.) extract with varying concentrations of HPMC gelling agents: 2%, 2.5%, and 3%, respectively

Ingredients	Function	Formula		
		FI	FII	FIII
Extract of telang flower	Active substance	1 g	1 g	1 g
HPMC	Gelling agent	2 g	2,5 g	3 g
Propylene glycol	Humectant	15 g	15 g	15 g
Methylparaben	Preservative	0.2 g	0.2 g	0.2 g
Aquadest until	Solvent	100	100	100

The gel-making stage began with weighing all the ingredients (Table 1). First, HPMC was made to swell in a mortar using hot water, then stirred slowly until it was homogeneous and formed a gel base. Methylparaben and telang flower extract were dissolved in propylene glycol. The mixture was added little by little to the gel base and stirred until homogeneous. The gel was put into a pot containing the gel container.

The telang flower extract gel underwent physical observation, which included examining its odor, color, and consistency [16]. A satisfactory preparation of the gel is clear and has a semisolid consistency [17].

pH test

pH measurement using pH meters (Ohaus). The pH meter electrode was immersed in 500 mg gel preparation dissolved with 100 ml aquadest, then viewed the scale indicated by the pH meter and replicated three times [17].

Stickiness test

The 0.25 g gel was placed on top of an object glass. The glass containing the gel was attached to another object glass and then loaded with 1 kg for 5 min. The object glass was mounted onto the test device, and the weight of 80 g was released, then marked for the time required until the two glasses were released. The stickiness test was replicated three times [18].

Spreadability test

The gel weighed 0.25 g and was placed on top of a round glass scale. Then, another round glass was given and left for 1 minute. The spread of the gel was measured and then placed in a 50 g barrel for a minute. Then, the diameter of the spread was recorded. The test was repeated with a weight of 50 g per minute until it reached 250 g [19].

Viscosity test

A test of gel viscosity was conducted using the Viskotester VT-06E rotor number 2. The gel sample was placed in the pot. The rotor was placed in the middle of the pot. The viscosity of the gel will appear on the display [20].

Homogeneity test

This test was done by applying a gel preparation to a transparent glass plate, and it was seen that there were no particles on the glass [21].

Antioxidant activity test of telang flower (*Clitoria ternatea* L.) extract and telang flower (*Clitoria ternatea* L.) gel

Preparation of 0.1 mmol 2,2-diphenyl-1-picrylhydrazyl (DPPH) solution

DPPH powder 3,94 mg dissolved with ethanol p. a. in 100.0 ml of volumetric flask, up to the boundary mark and then wrapped in aluminum foil. The solution was stored in a dark place until used.

Maximum wavelength measurement

DPPH 0.1 mmol solution 3.0 ml was placed in a 5.0 ml measuring volumetric flask, then ethanol p. a was added to the limit mark and homogenized. The solution was poured into the cuvette and measured at 515-520 nm wavelengths with UV-Vis spectrophotometry (Shimadzu UV-1280).

Preparation of DPPH control solution

A 0.1 mmol DPPH solution of 3.0 ml was put into a 5.0 ml volumetric flask and ethanol p. a was added up to the limit mark. The mixture was homogenized, and it was incubated for 30 min. The solution was poured into a cuvette and measured at a wavelength of 516 nm with UV-Vis spectrophotometry (Shimadzu UV-1280).

Antioxidant activity testing extract telang flower (*Clitoria ternatea* L.) and telang flower (*Clitoria ternatea* L.) gel

Extracts and gels with a concentration of 1000 ppm were made by weighing 10.0 mg of the extract and placing them in a 10.0 ml measuring flask. It was dissolved with ethanol p. a. to the limit. Extracts of 100, 200, 300, 400, and 500 µL were taken. 3.0 ml of 0.1 mmol DPPH solution and ethanol p. a. were added to the 5 ml volumetric flask until the limit mark. The solution was incubated for 30 min, and then the absorbance was read at a wavelength of 516 nm using UV-Vis spectrophotometry (Shimadzu UV-1280). The final concentration of ethanol extract was 20, 40, 60.80, and 100 ppm.

Data analysis

Calculation of IC_{50} values and inhibition percentages from the absorption results obtained, each concentration is calculated as the percentage value of inhibitions [14].

$$\text{Percentage (\%) inhibition} = \frac{\text{Absorbance DPPH (control)} - \text{test sample absorbance}}{\text{Absorbance DPPH (control)}} \times 100\%$$

The percentage value of the concentration was made a regression curve so that the equation value of y=bx+a is obtained. The axis x

was the extract concentration while the axis y is the representation value. Calculation of the inhibitory concentration (IC_{50}) as the concentration of a sample with a DPPH absorption inhibition of 50%.

The antioxidant activity with an IC_{50} value less than 50 ppm category is very strong, the IC_{50} rating is 50-100 ppm of the strong category, the IC_{50} value is 100-150 pppm of the moderate category, and the IC_{50} value is 151-200 ppm from the weak category [22].

The results of the physical properties of the preparation of the gel extract of telang flowers, including pH, stickiness, spreadability, and viscosity, were analyzed statistically using the one-way ANOVA test with a 95% confidence level.

RESULTS AND DISCUSSION

The maceration method was used for the extraction of telang flowers because of its simplicity. There is no heating involved, and the equipment is simple. 96% ethanol was used in the extraction due to its ability to detect the overall content of polar, semi-polar, and non-polar simplisia [12]. The resulting telang flower extract had a dark blue color, a distinct telang flower odor, and a thick consistency. The result was 40.47% (table 2). If the rendemen value of raw material is generally greater than 10%, telang flower extract meets the requirements [23].

Table 2: Characterization of telang flower (*Clitoria ternatea* L.) extract

Examination	Results
Color	Dark blue
Odor	Typically, telang flower
consistency	Thick
Extract weight	202.39 g
Condensation	40.47%

The phytochemical screening produced a positive telang flower extract that contained flavonoids, terpenoids, saponins, and tannins (Table 3). The results were in line with the research of Cahyaningsih (2019), which revealed flower extract contained flavonoids, terpenoids, saponins, and tannins [14].

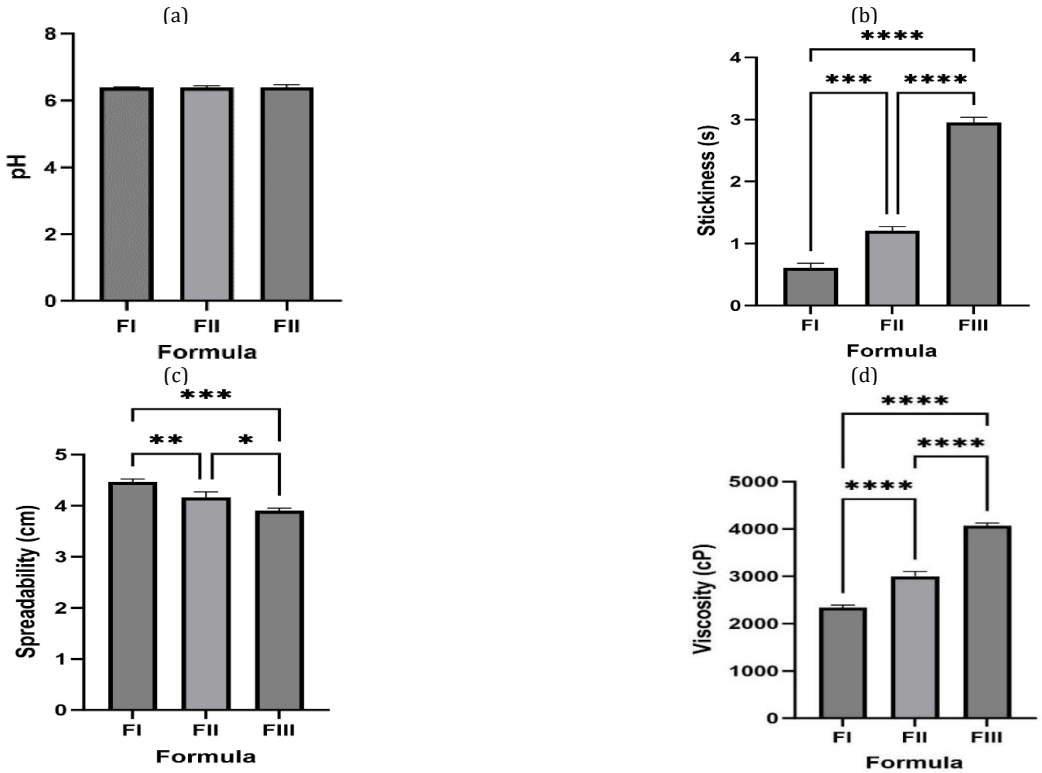
Table 3: Observations phytochemical test of telang flower (*Clitoria ternatea L.*) extract

Sample	Identification	Results	Conclusion
Telang flower extract	Flavonoids	Yellow	+
	Terpenoids	Purple	+
	Saponin	Formed foam	+
	Tannin	Black greenish	+

(+): Contained the secondary metabolite compound, (-): Did not contain these secondary metabolite compound

Table 4: Physical properties of telang flower *(Clitoria ternatea* L.*)* extract gel with concentration variation HPMC 2%, 2,5%, and 3%, respectively (±SD, n=3)

Formula	pH	Stickiness (s)	Spreadability (cm)	Viscosity (cP)
FI	6.393±0.01	0.587±0.08	4.47±0.06	2333.33±57.74
FII	6.393±0.05	1.203±0.07	4.17±0.10	3000.00±100.00
FIII	6.403±0.07	2.953±0.08	3.85±0.05	4066.67±57.74



(*): a significant difference

Fig. 1: Histogram of the physical properties of telang flower extract gel (*Clitoria ternatea* L.): (a) pH; (b) stickiness; (c) spreadability; (d) viscosity

According to the organoleptic observation, the gel extract had a consistent green-blue color, a characteristic flower-like smell, and a semi-density, homogeneous shape

The pH for the topical preparation was in the range of 4.5–6.0 [24, 25]. A topical preparation that is too acidic causes skin damage, while a preparation that is too basic causes drying and peeling [26]. The pH test results, ranging from 6.393 to 6.403 (Table 4), confirmed that the gel met the skin's pH requirement. The statistical pH analysis showed a p-value of 0.962 (>0.05), indicating no significant difference in the HPMC concentration of each formula (Fig. 1).

Good adhesion capacity is greater than one second [18]. Stickiness on FII and FIII was 1.203 s and 2.953 s, respectively (Table 4), which met the adhesive requirements. However, according to the study by Yusuf (2022) a satisfactory stickiness standard is not less than four seconds. This showed that a FI of 0.587 s (Table 4) met the requirements. Jayanti (2021) asserted that a satisfactory stickiness level should not fall below four seconds. Fig. 1 showed a statistical stickiness test with a p-value of 0.0000 (<0.05), indicating a difference in HPMC concentration for each formula. Increasing the concentration of HPMC leads to a longer production of adhesive force. The preparation's thicker consistency generates a stronger interatomic force, resulting in longer stickiness [18].

Spreadability demonstrated a favorable range on the skin, with a diameter of 3–7 cm [27]. But according to Senja and Amelia (2018), spreadability had a favorable range of 5-7 cm [28]. The spreadability test resulted in a gel of telang flower extract that met the requirements in the range of 3.85–4.47 cm (Table 4) according to Dwiastuti and Ariyanti (2020) [27]. The statistical test was shown with a p-value of 0.0003 (<0.05), which means that there is a difference in the concentration of HPMC in each formula (Fig. 1). The higher the concentration of HPMC, the less spreadability is produced.

A favorable gel has a viscosity in the range of about 2000–4000 cP [29]. Viscosity testing for each formula revealed that the higher the concentration of HPMC, the higher the viscosity. The results were consistent with the study, which found that increased concentrations of gelling agents increase viscosity. The viscosity of the telang flower extract gel preparation met the required values of 2333.33 and 3000 cP (Table 4). The statistical test was shown with a p-value of 0.0000 (<0.05), which means that the difference in HPMC concentration of each formula gave a difference in viscosity (Fig. 1).

Antioxidant activity

Antioxidant activity was conducted using the DPPH method (2,2-diphenyl-1-picrylhydrazyl). The maximum wavelength was 516 nm, with an absorption of 0.796. The study revealed antioxidant activity in telang flower extract, with an IC50 value of 71.12 ppm (table 5), which falls into the strong category. Based on the results of the physical properties of the gel from the three formulas, formula two was the best formula, and then an antioxidant test was carried out. The test results showed that an antioxidant gel formula II with 2.5% HPMC has a medium level of antioxidant activity, with an IC50 of 101.42 ppm (table 5). Antioxidant tests typically use vitamin C as a comparison. The antioxidant activity of vitamin C had an IC50 value of 2.819 ppm [30].

Table 5: Linear regression equation and IC_{50} values of extract and gel of telang flower

Telang flower extract			
	Test 1	Test 2	Test 3
Linier regression equation	Y= 0.5276x+12.39	Y= 0.5330x+12.34	Y= 0.5263x+12.61
R^2	0.992	0.992	0.990
IC_{50} (ppm)	71.285	71.043	71.026
IC_{50} ±SD (ppm)	71.12 ±0.145		
Gel of Telang flower extract			
	test 1	test 2	test 3
Linier regression equation	Y= 0.3373x+16.11	Y= 0.3291x+16.63	Y= 0.3184x+17.37
R^2	0.9944	0.9893	0.9925
IC_{50} (ppm)	100.447	101.374	102.446
IC_{50} ±SD (ppm)	101.42±1.00		

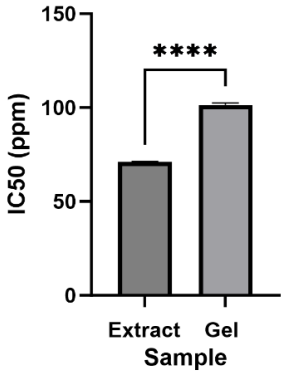


Fig. 2: Antioxidant activity of extract and gel of telang flower extract (*Clitoria ternatea* L.), (*): a significant difference

The extracts from telang flowers had an IC_{50} of 26.10 ppm, indicating that they have very strong antioxidant activity. The IC_{50} for the telang flower extract lotion was 37.92 ppm, which also means it has very strong antioxidant activity. Vitamin C was used as a comparison to the IC_{50} of 6.88 ppm [31]. Based on these results, there was an increase in the IC_{50} between the extract of telang flowers and the prepared ones, which was due to the telang flower formula containing additional ingredients in preparation. The difference in the IC_{50} value was due to the ability of each compound to give electrons to DPPH; the more electrons are given to DPPH, resulting in a decrease in its absorption value, which affects an increase in the inhibition percentage and decreased IC_{50} values [32]. The IC_{50} value of the extract and gel of the telang flower was analyzed with an unpaired t-test to see the difference between the extracted and gel flowers. The test results showed a significant difference with an R2 value of 0.9985 (2).

CONCLUSION

Telang flower (*Clitoria ternatea* L.) extract can be formulated into a gel with a variation in the concentration of HPMC as the gelling agent. Telang flower extract gel had the best physical properties on Formula II, with a concentration of 2.5% and an antioxidant activity value of 101.42 ppm.

FUNDING

The funding for this research was provided by the research grant scheme Hibah Integrasi Tridharma (HIT) from Universitas Muhammadiyah Surakarta, Indonesia.

AUTHORS CONTRIBUTIONS

Setyo Nurwaini has made contributions to the overall study design and has authored the publication. Aruniyal Alimatus Sadiah and Riza Maulana have made contributions to the supervised laboratory work. Teguh Imanto has made contributions to the data analysis and study report.

CONFLICT OF INTERESTS

Declared none

REFERENCES

1. Rasyadi Y, Rahim F, Devita S, Merwanta S, Hanifa D. Formulation and stability test hand body lotion ethanol soursop leaves extract (*Ammona muricata* Linn.). J Ilmiah Farm. 2022;11(1):15-23. doi: 10.31591/pjif.v11i1.2958.
2. Sari AN. Alternative antioxidants to eliminate the harm of free radicals on the skin. Elkawnie J Islamic Sci Technol. 2015;1(1):63-8.
3. Sapiun Z, Wicita PS, Buloto AS, Kamba V, Imran AK, Buana WA. Preparation and characterization of butterfly pea (*Clitoria ternatea* L.) nanoemulgel. Open Access Maced J Med Sci. 2022 Apr 14;10(A):585-9. doi: 10.3889/oamjms.2022.8964.
4. Oguis GK, Gilding EK, Jackson MA, Craik DJ. Butterfly pea (*Clitoria ternatea*) a cyclotide-bearing plant with applications in agriculture and medicine. Front Plant Sci. 2019;10:645. doi: 10.3389/fpls.2019.00645, PMID 31191573.
5. Jeyaraj EJ, Lim YY, Choo WS. Extraction methods of butterfly pea (*Clitoria ternatea*) flower and biological activities of its phytochemicals. J Food Sci Technol. 2021;58(6):2054-67. doi: 10.1007/s13197-020-04745-3, PMID 33967304.
6. Setyawan R, Masrijal CD, Hermansyah O, Rahmawati S, Intan R, Sari P. Formulation evaluation and physical stability test preparation gel antioxidant extract rope princess (*Cassytha filiformis* L.). Bencoolen J Pharm. 2023;3(1):27-33.
7. Wiyono AS, Lestari TP, Wardani VS. The influence of HPMC as a gelling agent on the optimization of the formula gel extract crude bromelin pineapple (*Ananas comossus* L. Merr.) skin. J Sint Penelit Sains Terap Anal. 2020;1(2):52-9.
8. Rowe RC, Sheskey PJ, Quinn ME. Handbook of pharmaceutical excipients sixth edition. In: Washington dan London. American Pharmaceutical Association and the Pharmaceutical Society of Great Britain; 2009.
9. Widhiardani FA, Setiyadi G. Optimization of glycerol as a humectant and HPMC as a gelling agent in the antioxidant gel formula of carrot extract (*Daucus carota* L.). Usadha J Pharm. 2023;2(3):278-90. doi: 10.23917/ujp.v2i3.86.
10. Valentina FE, Saryanti D. Formulasi gel antibakteri ekstrak daun pandan wangi (Pandanus amaryllifolius roxb.) menggunakan hydroxy propyl methyl cellulose(hpmc) dan uji aktivitas terhadap staphylococcus aureus. Pharmacon. 2023;20(1):1-9. doi: 10.23917/pharmacon.v20i1.18328.
11. Yusuf AL, Nurawaliah E, Harun N. Uji efektivitas gel ekstrak etanol daun kelor (Moringa oleifera L.) sebagai antijamur Malassezia furfur. KJIF. 2017;5(2):62-7. doi: 10.26874/kjif.v5i2.119.
12. Seru ER, Edy HJ, Siampa JP. Formulation of HPMC as a gelling agent gel of ethanol extract of leilem leaves (*Clerodendrum minahassae* Teisjm Dan Binn.) and antioxidant effectiveness test. Pharmacon. 2021;10(3):1033-9.
13. Farhan M, Putriana RA, Humaidi F. Formulation and physical quality test preparation of gel extract of telang flower (*Clitoria ternatea* L.) as a hand antiseptic. J Farmasi Herb. 2023;5(2):1-12.
14. Cahyaningsih E, Putu ES, Santoso P. Phytochemical screening and antioxidant activity of telang flower extract (*Clitoria ternatea* L.) using UV-vis spectrophotometry. J Ilmiah Med. 2019;5(1):51-7.
15. Dewi IS, Septawati T, Rachma FA. Phytochemical screening of tamarillo peel and seeds ethanol extracts (*Solanum betaceum* Cav.). Prosiding Seminar Nasional Unimus. 2021;4:1210-8.
16. Setiawati R, Sukmawati A. Physical characterization and antioxidant activity of peel-off gel face mask containing Hylocerus polyrhizus fruit juice. Pharmacon. J Farmasi Indonesia. 2018;15(2):65-74. doi: 10.23917/pharmacon.v15i2.7245.
17. Ardana M, Aeyni V, Ibrahim A. Formulasi dan optimasi basis gel hpmc (hidroxy propyl methyl cellulose) dengan berbagai variasi konsentrasi. J Trop Pharm Chem. 2015 Dec;3(2):101-8. doi: 10.25026/jtpc.v3i2.95.
18. Nurlely RA, Ratnapuri PH, Srikartika VM, Anwar K. Physical characteristics test preparation of gel extract *Chromolaena odorata* leaves with variations of carbopol and HPMC. J Pharmascience. 2021;8(2):79-89.
19. Setiyadi G, Qonitah A. Optimasi masker gel peel off ekstrak etanolik daun sirih (Piper betle L.) dengan kombinasi carbomer dan polivinil alkohol. Pharmacon. 2020;17(2):174-83. doi: 10.23917/pharmacon.v17i2.11976.
20. Imanto T, Prasetiawan R, Wikantyasning ER. Formulation and characterization of nanoemulgel containing (*Aloe vera* L.) powder. Pharmacon: Jurnal Farmasi Indonesia. 2019;16(1):28-37. doi: 10.23917/pharmacon.v16i1.8114.
21. Dhiafanti YA, Setiyadi G. Optimization of HPMC as a gelling agent and glycerin as a humectant in gel mask preparation of chayote (*Sechium edule* (Jacq.) Swartz). Usadha J Pharm. 2023;2(1):1-15. doi: 10.23917/ujp.v2i1.93.
22. Rauf J, Isa I, Thomas NA. Formulation of emulgel preparation of kelor leaf extract (*Moringa oleifera* Lam.) and antioxidant activity test using DPPH method. Indones J Pharm Educ. 2021;1(1):10-9.
23. Ramdhini RN. Standardization of the quality of simplisia and ethanol extracts of telang flowers (*Clitoria ternatea* L.). J Kesehat J Ilm Multi Sci. 2023;13(1):32-8.
24. Indriaty S, Rizikiyan Y, Firmansyah D. Formulation and stability testing of antiaging gel from a combination of ethanol extract of red dragon (*Hylocereus polyrhizus*) skin and bacon mucus (*Achatina fulica*) with gelling agent variations of carbomer. J Pharmacopolium. 2019;2(2):104-11.
25. Afifah H, Nurwaini S. Testing antifungal activity of 934 carbopol based *aloe vera* gel powder against *Candida albicans* dan *Trichophyton mentagrophytes*. Pharmacon J Farm Indones. 2018;15(2):42-51. doi: 10.23917/pharmacon.v15i2.7658.
26. Nurwaini S, Hafidzatun Nasihah R. Formulation and testing of antibacterial activity preparation hand gel extract of rose leaf seed (Psidium guajava L.). 7th Univ Res Colloqium 2018 Stikes PKU Muhammadiyah Surakarta. 2018. p. 24-30.
27. Dwiastuti R, Ardiyati S, EA. Formulation of nanoparticles gel of binahong leaf extract (*Anredera cordifolia* (Ten.) Steenis). Pharmacy Med J. 2020;3(2):40-6.
28. Senja RY, Amelia R. Formulation and test stability gel ethanol extract of kemangi leaves (*Ocimum sanctum* L.) with gelling agent carbopol 940 concentration 0.5% and 0.75% and HPMC. Medimuh. 2018;1(1):45-54.
29. Thomas NA, Tungadi R, Hiola F, Latif SM. The effect of the 940 carbopol concentration as a gelling agent on the physical stability of the *aloe vera* gel preparation. Indones J Pharm Educ. 2023;3(2):316-24.
30. Indrawati A, Baharuddin S, Kahar H. Antioxidant activity test of purple plant stem (*Graptophylum pictum* L.) extract in Takalar District using DPPH visible spectrophotometry. Lumbung Farm J Ilmu Kefarmasian. 2022;3(1):69-77.
31. Jayanti M, Ulfa AM, Saputra YA. The formulation and physical evaluation tests of ethanol in telang flower (*Clitoria ternatea* L.) extract losio form as an antioxidant. Biomed J Indones. 2021;7(3):448-95. doi: 10.32539/BJI.v7i3.543.
32. Kristian R, Raharjo S, Sulastrianah. Antioxidant activity test of freshwater microalgae. Medula. 2015;3(1):201-7.