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STABILITY AND SUNSCREEN ACTIVITY OF NUTMEG SEED OIL EMULGEL WITH CARBOPOL 940 VARIATION AS GEL BASE

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ABSTRACT

The nutmeg seed oil has antioxidant and sunscreen activity, but it is unstable in storage. The stability of nutmeg seed oil can be improved by developing the oil into an emulgel with carbopol 940. This study determined the stability of nutmeg seed oil emulgel (NSE) with carbopol 940 as a gel base. NSE contains of 10% nutmeg oil and variation of carbopol 940 were 0.60% (FI), 0.80% (FII), and 1.0% (FIII). NSE was tested for SPF value every week and physical stability, including organoleptic, homogeneity, adhesion, dispersibility, viscosity, and pH before and after 30 days of storage. NSE was stored at the climatic chamber at 30±2°C with RH 65±5%. Quantitative data from physical stability were analyzed by t-test dependent while SPF value and antioxidant were analyzed by univariate test. All the physical parameters showed no significant changes ($p > 0.05$). Emulgel was white thick, with a nutmeg seed oil odor. pH was in a safe range for skin (6.12-6.90). NSE had pseudo-plastic rheology, and it changed into pseudoplastic-thixotropic after 30 days of storage. The SPF value of NSE was above eight, and it did not show significant change after the storage from each week ($p > 0.05$). Nutmeg seed oil emulgel with carbopol 940 showed stable physical appearance and SPF value.

Keywords: Nutmeg seed oil; Carbopol 940; Emulgel Stability

1. INTRODUCTION

Nutmeg (*Myristica fragrans*) is one of the largest export commodities in Indonesia, but it has not been developed yet into cosmetics (Suhirman, 2013). Nutmeg seed oil can be used in cosmetics as an antioxidant, anti-inflammatory, antibacterial and antifungal (Duarte et al., 2011; Jangid et al., 2014). Nutmeg seed oil is known to have antioxidant and sunscreen activity (Ansory et al., 2020; Warsito, 2021). Nutmeg seed oil in microemulsion showed antioxidant activity with 72% of inhibition (Rahmadany et al., 2021). The microemulsion of nutmeg seed oil also showed sunscreen activity with an SPF value of 9.3. Nutmeg seed oil is known to protect skin from UV rays' inflammation by inhibiting interleukin-6 and COX-2 (Asgarpanah, J. & Kazemivash, 2012; Matulyte et al., 2020). Nutmeg seed oil is very sensitive to temperature and light exposure; also, it is not soluble in water (Rahardiyan et al., 2020). External application of essential oil must be mixed into a vehicle. The common vehicle used for topical application is emulgel (Satapathy et al., 2015). Nutmeg seed oil also cause discomfort and a greasy feeling when used, so it is necessary to formulate the oil into a more applicable form as emulgel.

Emulgel preparations themselves are comfortable to use and are able to stick for a relatively long time on the skin (Lidia et al., 2017) and can increase the stability of the preparation (Ajazuddin et al., 2013). Emulgel was developed as a new drug delivery system, one of which is for drugs that are hydrophobic such as essential oils via transdermal (Sreevidya, 2019). One of the gel bases that can be used is carbopol 940, which can produce a clear gel form and can be used as a good thickening agent because it has high viscosity (Wahyuddin et al., 2018). Carbopol also has a cooling effect on the skin when used, has high adhesion, is easily washed off with

water, and has good drug release (Megawati et al., 2019). Carbopol as a gelling agent has better stability and has potential as a controlled release drug delivery system (Ajazuddin et al., 2013). The preparation of lavender essential oil gel with carbopol 940 as a gelling agent showed good physical stability criteria such as organoleptic, pH, homogeneity, and viscosity for 30 days of storage at room temperature (Astuti et al., 2017). Based on the description above, it is necessary to conduct research related to the stability of nutmeg seed oil in emulgel with parameters of physical properties and SPF values in vitro.

2. METHODS

2.1. Materials

The material that used in this research were divided into active ingredient and gel bases. The active ingredient was nutmeg seed oil (Myristica fragans) from PT. Nusaroma Essential Indonesia. The gel base was made from carbopol 940, Tween 80, Span 80, sorbitol, liquid paraffin, triethanolamine (TEA), methylparaben, propylparaben, and distilled water with pharmaceutical grade. Ethanol used in this research was analytical grade. Equipment used in this study were mixer, climatic chamber (HWS-70 BX), spectropotometer UV-Visible (Shimadzu), viscometer (Rheosys Merlin VR II) and pH meter (Electrolab).

2.2. Preparation of nutmeg oil emulgel

Emulgel were made using three variations of carbopol 940 concentration which are shown in **Table 1**.

Table 1. Formula of Nutmeg Seed Oil Emulgel

Materials	(%)		
	FI	FII	FIII
Nutmeg Oil	10	10	10
Carbopol 940	0.60	0.80	1.00
Tween 80	17.50	17.50	17.50
Span 80	2.50	2.50	2.50
Sorbitol	1.00	1.00	1.00
Paraffin Liquid	1.25	1.25	1.25
Methyl Paraben	0.18	0.18	0.18
Propyl Paraben	0.02	0.02	0.02
TEA	0.80	0.80	0.8
Distilled water		Up to 100	

Emulgel was made by dispersing carbopol 940 into distilled water which has been heated at a temperature of 80-90°C. Carbopol 940 was incorporated in water to form a homogeneous dispersion. The aqueous phase consisted of methylparaben and tween 80. while the oil phase consisted of propylparaben. liquid paraffin. and span 80. Each phase was homogenized first. The aqueous phase was added into the oil phase. then distilled water and sorbitol were added and stirred until homogeneous. The nutmeg oil was added little by little with stirring until homogeneous. The emulgel were homogenized by mixer on a scale of 1 to form a homogeneous emulgel system. TEA was added lastly until the emulgel pH was 4.5-8 while stirring until a homogeneous emulgel was formed. Emulgel were stored in a climatic chamber at a temperature of 30 °C± two °C with RH 65%±5% for 30 days.

2.3. Evaluation of Physical Stability of Nutmeg Seed Oil Emulgel Preparations

Physical characterization of nutmeg oil emulgel was organoleptic. homogeneity. viscosity. pH. and stickiness test. Organoleptic tests were performed to show the physical appearance and the presence of aggregate in the emulgel. The viscosity test was measured by Rheosys Merlin VR II. The pH of emulgel formulations was measured by pH meter (Analytics). An adhesion test was carried out by weighing 1 g of emulgel. then flattened on one object glass and covered with

another object-glass until the two plates were fused. The pair of object glasses were pressed with a load of 1000 g for 5 minutes. then mounted on the adhesive test equipment. simultaneously recording the time it takes for the two plates to separate from each other. All parameters were evaluated before and after 30 days of storage.

2.4. Evaluation of Stability of SPF Values Nutmeg Seed Oil Emulgel Preparations

The nutmeg seed oil emulgel test was conducted in vitro using UV-Vis spectrophotometric analysis. The nutmeg seed oil emulgel was weighed 0.1 grams each and dissolved in ethanol p.a. then poured into a 10 mL volumetric flask and made up to the mark with ethanol p.a. Each sample was measured absorbance at a wavelength of 290-320 nm. absorbance was recorded at each additional 5 nm wavelength. Testing the SPF value was carried out three times of replication. The absorbance results obtained were recorded. and the SPF value was calculated based on the Mansur equation below (Daud & Suryanti, 2017; Dipahayu, 2020).

$$SPF = CF \times Total\,(EE \times I \times Absorbance) \quad (1)$$

Note:

SPF : SPF Value on product label
CF : Correction Factor
Total EE x I x Absorbance : Total erythema edema and intensity of UV rays based on spectrophotometer

The SPF value in vitro was calculated using the correction factor. The product used for correction factor determination was Wardah Acne Gel SPF 15. The determination of the CF value of the Wardah Acne Gel product was 10.02. and this value was used to determine the SPF value of the nutmeg oil emulgel. The SPF is then categorized for protection based on SPF value (Food and Drug Administration, 2012). The SPF value was analyzed every week for 30 days.

2.5. Statistical Analysis of Data

Physical stability data were statistically analyzed with T-dependent. SPF value data were analyzed with the univariate test to compare the value of each week's test. All parameters are declared stable if there were no significant difference or p-value > 0.05.

3. RESULTS AND DISCUSSION

3.1. Organoleptic and homogeneity test result

The results of organoleptic tests on the three-nutmeg oil emulgel formulas for 30 days of storage did not show any change in characteristics after 30 days of storage. both at storage temperatures of 30±2°C with RH 65±5% and 4±2°C. All of the formulas were white. thick. and had a characteristic odor of nutmeg seed oil. The results of the organoleptic test of the nutmeg oil emulgel can be seen in **Figure 1**.

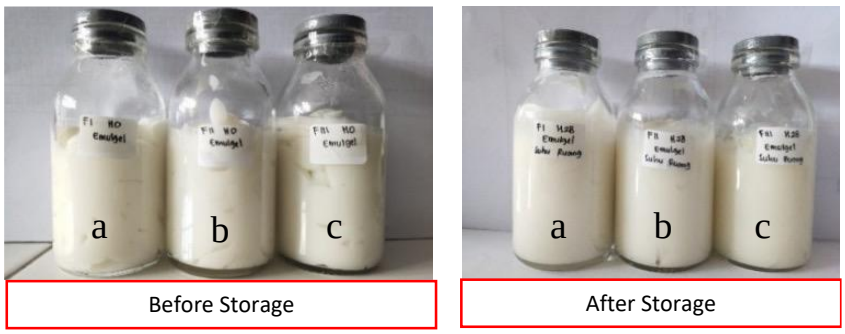


Figure 1. Organoleptic Result of NSE FI (A). FII (B) and FIII (C) Before and After 30 Days of Storage

The results of the homogeneity test on nutmeg seed oil emulgel showed that FI. FII. and FIII were homogeneous during 30 days of storage both at storage temperatures of 30±2°C with RH

65±5% and 4±2°C. indicated by the absence of particles rough on the slide. The homogeneity test result of the nutmeg seed oil emulgel can be seen in **Figure 2**.

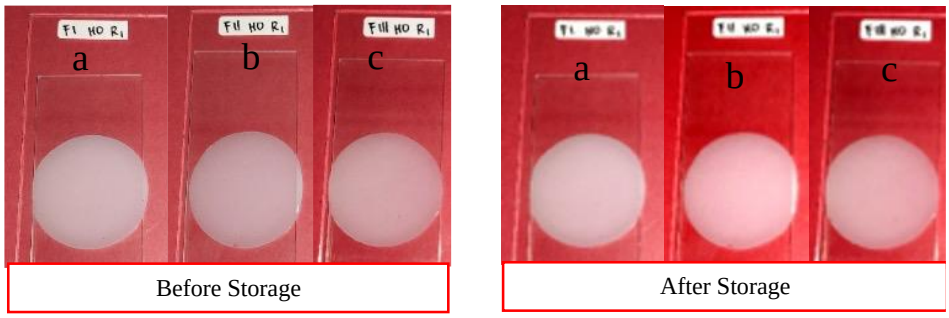


Figure 2. Homogenity Result of NSE FI (A). FII (B) and FIII (C) Before and After 30 Days of Storage

The organoleptic result was in line with Jana et al (2014) that emulgel had white and clear emulgel. The thick texture was because of the increasing concentration of carbopol 940 (Putriana et al., 2019).

3.2. Adhesiveness of Nutmeg Seed Oil Emulgel

Adhesiveness of nutmeg seed oil emulgel can be seen in **Table 2.**

Table 2. Adhesiveness of Nutmeg Seed Oil Emulgel (Seconds)

Formula	Adhesiveness (Mean±SD)		p Value
	Day 0	Day 30	
FI	6.14 ± 0.86	6.12 ± 0.40	0.239
FII	11.77 ± 0.67	11.74 ± 0.61	0.516
FIII	19.97 ± 0.44	19.92 ± 0.59	0.096

Data from the adhesion test showed sig. Value (p>0.05). which means that there was no significant difference before and after the storage. It can be concluded that the nutmeg seed oil emulgel has stable adhesion for 30 days. The adhesion from all formulas was decreased. This decrease in adhesion is related to the viscosity of the preparation that can occur due to the longer temperature and storage time (Rismawati et al., 2020). According to the research of Saryanti et al. (2019). the adhesion of preparation is directly proportional to the viscosity. where the higher the viscosity of preparation. the higher the adhesive power. The increase in adhesion to each formulation of the emulgel preparation is influenced by the viscosity of the emulgel. which increases due to variations in the concentration of carbopol so that it affects the longer the emulgel preparation is attached to the skin. which causes the emulgel to be more effective because of the absorption of the active substance increases (Oktavia, 2016).

3.3. pH Nutmeg Seed Oil Emulgel

T-test of pH data showed there were no significantly different results as the significance value (p>0.05). pH of nutmeg seed oil emulgel can be seen in **Table 3.**

Table 3. Ph of Nutmeg Seed Oil Emulgel

Formula	pH (Mean±SD)		p Value
	Before Storage	Day 30	
FI	6.15 ± 0.03	6.12 ± 0.04	0.245
FII	6.90 ± 0.05	6.88 ± 0.05	0.336
FIII	6.64 ± 0.04	6.60 ± 0.04	0.359

During the storage of nutmeg oil emulgel preparations. the pH value decreased. This decrease in pH value is possible due to chemical reactions that occur in the preparation during the storage process (Riski et al., 2016). Besides that. changes in pH can also be caused by the influence of environmental conditions such as temperature and humidity but are still in the safe range for skin

(Wahyuddin et al., 2018). Changes in pH can be caused by oxygen from the air to oil in the formula that can cause accelerated fat oxidation (Tatiana et al., 2020). Emulgels that are too alkaline can cause skin irritation. while preparations that are too acidic cause the skin to feel scaly and itchy when applied (Rahmatullah et al., 2020). Triethanolamine is also known to have an effect on the pH value of preparations using carbopol 940 (Rahayu et al., 2016). The pH in this study was in line with Rahmawati and Setiawan (2019) that all pH was in the range of 4.50 to 7.00. The emulgel at this pH did not irritate the skin.

3.4. Nutmeg Seed Oil Emulgel Viscosity

The data from the T test results for the viscosity of emulgel showed sig values (p>0.05). which means there was no significant difference before and after storage so that it can be concluded that the nutmeg oil emulgel preparation had a stable viscosity for 30 days of storage. Data of viscosity test can be seen in **Table 4**.

Table 4. Viscosity of Nutmeg Seed Oil Emulgel (Cps)

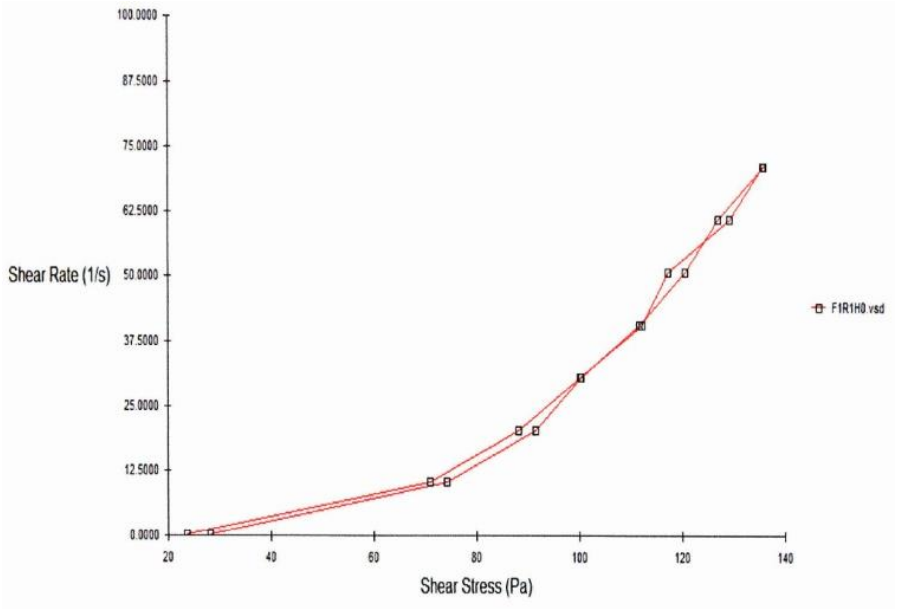
Formula	Viscosity (Mean±SD)		p Value
	Before Storage	Day 30	
FI	246.08 ± 18.13	243.69 ± 17.86	0.667
FII	324.90 ± 34.38	340.12 ± 33.95	0.127
FIII	499.75 ± 27.22	443.38 ± 13.48	0.349

Carbopol has the effect of increasing the viscosity of the gel (Tatiana et al., 2020). Carbopol is one of the gelling marketers who can shape a structural community that can reason a boom in viscosity in order that it's miles a crucial thing withinside the system; consequently. the gelling agent will have an effect on the bodily residences and gel stability (Kuncari et al., 2014). According to research by Rismawati et al. (2020). the decrease in viscosity can occur due to the more extended temperature and storage time. This condition happened due to the syneresis. which emulgel could release liquid on the surface of the emulgel. The emulgel viscosity is also influenced by variations carbopol 940 variations where the higher the concentration of the gel base. the viscosity of the preparation will increase. This is due to an increase in the gel matrix bonds (Astuti et al., 2017).

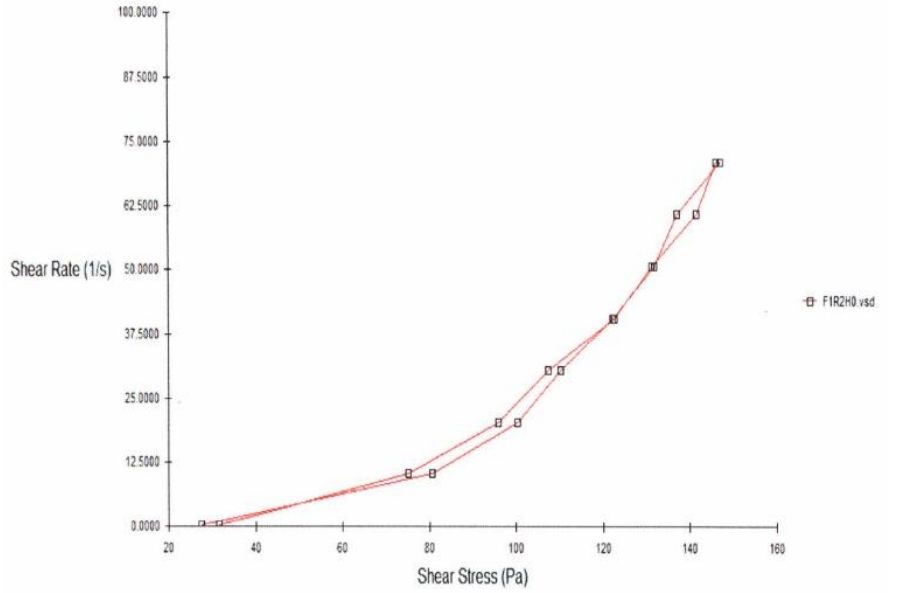
The rheogram results in Error! Reference source not found. showed the flow properties of the FI. FII. and FIII emulgels having pseudoplastic rheology. This rheology was characterized by a slightly curved upward-shaped graph (Patricia & Yuliani, 2015) and a curve through the point (0.0). which is called pseudoplastic flow. The rheogram results in Error! Reference source not found. showed flow properties of all formulas on Day 30. The rheology changed from pseudoplastic to pseudoplastic-thixotropic. It was shown by the downward curve to the left of the ascending curve is called thixotropic flow (Kuncari et al., 2014). Thixotropy or time-dependent flows occur because the gel takes a finite amount of time to reconstruct its original structure. It breaks during continuous shear measurements. It is worth noting that thixotropy is not a thin and easily spreadable material but a desirable property of pharmaceuticals to initially provide thick products (DAOOD et al., 2019). The changes in rheology were probably due to the condition and long storage time (Patricia & Yuliani, 2015).

3.5. Stability of SPF Value of Nutmeg Seed Oil Emulgel

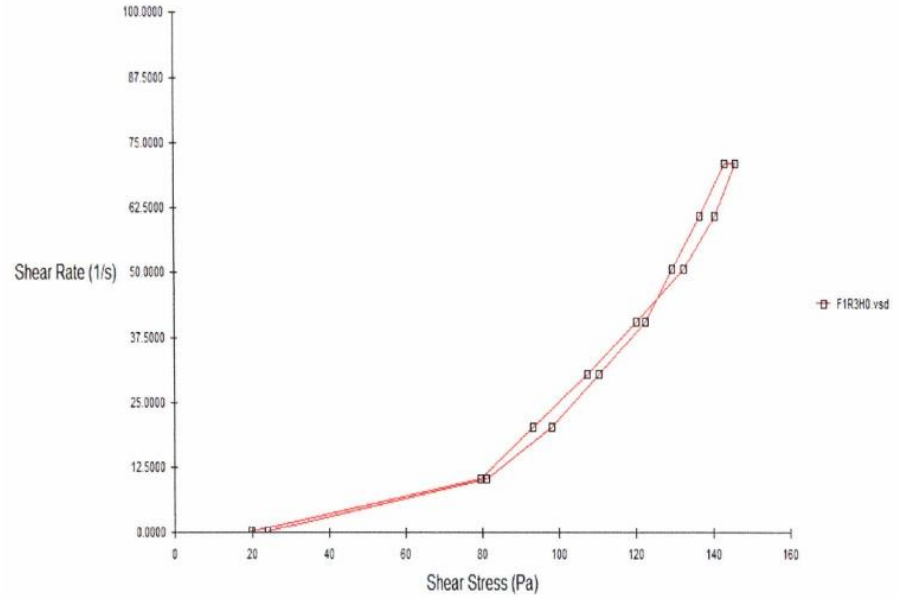
The results of statistical tests on the NSM emulgel SPF value showed sig values p>0.05 which means that there was no significant difference between the preparations before and after storage. It can be concluded that the nutmeg oil emulgel preparation has a stable SPF value. The result of SPF value can be seen in **Table 5.**



(A)

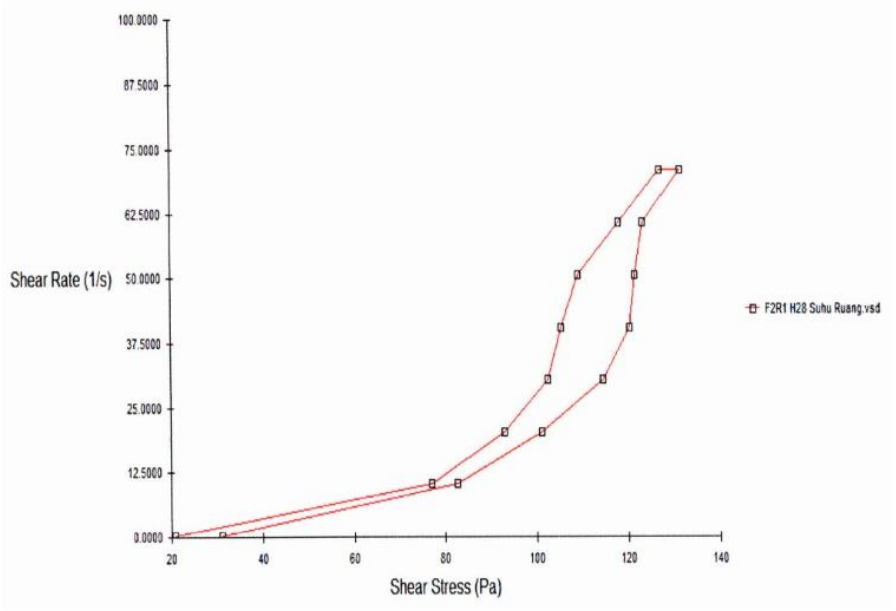


(B)

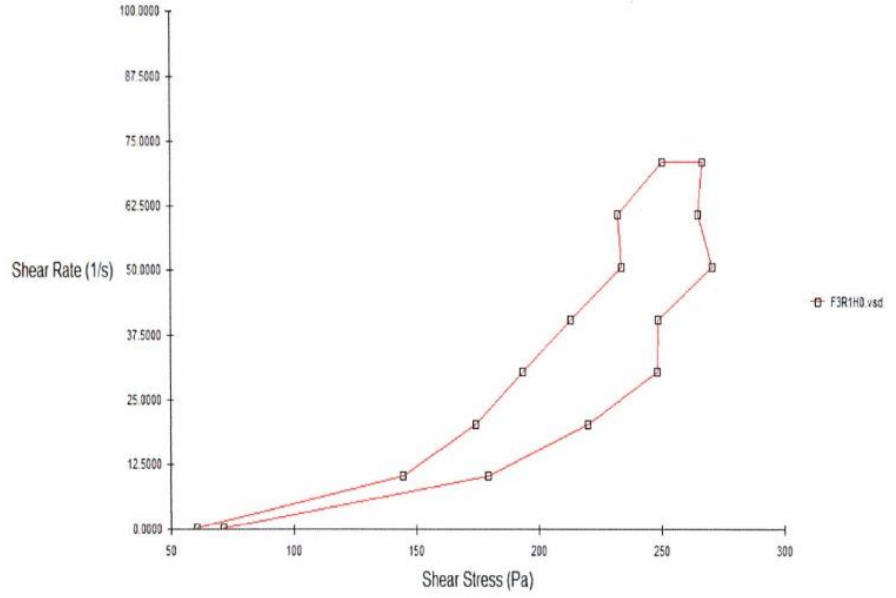


(C)

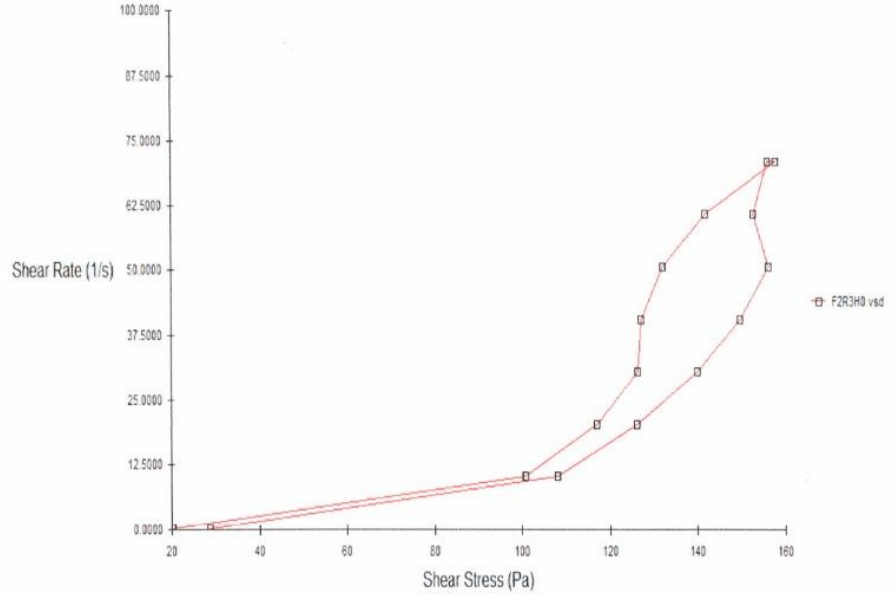
Figure 3. Rheogram of Nutmeg Seed Oil Emulgel FI (A). FII (B). FIII (C) Before Storage



(A)



(B)



(C)

Figure 4. Rheogram of Nutmeg Seed Oil Emulgel FI (A). FII (B). FIII (C) After 30 Days of Storage

Table 5. SPF Value of Nutmeg Seed Oil Emulgel

Formula	SPF Value (Mean±SD)				
	Before Storage	Week 1	Week 2	Week 3	Week 4
FI	8.54 ± 0.25	8.44 ± 0.42	8.71 ± 0.44	8.67 ± 0.23	8.79 ± 0.13
FII	8.37 ± 0.45	8.42 ± 0.38	8.53 ± 0.27	8.55 ± 0.25	8.41 ± 0.23
FIII	8.24 ± 0.13	8.33 ± 0.22	8.57 ± 0.21	8.66 ± 0.24	8.28 ± 0.38

The emulgel with Carbopol 940 showed SPF value stability after 30 days of storage. The statistical result showed there was no significant difference between formulas each week. The p value between formula compared to weekly sampling was 0.195 and p value within the formula was 0.063. Carbopol 940 provides good physical properties and stability (Yandri & Setyani, 2021). Vehicles such as gel base. apart from being able to maintain physical stability. are also able to maintain the stability of the effectiveness of the preparation (Hossann et al., 2007). When Carbopol 940 is used as a gelling agent in sufficient amounts. it can prevent liquid separation and form a stable gel (Tatiana et al., 2020). Carbopol base gels have protective and dispersal power better than other base gels (Dantas et al., 2016).

The SPF value is a value that shows the ability of sunscreen preparations in terms of protecting the skin and preventing sun exposure. so, the higher the SPF value of a sunscreen. the better its ability to provide protection. Therefore. the SPF value indicates the ability of sunscreen products to reduce erythema caused by UV radiation (Suryanto, 2012). The ability to absorb UV rays shows that nutmeg oil has potential as a sunscreen. The absorption ability of nutmeg oil is also possible because of the content of terpene group compounds such as α-pinene. which is able to prevent skin damage due to exposure to UV-A rays (Karthikeyan et al., 2018). Pretreatment of α-pinene and β-phellandrene prior to UVA exposure in rats also significantly increased SOD. CAT. and GPX in mouse skin. SPF values of nutmeg oil emulgel could be categorized as maximum protection.

4. CONCLUSION

Nutmeg seed oil emulgel with carbopol 940 in range of 0.6-1.0% as gel base were stable. SPF value from all formula did not show significant change after 30 days of storage and could be categorized as maximum protection. Further studies need to be carried out in order to determine the content stability of nutmeg oil emulgel.

5. ACKNOWLEDGMENT

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6. CONFLICT OF INTEREST

The author declares that there no competing conflicts of interest.

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