ISSN 0974-3618 (Print)
0974-360X (Online)

www.rjptonline.org

RESEARCH ARTICLE

Determination of Physical Stability Spray Sunscreen of Extract Wungu Leaf (*Graptophyllum pictum* (L.) Griff) with Varied Concentrations of Glycerine as A Humectant

Mayu Rahmayanti, Annisa Tri Maulidina, M. Bayu Firdaus Buana Putra
Maulana Malik Ibrahim State Islamic University of Malang,
Jl. Locari, Tlekung, Junrejo, Batu City, East Java 65151, Indonesia.
*Corresponding Author E-mail: **mayu31@farmasi.uin-malang.ac.id**

ABSTRACT:

Sunscreen is a preparation intended to counteract, reduce the effects, and protect the skin from ultraviolet (UV) radiation. Wungu leaf is one of the plants that contain antioxidants that can be used as a natural sunscreen preparation. In the manufacture of sunscreen, spray wungu leaf extract required additional materials in the form of humectants. Glycerin was chosen as a humectant with varying concentrations of 5%, 10%, and 15% in the formulation of a spray sunscreen which aims to improve the quality and maintain the stability of the resulting preparation. This study aims to determine the physical stability of the spray sunscreen preparation of wungu (*Graptophyllum pictum* (L.) Griff) leaf extract with varying concentrations of glycerin as a humectant. Spray sunscreen of wungu leaf extract was made in three formulas with variations in the concentration of glycerin used. The formulations that have been formulated are tested for physical stability by using the cycling test method for six cycles, and testing includes organoleptic, homogeneity, pH, viscosity, and diameter of the spray pattern. The organoleptic, homogeneity and pH tests of the preparations showed no significant changes after the physical stability test was carried out for six cycles with a significance pH value of 0.079 (<0.05). The resulting value still met the pH value criteria for topical preparations. The results of the viscosity test and spraying pattern showed an increase in the viscosity value and a decrease in the diameter of the spray pattern with a significant change with a significance of 0.01(<0.05) and 0.008 (<0.05). However, this change still met the physical criteria for topical preparations. Based on the study's results, it can be concluded that the spray sunscreen preparation of wungu leaf extract (*Graptophyllum pictum* (L.) Griff) with variations in glycerin concentration has good physical stability.

KEYWORDS: Cosmetics, Cycling test, Glycerin, Spray sunscreen, Wungu leaves.

INTRODUCTION:

Sunscreen is a pharmaceutical product that protects the skin from exposure to ultraviolet (UV) radiation by forming a protective barrier on the skin surface[1,2]. Today, many sunscreens on the market are in the form of creams and lotions, which has the drawbacks that it leaves an oily impression after wearing and most of them contain synthetic ingredients that are harmful if used in the long term[3,4].

Received on 24.10.2022 Modified on 30.03.2023
Accepted on 03.06.2023
Research J. Pharm. and Tech 2023; 16(11):5245-5249.
DOI: 10.52711/0974-360X.2023.00850

In response to this problem, many studies have developed sunscreen preparations made from herbs and in various dosage forms. One of them is the development of a spray sunscreen which is considered more practical in its use. The type of system determined based on the physical, chemical, and pharmacological properties of the active ingredients and application sites[5]. Sunscreens with herbal ingredients are considered to have fewer unwanted side effects than sunscreens with synthetic ingredients, are non-toxic, and do not irritate the skin[6,7,8]. Wungu leaves can be used in making herbal sunscreens. This plant is easy to find in Indonesia[9]. *Graptophyllum pictum* L. Griff contains various phytochemical compounds, one of which is antioxidants. Antioxidants are an essential compound in sunscreen preparations[10,11,12]. Antioxidants can play a role in counteracting free radicals that can damage

tissues in the body[13,14,15].

The dosage form of sunscreen that is currently becoming a trend is spray sunscreen. This dosage form provides advantages in its use which is easily spread to the surface of the skin and has the same effectiveness as a lotion or cream[15,16,17]. The manufacture of preparation required additional materials that have an essential role in the formulation of the sunscreen product, one of which is glycerin. Glycerin in topical preparations acts as a humectant that forms a layer on the skin's surface to protect the skin[18,19,20]. In addition, glycerin can maintain the stability of the preparation in the long term and bind the components contained in the dosage form[21]. Currently, no scientific data and research have been found that observes the effect of glycerin concentration on the stability of spray sunscreen by utilizing wungu leaf extract as an active ingredient. Physical stability is one of the critical criteria in the manufacture of a cosmetic preparation. This study aims to determine the physical stability of the spray sunscreen preparation of wungu (*Graptophyllum pictum* (L.) Griff) leaf extract with varying concentrations of glycerin as a humectant.

MATERIALS AND METHODS:

Materials:

The materials used in this research are Dry extract of wungu leaves (*Graptophyllum pictum* (L.) Griff) from Karanganyar, Central Java, Indonesia, methyl paraben, propyl paraben, glycerin, propylene glycol, BHT, carbopol 940, triethanolamine (TEA), ethyl vanillin, green dye, and aquadest. The tools used in this research are rotary evaporator (Heidolph), analytical balance (Shimadzu), oven (Memmert), refrigerator (Sharp), Ostwald viscometer, pH meter (ATC), magnetic stirrer, glassware (Pyrex, Iwaki, and Herma), spatula, porcelain cup, filter cloth, aluminum foil, and spray bottle.

Methods of Formulation of Spray Sunscreen Wungu Leaf Extract:

The formulation of spray sunscreen was made by dispersing 0.06g of carbopol 940 with 1/3 hot distilled water (temperature 70ºC) for 30 minutes in container A. Then stirred until homogeneous and added TEA. Methylparaben, glycerin, propylene glycol, BHT, and propylparaben were mixed in distilled water at a temperature of 70ºC in container B. Then, the mixture of materials in container B with the remaining distilled water was put in container A and stirred until homogeneous. Dissolve the extract with 70% ethanol, then mix it in the preparation mixture and homogenize it with a magnetic stirrer on a hotplate for 2 minutes at a speed of 1200rpm. The preparation is put in a spray bottle, and replicated each formula in 3 replications with variations in glycerin concentrations of 5%, 10%, and 15%.

Physical Stability Test of Spray Sunscreen Wungu Leaf Extract:

The physical stability test was carried out using the cycling test method by placing the preparation in a cold room (4±2ºC) and a higher temperature room (40±2ºC) for 48hours each, counted as one cycle. This test was carried out for six cycles and observed changes in organoleptic, homogeneity, pH, viscosity, and spray patterns.

Organoleptic Test:

Direct visual observation carried out organoleptic tests, including the dosage form's color, odor, clarity, and texture.

Homogeneity Test:

The homogeneity test was carried out by observing all completely dissolved materials.

pH test:

The pH test was carried out using a pH meter with the required range of 4.5 - 7.

Viscosity Test:

The viscosity test measured the density and flowed time of each preparation and distilled water using a pycnometer and Ostwald viscometer. Density is calculated using equation (i). The flow time is calculated using equation (ii).

$$P = \frac{m}{V} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

ρ = density of the sample
m = weight of the stock
v = volume of the pycnometer

$$\eta = \eta_o \frac{t.\rho}{t_o.\rho_o} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

η = viscosity of the sample
η_o = viscosity of water
t = stock flow time
t_o = water flow time
ρ = density of the sample
ρ_o = density of water

Spray Pattern Test:

The spray pattern test was carried out by spraying the preparation on mica plastic at a distance of 3, 5, 10, and 15 cm. The determination of the sample is repeated three times. Then, measured the diameter spray of the sample.

RESULT:

Organoleptic Test:

Based on the cycling test results for six cycles, there were no significant changes in the color, shape, odor, and clarity of each dosage formula.

Table 1: Organoleptic data of spray sunscreen [n=3]

Formulate	Cycle-0				Cycle-6			
	Color	Fragrant	Shape	Clarity	Color	Fragrant	Shape	Clarity
F1A	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant
F1B	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant
F1C	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant
F2A	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant
F2B	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant
F2C	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant
F3A	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant
F3B	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant
F3C	Green	Vanilla	Liquid	Transparant	Green	Vanilla	Liquid	Transparant

Homogeneity Test:

Based on the test for six cycles, the particles in formulas 1, 2, and 3 were dissolved entirely with no accumulation in each formula after six environmental cycles.

Table 2: Homogeneity data of spray sunscreen [n=3]

Formulate	Cycle-0	Cycle-6
F1A	Homogeneous	Homogeneous
F1B	Homogeneous	Homogeneous
F1C	Homogeneous	Homogeneous
F2A	Homogeneous	Homogeneous
F2B	Homogeneous	Homogeneous
F2C	Homogeneous	Homogeneous
F3A	Homogeneous	Homogeneous
F3B	Homogeneous	Homogeneous
F3C	Homogeneous	Homogeneous

pH test:

Observational data show no significant change in the pH value between the preparations in the 0th and 6th cycles. The pH of each preparation is within range 4,5 - 7.

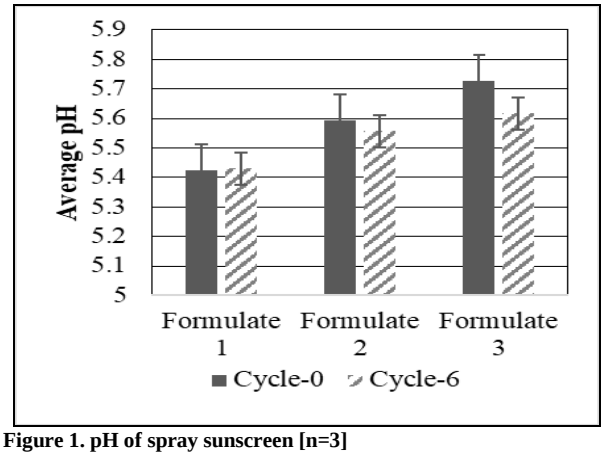

Figure 1. pH of spray sunscreen [n=3]

Viscosity Test:

All preparations have an increase in the viscosity value and there was no significant change in the viscosity of the preparation during the 0th and sixth cycles on statistical data.

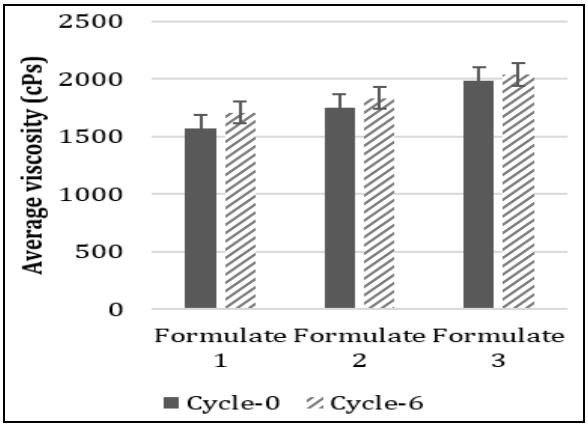

Figure 2. Viscosity of spray sunscreen [n=3]

Spray Pattern Test:

The results of this study show variations in diameter of spray pattern in each formula and no significant changes of the diameter on statistical data.

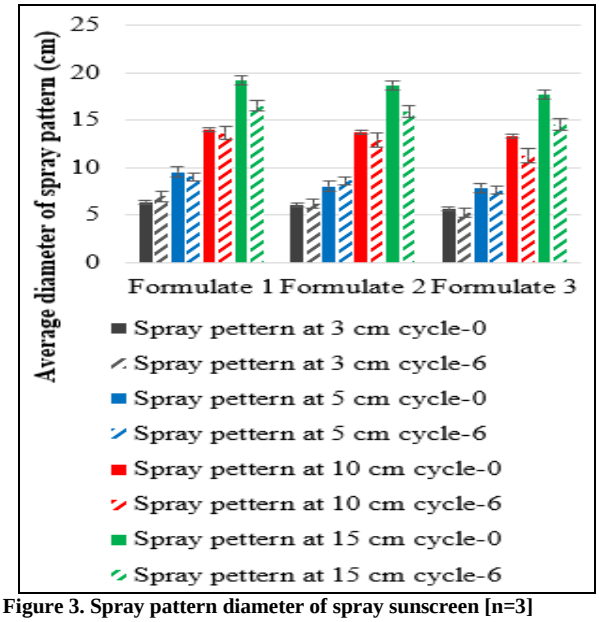

Figure 3. Spray pattern diameter of spray sunscreen [n=3]

DISCUSSION:

Organoleptic Test:

The organoleptic test compared the preparation's color, shape, odor, and clarity during the 0th and 6th cycles (Table 1) and there were no significant changes in each dosage formula. These results are from research conducted by Maharani et al. (2021), who showed no change in the preparation after stability testing was carried out for up to 21 days (4 cycles)[22]. Research conducted by Faizah and Sutiningsih (2019) showed no color, odor, or shape change after six storage cycles[23]. Spray sunscreen of wungu leaf extract (*Graptophyllum pictum* (L.) Griff) has stable organoleptic characteristics and meets the requirements, namely in liquid form, no phase separation, has a color according to the active ingredient, and does not have a pungent odor[24].

Homogeneity Test:

The homogeneity test was carried out by observing the presence or absence of materials not completely mixed in the preparation during the 0th and 6th cycles. The particles in formulas 1, 2, and 3 were dissolved entirely with no accumulation in each formula after six environmental cycles (Table 2). That follows research conducted by Iswandana and Sihombing (2017), which showed that after 12 weeks of storage, all preparations remained homogeneous, with no clumping, and the preparations remained physically stable[25]. So it can be said that the spray sunscreen preparation of wungu leaf extract (*Graptophyllum pictum* (L.) Griff) has a stable homogeneity of the preparation after the test and meets the requirements, such as no insoluble particles[26,27].

pH test:

Based on observational data, the pH of each preparation in cycle 0 and cycle 6 had a pH between 5.31 - 5.85 with a significance value (Figure 1) for each formula 1, 2, and 3, respectively, 0.593; 0.053; and 0.145 (P>0.05) which indicated that there was no significant change in the pH value between the preparations in the 0th and 6th cycles. These results suggest that all formulations of spray sunscreen preparations of wungu leaf extract meet the pH value of topical preparations, namely 4.5 - 7[26,27]. The results of this study follow the results of research conducted by Ariyanti et al. (2022), where there was no change in the pH of the preparation after four storage cycles there was no significant change[28].

Viscosity Test:

The results of the viscosity test observations are shown in Figure 2. There is an increase in the viscosity value of all preparations with a significance value in formulas 1, 2, and 3 after the cycling test for six cycles of 0.43; 0.49; and 0.126 (P>0.05), which indicated that there was no significant change in the viscosity of the preparation during the 0th and sixth cycles.Observational data showed that the viscosity of the entire formula was 1546.84 - 2091.01 Cp. This value indicates that all formulations of spray sunscreen preparations meet the criteria for good viscosity, namely the viscosity value in the range of 1080 to 5000 Cp[29]. These results follow the research conducted by Sumule et al. (2020), which stated that there was an increase in viscosity on the second day to the fourth week of storage, from 353.33 dPas to 383.33 dPas[30]. This change is due to the difference in the concentration of glycerin in each formula. Glycerin acts as a humectant that can maintain the stability of the preparation in the long term and bind the components contained in the preparation[21]. Glycerin can increase the viscosity of preparation by binding to water, thereby increasing the molecular size, which also affects the increase in resistance to flow[30].

Spray Pattern Test:

The results of the pattern observation show the cycles in Figure 3, which indicate variations in each formula, both the 0th and 6th cycles. The difference is due to the influence of the spraying distance. The farther the spraying distance, the wider the resulting diameter[31]. These results have similarity to the results from Anindhita and Oktaviani's (2020) research, where the average spraying diameter at a distance of 3cm, 5cm, 10 cm, and 15cm is 2.57cm, 2.87cm, and 3.67cm, respectively, 4.57cm, and 6.13cm. The results of this study indicate that the significant value in formula 1 with spraying distances of 3cm, 5cm, 10cm, and 15cm is 0.180; 0.285; 0.276; and 0.109 (P>0.05)[32]. The significance of formula 2 with spraying distances of 3 cm, 5cm, 10cm, and 15cm is 0.180; 0.180; 0.109; and 0.109 (P>0.05). The significance of formula 3 with spraying distances of 3 cm, 5 cm, 10 cm, and 15 cm are 0.276; 0.655; 0.102; and 0.109 (P>0.05). The significance values in formulas 1, 2, and 3 indicated no significant change in the spray diameter during the 0th and 6th cycles. Besides being influenced by the spraying distance, this difference is also influenced by an increase in viscosity. The increase in viscosity causes the pressure to spray the preparation to be greater, making it difficult for the preparation to be sprayed from the device[31].

CONCLUSION:

The study results concluded that the spray sunscreen preparations with varying concentrations of glycerin (5%, 10%, and 15%) were physically stable.

CONFLICT OF INTEREST:

The authors have no conflicts of interest regarding this investigation.

ACKNOWLEDGMENTS:

The authors would like to thank DIPA of Faculty of Medicine and Health Sciences of Maulana Malik Ibrahim State Islamic University of Malang for their kind support for funding this research.

REFERENCES:

1. Bhattacarya, S., and Sherje, A.P. Development of Resveratrol and Green Tea Sunscreen Formulation For Combined Photoprotective and Antioxidant Properties. Journal of Drug Delivery Science and Technology. 2020; 60: 1–6.https://doi.org/10.1016/j.jddst.2020.102000
2. Mota, M.D., da Boa Morte, A.N., Silva, L.C.M., and Chialia, F.A. Sunscreen Protection Factor Enhancement Through Supplementation with Rambutan (Nephelium lappaceum L.) Ethanolic Extract. Journal of Phytochemistry and Photobiology B: Biology. 2020; 205: 1–7. https://doi.org/10.1016/j.jphotobiol.2020.111837
3. Trilokchandran, B., Vijayakumar, G., and Thippareddy, K.S. Formulation and Evaluation of Cosmetic Cream from Cabbage Extract. Research Journal of Pharmacy and Technology. 2019; 12(8): 3589–3594. doi.org/10.5958/0974-360X.2019.00612.7
4. Choutri, C., N. Jawahar., Mythili, L., and Arun, R. Spray Technology: A Novel Approach in Transdermal Drug Delivery. Research Journal of Pharmacy and Technology. 2020; 13(2): 1015–1027. doi.org/10.5958/0974-360X.2020.00188.2
5. Raval, A. Formulation and Evaluation of Itraconazole Topical Spray. Research Journal of Topical and Cosmetic Sciences. 2015; 6(2):91–126. doi.org/10.5958/2321-5844.2015.00013.8
6. Wathoni, N., Haerani, A., Yuniarsih, N., and Haryanti, R. A Review on Herbal Cosmetics in Indonesia. International Journal of Applied Pharmaceutics. 2018; 10(5): 1–16. doi.org/10.22159/IJAP.2018V10I5.28102
7. Jangde, R., and Daharwal, S.J. Herbal Sunscreen: An Overview. Research Journal of Topical and Cosmetic Science. 2011; 2(2):35–39.
8. Ratnasooriya, W.D., Pathirana, R.N., Gamage, R.N.N., Hasanthi, K.B., and Hettihewa, S.K. In Vitro Sunscreen Activity of Methanolic Root Extract of A Sri Lankan Grass Heteropogon contortus. Asian Journal of Pharmaceutical Analysis. 2018; 8(2): 65–68. doi.org/10.5958/2231-5675.2018.00012.1
9. Sujarwo, W., Pendit, I.M.R., and Hoeven, B. Studi Etnobotani Tumbuhan Obat dan Upacara Adat Hindu di Bali. Buletin Kebun Raya. 2018; 21(2): 117–139. https://doi.org/10.14203/press.7
10. Salim, R., and Suryani. Aktivitas Antioksidan si Ungu Mentawai. Jurnal Katalisator. 2020; 5(1): 17–31. doi.org/10.22216/JK.V5I1.5275
11. Mansuri, R., Diwan, A., Kumar, H., Dangwal, K., and Yadav, D. Potential of Natural Compounds as Sunscreen Agents. Pharmacognosy Reviews. 2021; 15(29): 47–56. doi.org/10.5530/phrev.2021.15.5
12. Muthumani, T., Sudhahar, V., and Mukopadhyay, T. Review on Sunscreen and Sun Protection Factor. Research Journal of Topical and Cosmetic Sciences. 2015; 6(2): 55–65. Doi.org/10.5958/2321-5844.2015.00009.6
13. Budiaji, A., Ismail, and Nani, H. Identification Compound Contained in Extract Methanol Leaf Wungu (Graptophyllum pictum (L.) Griff). International Journal of Health Medicine and Current Research. 2018; 3(3): 961–964.doi.org/10.22301/IJHMCR.2528-3189.961
14. Roy, A., and Sahu, R.K. Formulation and Development of Herbal Sunscreen Cream. Research Journal of Topical and Cosmetic Sciences. 2014; 5(1): 12–14.
15. Rathod, S., Mali, S., Shinde, N., and Aloorkar, N. Cosmeceuticals and Beauty Care Products: Current Trends with Future Propspects. Research Journal of Topical and Cosmetic Sciences. 2002; 11(1): 45–51. Doi.org/10.5958/2321-5844.2020.00008.4
16. Ngoc, L.T.N., Tran, V.V., Moon, J., Chase, M., Park, D., and Lee, Y. Recent Trends of Sunscreen Cosmetic: An Update Review. Cosmetics. 2019; 6(64): 1–5. https://doi.org/10.3390/cosmetics6040064
17. Addor, F.A.S., Anna, et al. Sunscreen Lotions in The Dermatological Prescription: Review of Concepts and Controversies. Anais Brasileiros de Dermatologia. 2022; 97(2): 1–9. doi.org/10.1016/j.abd.2021.05.012
18. Bura, A.R. Effect of Wound Healing Potential of Plumeria obtusa (Champa) Spray. Asian Journal of Pharmaceutical Research. 2018; 8(4): 231–235. doi.org/10.5958/2231-5691.2018.00039.4
19. Solanki, H., Verma, V.S., Sharma, M., Singh, A., Sharma, G., Majumdar, M., Gupta, S., Sadhya, Sahu, V., Dewangan, K., Tripathi, D.K., Alexander, A., Ajazuddin. Natural Humectants in Formulation of Calamine Lotion: Its Evaluation and Comparison. Research Journal of Topical and Cosmetic Sciences. 2016; 7(2): 41–45. Doi.org/10.5958/2321-5844.2016.00007.8
20. Rohmani, S., Miararani, N., Yugatama, A., Ermawati, D.E., and Prihapsara, F. Formulation and The Release of Eugenol from Cream Using Glycerin Base. IOP Conf Series: Material Science Engineering. 2019; 578: 1–6. Doi.org/10.1088/1757-899X/578/1/012052
21. Sukmawati, A., Laeha, M.N., and Suprapto. Efek Gliserin sebagai Humektan Terhadap Sifat Fisik dan Stabilitas Vitamin C dalam Sabun Padat. Pharmacon: Jurnal Farmasi Indonesia. 2017; 14(2): 40–47. doi.org/10.23917/pharmacon.v14i2.5937
22. Maharani, N., Aisiyah, S., and Purwaningsih, D. Formulasi Mouthwash ekstrak Kulit Buah Nanas (Ananas comosus (L.) Merr) dengan Variasi Konsentrasi Gliserin sebagai Antibakteri Terhadap Streptococcus mutans ATCC 25175. Journal of Pharmacy. 2021; 10(2): 8–19. doi.org/10.37013/jf.v10i2.137
23. Faizah, M.H., and Sutiningsih. Pengaruh Formulasi Sediaan Facial Spray Gel Ekstrak Etanol 70% Kulit Buah Pisang Nangka (Musa AAB) Terhadap Sifat Fisik, Stabilitas Fisik, dan Aktivitas Antioksidan. Indonesia Natural Research Pharmaceutical Journal. 2019; 4(2): 85–100.
24. Fitriansyah, S.N., Wirya, C., and Hermayanti. Formulasi dan Evaluasi Spray Gel Fraksi Etil Asetat Pucuk Daun Teh Hijau (Camelia sinensis (L.) Kuntze) sebagai Antijerawat. Pharmacy. 2016; 13(2): 202–216. doi.org/10.30595/pji.v13i02.1257
25. Iswandana, R., and Sihombing, L.K.M. Formulasi, Uji Stabilitas Fisik, dan Uji Aktivitas Secara In Vitro Sediaan Spray Antibau Kaki yang Mengandung Ekstrak Etanol Daun Sirih (Piper betle L.). Pharm Sci Res. 2017; 4(3): 121–131.https://doi.org/10.7454/psr.v4i3.3805
26. Salwa, Kadir, M.B.A., and Sulistyowati, Y. Formulasi dan Evaluasi Sediaan Spray Gel Tabir Surya Fraksi Etil Asetat Daun Cempedak (Artocarpus integer (Thunb.) Merr. Dengan Kombinasi Basis HPMC dan Karbopol 940. Jurnal Kesehatan Mahasiswa UNIK. 2020; 2(1): 12–23. https://doi.org/10.30737/jumakes.v2i1.1222
27. Paramawidhita, R. Y., Adawiyah, R., and Umaternate, A. The Formulation and Physical Evaluation of Emulgel the Kalakai (Stenochlaena palustris Bedd) Roots Ethanol Extract As a Sunscreen. Journal of Physics: Conference Series. 2021; 1764: 1–5. doi.org/10.1088/1742-6596/1764/1/012021
28. Ariyanti, Maruriati, E., Lindawati, N.Y., Setyowati, D., and Nurulita, F.M. Uji Spray Lotion Sunscreen Buah Tomat (Licopersicon esculentum Mill). In: Prosiding Seminar Informasi Kesehatan Nasional 2022; Surakarta, June 18th, 2022. Surakarta: Fakultas Ilmu Kesehatan Universitas Duta Bangsa Surakarta.
29. Wang, W.M., Chen, C.Y., Lu, T.H., Yang, Y.F., and Liai, C.M. Estimates of Lung Burden Risk Associated with Long-Term Exposure to TiO2, Nanoparticles As a UV-Filter in Sprays. Environmental Science and Pollution Research. 2021; 28(25): 32460–32474. doi.org/10.1007/s11356-021-12924-8
30. Sumule, A., Kuncahyo, I., and Leviana, F. Optimasi Carbopol 940 dan Gliserin dalam Formula Gel Lendir Bekicot (Achatina fulica Ferr) sebagai Antibakteri Staphylococcus aureus dengan Metode Simplex lattice Design. Pharmaceutical Journal of Indonesia. 2020; 17(1):108–117. Doi.org/10.30595/pharmacy.v17i1.5640
31. Cendana, Y., Adrianta, K.A., and Suena, N.M.D.S. Formulasi Spray Gel Minyak Atsiri Kayu Cendana (Santalum album L.) sebagai Salah Satu Kandidat Sediaan Anti Inflamasi. Jurnal Ilmiah Medicamento. 2021; 7(2): 84–89. Doi.org/10.36733/medicamento.v7i2.2272
32. Anindhita, M.A., and Oktaviani, N. Formulasi Spray Gel Ekstrak Daun Pandan Wangi Sebagai Antiseptik Tangan. Ejournal Poltektegal. 2020; 9(1): 14–21. http://dx.doi.org/10.30591/pjif.v9i1.1503