

Formulation and Evaluation of Physical Characteristics of Butterfly Pea Flower (*Clitoria ternatea* L.) Gel with Different Concentrations of Carbopol 940 and HPMC

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Abstract. Butterfly pea flower (*Clitoria ternatea* L.) contains bioactive compounds such as flavonoids, alkaloids, tannins, and saponins, which have antibacterial potential against *Propionibacterium acnes*, a major cause of acne. Gel is preferred as a topical dosage form due to its ease of use and cooling effect. The selection of gelling agents like Carbopol 940 and HPMC influences the stability and physical quality of the preparation. This experimental study used 15% ethanol extract of butterfly pea flower and was formulated into three variations: Formula 1 (Carbopol 940 0.5% and HPMC 2%), Formula 2 (Carbopol 940 0.75% and HPMC 2.5%) and Formula 3 (Carbopol 940 1% and HPMC 3%). Physical evaluations included organoleptic, homogeneity, pH, viscosity, spreadability, adhesion, and cycling tests. Before the cycling test, Formulas 2 and 3 met the physical quality standards of gel preparations, while Formula 1 did not meet several parameters. After the cycling test, only Formula 3 remained stable and met all the required standards. Variations in Carbopol 940 and HPMC concentrations affect the physical characteristics of the gel. Formula 3 (Carbopol 940 1% and HPMC 3%) was the most optimal formulation.

Keywords: Butterfly pea, gel, Carbopol 940, HPMC, physical characteristics.

INTRODUCTION

Acne vulgaris (acne) is a skin disorder caused by chronic inflammation with complex mechanisms. This condition involves sebaceous glands, follicular hyperkeratinization, bacterial overgrowth, the body's immune response, and the inflammatory process (Lestari *et al.*, 2021). One of the bacteria that causes acne is *Propionibacterium acnes*. These bacteria utilize sebaceous gland secretions as a source of nutrition and can damage the skin layer with chemicals that cause pore blockage, inflammation and acne formation (Imasari & Emasari, 2022). The use of antibiotics in synthetic anti-acne drugs can cause side effects such as irritation, bacterial resistance, organ damage and immunohypersensitivity, so alternative natural ingredients are needed that are easily available and effective in treating acne (Wardani, 2020). Butterfly pea flower (*Clitoria ternatea* L.) is a natural ingredient that can be used as an alternative to treat acne problems.

Butterfly pea flowers (*Clitoria ternatea* L.) have many benefits, one of which is their antibacterial activity. Butterfly pea flower extract (*Clitoria ternatea* L.) exhibits antibacterial activity due to the presence of secondary metabolites such as flavonoids, phenols, saponins, alkaloids, and tannins (Febrianti *et al.*, 2022). Extract ethanol 96% of butterfly pea flowers were proven to be effective in inhibiting the growth of *Propionibacterium acnes* at a concentration of 15%, which is one of the main causes of acne, so it has the potential to be developed as an active ingredient in anti-acne gel formulations.

Gels are semi-solid preparations consisting of suspensions made of small inorganic particles or large organic molecules penetrated by a liquid. Gels can be made for topical applications or inserted into body cavities (Ministry of Health of the Republic of Indonesia, 2020). The factor that influences the physical properties of the gel is the use of a gel base (gelling agent). The use of a gel base (gelling agent) with a high concentration will produce a very thick gel that is difficult to remove from its container (Kusuma *et al.*, 2018). Gel base (gelling agent) is a hydrocolloid substance that can increase viscosity and stabilize gel preparations. There are 3 types of gelling agents, namely natural polymers consisting of sodium alginate, gelatin, chitosan and cellulose derivatives, semisynthetic polymers consisting of cellulose derivatives namely Methylcellulose (MC), Hydroxyethyl Cellulose (HEC), Hydroxypropyl Cellulose (HPC), Sodium Carboxymethyl Cellulose (Na.CMC), Hydroxypropyl Methyl Cellulose (HPMC) and synthetic polymers consisting of carbopol, polyethylene glycol, poloxamer, polylactide, polyamide, acrylic acid polymer (Chaerunisa *et al.*, 2020). Gelling agents have an important role in the physical properties and final quality of gel preparations. HPMC (Hydroxypropyl Methyl Cellulose) and Carbopol 940 are one of the frequently used gelling agents. HPMC (Hydroxy Propyl Methyl Cellulose)

is a semi-polymer synthetic cellulose derivative that can produce a neutral, clear gel, stable at pH 3-11, has good resistance to microbes, and is stable in long-term storage. Carbopol 940 is one of them material frequent gelling agents used Because capable produce gel with viscosity tall although used in concentration low (Uzma *et al.*, 2024).

Various studies have been conducted to explore the use of natural ingredients in gel formulations, considering the results of previous research by Sulistyaningtyas & Diasturi (2021), the combination of Carbopol and HPMC was proven to produce a physically stable gel preparation when used on potato peel extract with a concentration of 0.75% Carbopol and 2.5% HPMC. Based on this success, this combination formulation was adapted in this study by replacing the active ingredient with 15% butterfly pea flower extract, to determine its effect on the physical characteristics of the resulting gel preparation .

METHODS

Tools and materials

The tools used in this study were porcelain cups (Pyrex), mortars, stampers, beaker glass (Pyrex), analytical scales (Ohaus), test tubes, blenders (Philips), measuring cups (Pyrex), glass stirrers (Pyrex), watch glasses (Herma), dropper pipettes, pH meters 45 (Ohaus), Brookfield viscometers (DV-E Viscometer), moisture balances (Ohaus), adhesive strength testers, refrigerators, ovens, transparent glass (Pyrex). The materials used in the study were butterfly pea flower extract (*Clitoria ternatea* L.), hydroxypropyl methylcellulose (HPMC) (Dow Chemical), carbopol 940 (Lubrizol), triethanolamine (TEA) (Merck), propylene glycol (PEG) (Dow Chemical), methylparaben, distilled water, 96% ethanol (Brataco), concentrated HCl (Merck), Mg powder, 2N HCl, concentrated H₂SO₄ (Merck), 10% FeCl₃, Mayer's reagent , Bouchardat's reagent, Dragendorff's reagent .

Making extract flower telang

The butterfly pea flower extract (*Clitoria ternatea* L.) was made by macerating 600 grams of butterfly pea flower powder with 6 liters of 96% ethanol. The mixture was soaked for the first 6 hours and stirred periodically, then left to stand for 18 hours. The mixture was filtered to separate the filtrate from the residue. The resulting extract was thickened using a rotary evaporator at 50°C, resulting in an extract. thick (Ministry of Health Republic of Indonesia, 2017).

Preparation of butterfly pea flower extract gel preparation

The gel formulation in this study used a combination of Carbopol 940 and HPMC bases, adopted from previous research by Sulistyaningtyas & Diasturi (2021), as it was proven to produce optimal gel physical stability. The main difference in this formulation lies in the active ingredient used, namely butterfly pea flower extract (*Clitoria ternatea* L.) with a concentration of 15% as a modification of previous research using 0.2% potato peel extract. Making extract gel flower telang started with weigh all ingredients , then developing HPMC in hot water for 15 minutes while Keep going stirred . Carbopol 940 was developed in another mortar and developed with hot water as much as 20 times its weight. TEA was added to the mortar containing carbopol 940 as a base neutralizer, crushed until a clear gel mass was formed. Methylparaben was dissolved using propylene glycol until dissolved. HMPC and carbopol 940 were mixed and crushed until homogeneous. Then, methylparaben that had been dissolved using some propylene glycol was added, crushed until homogeneous. The ethanol extract of butterfly pea flowers that had been dissolved with the remaining propylene glycol was added to the gel base and stirred until homogeneous. The remaining distilled water was added and crushed until homogeneous. After that, it was transferred into the gel pot in each formula (Diantri *et al* ., 2024). Extract gel formula flower telang can seen in Table 1.

Evaluation quality physique

1. Organoleptic test carried out to determine the physical properties of the preparation visually by looking at the color, smell and shape (Wiyono & Mustofani, 2019) .
2. Color test done use senses vision (eyes) with objective For know color what is formed in the extract gel preparation flower telang (Wiyono & Mustofani , 2019) .
3. Smell test done For know smell what is contained in the extract gel preparation flower telang (Wiyono & Mustofani , 2019).
4. Form test carried out using the sense of touch with the aim of knowing the texture formed in the

butterfly pea flower extract gel preparation, with the hope that the preparation has a good texture (Wiyono & Mustofani, 2019) .

5. Homogeneity test This is done by taking a small gel sample and applying it to a watch glass and observing whether there are coarse particles in the preparation (Mardikasari *et al.* , 2017) .
6. Power test spread done with weigh A 500 mg sample of gel was placed in the center of a graduated watch glass. Another watch glass was weighed, placed on top of the gel, and left for 1 minute. The diameter of the gel distribution was then measured by averaging the measurements from several sides. The diameter measurements were carried out until a 200 gram load was applied (Sani *et al.* , 2018).
7. Power test sticky done with method take 0.5g of gel then placed on a glass object and attached to another glass object and pressed with 1 kg load for 5 minutes . The glass object is mounted on the tool test and release load . Noted the time required for the object glass to regardless (Nurwaini , 2018).
8. pH test This was done by weighing 0.5 grams of gel dissolved in 50 ml of distilled water, then the pH meter was dipped into the solution to obtain the pH value (Triananda & Wijaya, 2021).
9. Cycling tests are conducted by maintaining a cold temperature of 2°C in a refrigerator *chiller* and 40°C in an oven at specific intervals. This method exposes the product in its packaging to varying levels of stress. This physical stability testing is essential for assessing the durability of gel preparations during storage .
10. Viscosity test was carried out using a *Brookfield viscometer* by inserting the gel preparation into a *beaker glass* , then inserting spindle number 4 into the beaker glass at a speed of 60 rpm, turning on the tool and recording the results (Sarlina *et al.* , 2017).

Table 1. Extract gel formulation flower telang

Bahan	Konsentrasi (%)			Keterangan	Pustaka	Range	Pustaka
	F1	F2	F3				
Ekstrak etanol 96% bunga telang	15	15	15	Bahan aktif	(La, 2024)	5-15%	(La, 2024)
Karbopol 940	0,5	0,75	1	Basis gel	(Sulistyaning tyas & Diasturi, 2021)	0,5-2%	(Rowe <i>et al.</i> , 2009)
HPMC	2	2,5	3	Basis gel	(Diantri <i>et al.</i> , 2024)	2-20%	(Rowe <i>et al.</i> , 2009)
TEA	1	1	1	Alkalizing agent	(Diantri <i>et al.</i> , 2024)	0,5-2%	(Rowe <i>et al.</i> , 2009)
PEG	5	5	5	Humektan	(Diantri <i>et al.</i> , 2024)	1-15%	(Rowe <i>et al.</i> , 2009)
Metil paraben	0,2	0,2	0,2	Pengawet	(Diantri <i>et al.</i> , 2024)	0,02-0,3%	(Rowe <i>et al.</i> , 2009)
Aguades ad	100	100	100	Pelarut	(Diantri <i>et al.</i> , 2024)	-	-

RESULTS AND DISCUSSION

Characteristic test results physique extract gel preparation flower telang

Organoleptic test shows that the three formulas have the typical color of butterfly pea flowers, namely purple and the typical odor of butterfly pea flower extract which is still acceptable and not pungent. The dosage form varies for F1 which is slightly thick, for F2 and F3 it is thick, this is caused by the increase in the concentration of Carbopol 940 and HPMC. The higher the concentration of the two *gelling agents*, the thicker the gel produced .

Homogeneity test shows homogeneous results, characterized by the absence of coarse particles, lumps, or phase separation in the gel preparation. pH test showed that the pH value of F1 had an average of 6.74, F2 had an average of 5.82, and F3 had an average of 5.53. Each formula has a pH within the physiological skin pH range of 4.5–8.0, making it safe and non-irritating (SNI 16-3499-1996).

Viscosity test on formula F1 obtained results average of 2047.57 cPs so that F1 does not meet the viscosity standards of gel preparations, F2 has an average of 3575.90 cPs and F3 has an average of 4422.67 cPs so that F2 and F3 meet the viscosity standards of gel preparations. The results can be seen in Table 2.

Table 2. Results of the Viscosity Test of Butterfly Pea Flower Extract Gel

Formula	Average (%)± Elementary School (cPs)	SNI (cPs)	Information
F1	2047.57±60	3,000-50,000	No Fulfil Standard
F2	3575.90±179	3,000-50,000	Fulfil Standard
F3	4422.67±72	3,000-50,000	Fulfil Standard

Source: Processed Primary Data (2025)

Information:

F1 : Gel formulation combining Carbopol 940 0.5% and HPMC 2%

F2 : Formulation gel combination Carbopol 940 0.75% And HPMC 2.5%

F3 :Gel Formulation Combination of Carbopol 940 1% and HPMC 3%

Power test spread show that formula F1 own average power spread as big as 6.67 cm, F2 as big as 6.28 cm, And F3 as big as 5.74 cm . Third formula Still is at in range ideal Power spread For stock gel Topical. The highest spreadability is shown by F1 because it has the lowest viscosity, so the gel is easier to spread, conversely F3 shows the lowest spreadability consequence viscosity Which most tall, so that gel become more thick and difficult to spread . The results can be seen in Table 3.

Table 3 Power test results spread the extract gel flower telang

Formula	Average (%)± SD (cm)	SNI (cm)	Information
F1	6.67±0.08	5- 7	Fulfil Standard
F2	6.28±0.07	5- 7	Fulfil Standard
F3	5.74±0.03	5- 7	Fulfil Standard

Source: Processed primary data (2025)

Power test sticky show that formula F1 own average power sticky as big as 4.30 second, F2 5.60 second And F3 7.62 second. Mark Power increased stickiness along with rise viscosity And decline Power spread. The gel that more thick will more sticky And stick more long. Third The formula still meets the good criteria for topical preparations . The results can be seen in Table 4

Table 4 Power test results sticky gel extract flower telang

Formula	Average (%) ±SD (seconds)	SNI (second)	Information
F1	4.30±0.05	≥1	Fulfil Standard
F2	5.60±0.23	≥1	Fulfil Standard
F3	7.62±0.20	≥1	Fulfil Standard

Source: Processed primary data (2025)

Cycling Test of the preparation gel extract flower telang after going through 3 cycle *cycling test* show that all over formula (F1, F2, and F3) in a way visual still maintain color purple typical extract butterfly pea flowers and specific odor of the extract . Viscosity test The three formulas experienced a decrease after *the cycling test* . F1 decreased from 2047.57±60 cPs to 1962.9±8 cPs, F2 from 3575.9±179 cPs to 3485.0±118 cPs and F3 from 4422.67±72 cPs to 4297.0±37 cPs. This decrease indicates that Temperature fluctuations during *the cycling test* affected the gel thickness, which was indicated by a decrease in viscosity values. F2 and F3 remained within the viscosity range. ideal For gel preparation topical according to SNI 16-4380-1996 i.e. 3,000–50,000 cPs .

CONCLUSION

Conclusion in study this is The difference in concentration of Carbopol 940 and HPMC affects the characteristics physique gel extract flower telang, like viscosity, Power spread, adhesive power, and pH. 2. Formula 2 (Carbopol 940 0.75% and HPMC 2.5%) and formula 3 (Carbopol 940 1% and HPMC 3%) showed characteristics optimal physical condition before the cycling test. After the cycling test process of 3 cycles only formula 3 (Carbopol 940 1% and HPMC 3%) showed stability characteristics physical gel extract flower telang.

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