Jurnal Info Kesehatan
Vol.17, No.2, December 2019, pp.101-107
P-ISSN 0216-504X, E-ISSN 2620-536X
DOI: *10.31965/infokes.Vol17.Iss2.309*
Journal homepage: *http://jurnal.poltekeskupang.ac.id/index.php/infokes*

RESEARCH **Open Access**

Synthesis and Test of C-Phenylcolics [4] Resorcinilate Octabenzoat Sunblock Activity

Budiana I Gusti M. Ngurah [1a*], Ni Nyoman Yuliani [2b]

[1] Department of Chemistry, Faculty of Teacher Training and Education, Universitas Nusa Cendana, Indonesia.
[2] Department of Pharmacy, Poltekkes Kemenkes Kupang, Indonesia.

[a] Email address: ngurahbudiana.igm@gmail.com
[b] Email address: y.ninyoman@yahoo.com

Received: 11 November 2019 Revised: 27 December 2019 Accepted: 27 December 2019

Abstract
Research on the discovery of organic sunblock today continues to be intensively conducted because cases of skin cancer caused by sun exposure continue to increase from year to year. Recently, what is used to protect the skin from the dangers of sun exposure is a sunblock lotion product. This research aims to synthesize and test the new organic C-phenylcolics [4] resorcinaryl octabenzoat compound. This research is pure experimental research by testing sunblock activity using Ultraviolet-Visible Spectrophotometry. The C-phenylcallic [4] resorcinaryl octabenzoate compound was synthesized by the C-phenylcalcid [4] resorcinarene method with benzoyl chloride using a catalyst and pyridine solvent. Characterization of reaction products used infra-red spectrometers and proton-NMR. Meanwhile, testing sunblock activity was conducted in vitro using the ultraviolet spectrometry method. The synthesis results showed that C-phenylcalcid [4] resorcinyl octabenzoat was in the form of a dark yellow solid, melting point of 238-240 ^{o}C and yield of 74.10%. The in vitro test results showed that C-methylcolics [4] resorcinyl octabenzoat has a broad spectrum because it can absorb UV B and UV C rays with an SPF value of 30. This compound has the potential to be developed as a sunblock.

Keywords: Synthesis, C-Phenylcolics [4] Resorcinilate Octabenzoat Sunscreen Activity, Sunblock

Corresponding Author:

Budiana I Gusti M. Ngurah,
Department of Chemistry, Faculty of Teacher Training and Education, Universitas Nusa Cendana
Adisucipto Street-Penfui Kupang, 85001, Indonesia.
Email: ngurahbudiana.igm@gmail.com

1. INTRODUCTION

The sun is the main source of heat and light in the solar system and produces electromagnetic radiation in a wide range. Sunlight is very important to support survival on earth, such as photosynthesis in plants that produce oxygen, synthesis of vitamin D, kill germs, phototherapy and as a provider of light and warmth (Gonzalez et al., 2006). Sunlight needed for the synthesis of vitamin D is only for 10-15 minutes, so exposure to sunlight for more than 15 minutes especially during the day can cause some health problems. These disorders are as sunburn, skin cancer and eye damage. The dangerous nature of sunlight is caused by the presence of ultraviolet light that is not visible. Ultraviolet light based on its wavelength can be divided into three groups that is; UV A from 320-400 nm, UV B from 290-320 nm and UV C from 200-290 nm (Dutra et al., 2004, Pratama & Zulkarnaen, 2015). Meanwhile, Autier (2009), Duale et al., (2010) dan Chawla et al., (2011), also grouped ultraviolet light into three groups but for UV B it was in the wavelength range of 280-320 nm.

Excessive exposure to UV C can cause blindness and severe sunburn. UV C does not reach the surface of the earth as long as the ozone layer has not been damaged. UV B only partially passes through ozone while UV A can all pass through ozone. Judging from the increasing cases of skin cancer, it does not rule out the possibility of UV C also has contributed to the onset of skin damage (Nishanthin et al., 2012).

Advances in technology and patterns of human life have caused damage to the ozone layer in several regions of the world as happened in the South Pole, with the level of ozone damage has reached an area of Europe. The condition of the ozone layer is expected to recover in 20 years, and even then, if there is no chemical industry activity that produces chemicals that can damage ozone. For the time being the most considered dangerous are UV A and UV B rays (Herzog et al., 2009, Mbanga, 2014). Every year, around one million people are diagnosed with skin cancer and around 10,000 die. Most skin cancers occur in the parts of the body most frequently exposed to sunlight, such as face, neck and head (Dutra at al., 2004).

Recently, efforts to protect the skin have been done using lotion products whose active ingredients are sunblock compounds. Sunblock compounds can absorb or reflect UV rays so they can prevent skin damage. There are two types of sunblock compounds, which are organic and inorganic sunblocks. Organic sunblock compounds generally have benzene nuclei conjugated with carbonyl groups, for example oxybenzone and octamic methoxy cinnamon (Wong & Currie, 2011). Inorganic sunblocks such as ZnO, MgO, $CaCO_3$ and TiO_2 (Susanti et al., 2012). However, nowadays, inorganic sunblocks are rarely used anymore because they can cause a high risk of allergies and irritations and are harmful to the skin. Meanwhile, on the other hand, organic sunblocks such as octyl methoxy sinamat are increasingly in demand because they do not cause DNA damage (Duale, et al., 2010, Wright et al., 2012). However, organic sunblocks still have the disadvantage of being less stable to long-term exposure to solar radiation. Therefore, research on the discovery of new organic sunblock compounds that have good activity do not irritate the skin and is deemed important to develop.

Organic sunblock compounds that have good stability are currently the focus of researchers in the field of organic chemistry, because sunblocks lose their function if they are unstable when exposed to sunlight. Efforts to improve the stability of organic sunblocks have been made by Chawla et al., (2011), who succeeded in making tetra propocicalix [4] cinema arena. This compound does have a better stability and activity than sunblock oxybenzone, but the reaction stage is quite complicated and has a low

reaction yield of only 25%. One of the calixarine group compounds which can be synthesized in only one reaction step with a high yield is the calix [4] resorcinarene group. This compound has good stability to temperature (does not melt to 400 °C), so that when coupled with a benzoyl group that has the character of a sunblock compound, it will be obtained by the compound resixcinarene calix [4] derivatives which have stable properties while having good activity as UV radiation absorbent (Ngurah et al., 2014). One compound of cervical [4] resorcinarene which has good sunblock activity is C-methyl calix [4] resorcinyl octinamic (Ngurah et al., 2017).

2. RESEARCH METHOD

This research is a pure experimental study and was conducted at Chemistry Laboratory of Undana FKIP, for 6 months (June-December 2018). Materials and tools used in the study consisted of; C-phenylcalix [4] resorcininar, benzoyl chloride (C_7H_5OCl), concentrated sulfuric acid (H_2SO_4), hydrochloric acid (HCl) and acetic anhydride ($C_4H_6O_3$). The tools used in this study include: 1) reflux acid, separating funnel , Cordtrol II Z10,769-7 electric heaters, magnetic breakers, 2) thin-layer chromatography, UV lamps, waterbath shaking, Buchii rotary evaporators, pH, 3) Hana meters (1-14), desiccators, and glassware, Spectrometers UV-Vis (Milton Roy Spectronic 3000 Array).

The procedure for the synthesis of C-phenylcalcose [4] resorcinaryl octabenzoate is as follows; compound C-phenylks [4] resorcinarene 2.5 g (4.6 mmol) is dissolved in 22.7 ml of pyridine, and 8.9 mL (73.6 mmol) benzoylchloride is added to the solution which is placed in an ice bath. The mixture is stirred and heated at 60^{o}C for 2 hours. After cooling, 150 mL of water is added to the mixture; the separate solid is filtered and dried in the oven. The melting product is determined by its melting point and is characterized using an infrared spectrometer and a proton-NMR. While the procedures for testing the activities of a veil are as follows; a total of 3.5 mg of C-phenylcalcid compound [4] resorcinaryl octabenzoate was dissolved in 70 mL chloroform, so a test solution with a concentration of 50 ppm was obtained. The test solution is measured by absorption with a UV-Vis spectrometer at a wavelength of 200-400 nm. As a blank, chloroform is used.

3. RESULTS AND DISCUSSION

Results of the Synthesis of C-phenylcalcose [4] resorcinyl octabenzoate. The results of the reaction showed that C-phenylcalcid [4] resorcinyl octabenzoate was a dark yellow solid, with a melting point of 238-240 ^{o}C and a yield of 74.10%. The mechanism of the synthesis reaction of C-phenylcalix [4] resorcinyline octabenzoate as shown in Figure 1. The results of the characterization of the reaction product using an infrared spectrometer as shown in Figure 2, which shows the loss of the hydroxy group and replaced with the appearance of C=O ester at 1743 cm-1. Moreover, the stronger absorption in the region of 1249 cm-1 which is the absorption of the C-O ether group shows that the benzoyl group has been bound to the molecule of calix [4] resorcinarene.

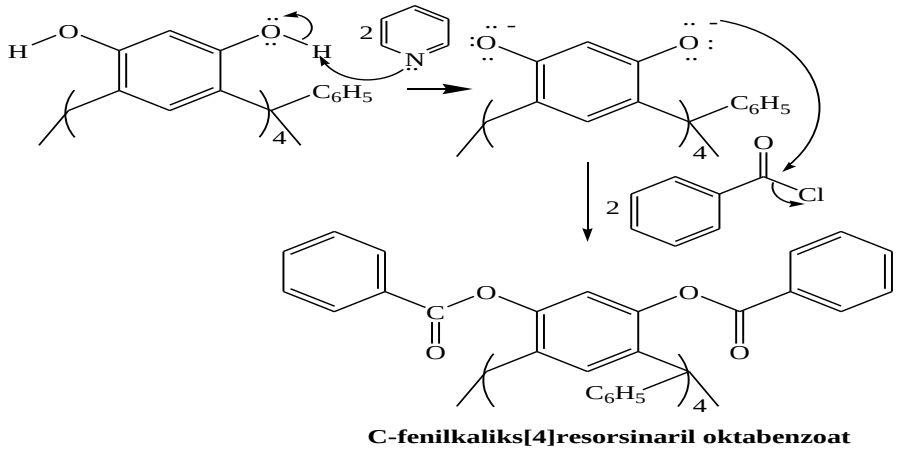

Figure 1. Mechanism of synthesis of C-phenylcallic [4] resorcinyl octabenzoate.

The mechanism of synthesis of the C-phenylcalcid compound [4] resorcinaryl octabenzoate starts from the attack of hydrogen atoms by pyrimidine bases to form phenolic ions, with a negative charge then the phenolic ion becomes reactive and can attack the carbonyl benzoyl chloride group (Budiana, 2017).

When compared with the melting point of C-phenylcalcidus [4] resorcinarene as calixsarena parent melting at temperatures above 400 oC appears to have decreased melting point. This decrease in melting point according to Gutsche (1989) is caused by the loss of intramolecular hydrogen bonds. This is reinforced by the results of the characterization of the reaction product using an infrared spectrometer as shown in Figure 2, which shows the loss of a hydroxy group and is replaced by the appearance of C=O esters at 1743 cm-1. Besides that the stronger absorption in the area of 1257 cm-1 which is the absorption of the C-O ether group shows that the benzoate group is already bound to the molecule of calix [4] resorcinarene (Handayani, 2011).

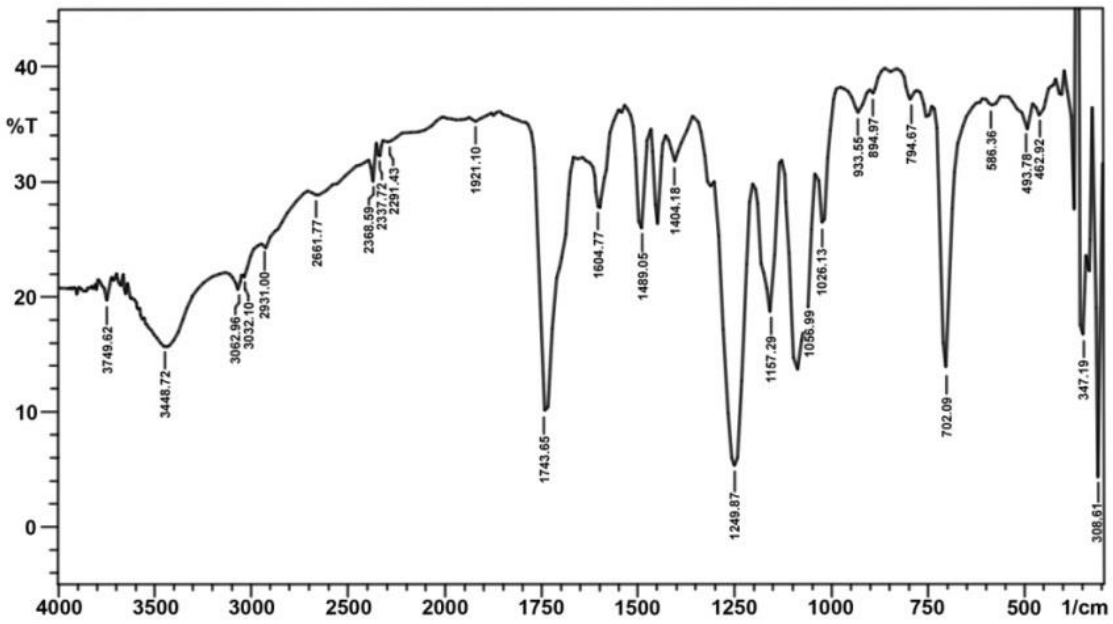

Figure 2. C-phenylcalcid infra-red spectrum [4] resorcinyl octabenzoate.

The results of characterization of the reaction product using 1H-NMR as shown in Figure 3, show that the calibration proton bridge [4] resorsinarena appears at a shift of 5.74 ppm (A).

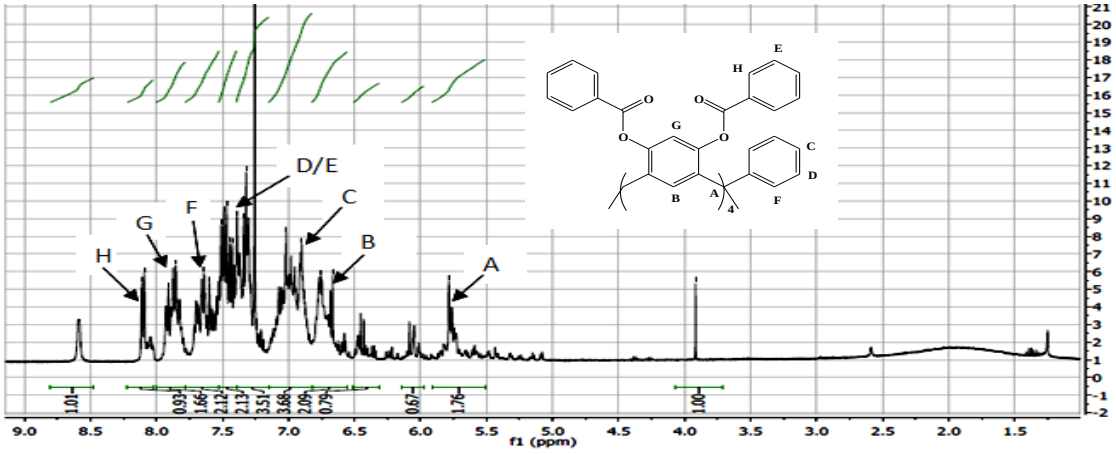

Figure 3. Spectrum of 1H-NMR C-phenylcalic [4] resorcinyl octabenzoate

The aromatic protons appear at a shift of 6.74 ppm and 7.75 ppm, while the shift of the benzoyl group appears at a shift of 7.56 ppm and 8.17 ppm. The phenyl group protons bound to the calix [4] resorcinarene bridge appear successively at a chemical shift of 7.04 ppm, 7.42 ppm and 7.64 ppm. Based on the results of the characterization of the synthesis product with Infra-Red spectrophotometer and proton-NMR, it can be concluded that the compound C-phenylcalcid [4] resorcinaryl octabenzoate has been well formed. The yield of synthesis is higher than the results of previous studies conducted by (Chawla et al., 2011).

The activity of C-phenylcalcid [4] resorcinaryl octabenzoate sunblock was conducted in vitro using an untraviolet spectrophotometer. Through this tool, it can be known whether the absorption pattern of the test compound can absorb UVA, UVB or UVC radiation. A good sunblock compound according to the American Academy of Dermatology is a compound that has a broad spectrum which means that it is able to absorb all types of UVB and UVA rays, has a high sun protection factor (SPF) value (≥ 30), at concentrations that are not toxic to cells skin fibroblasts and not soluble in water in the span of 40-80 minutes. The results of the C-phenylcalcid [4] -ororinarilyl octabenzoate sunblock activity as shown in Figure 4, show that the test compound can absorb two types of UV rays quite well which are UVC at a wavelength of 248 nm and UVB at 290 nm.

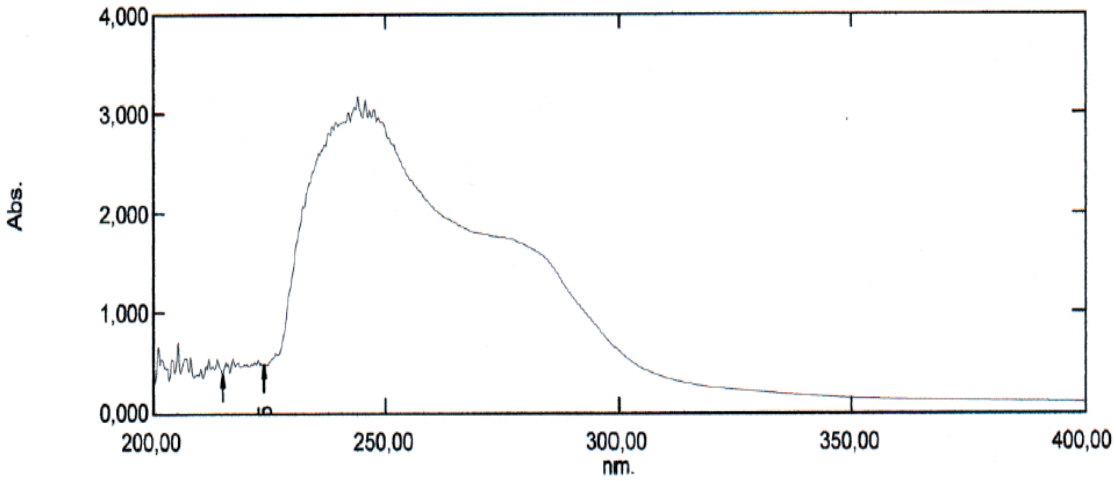

Figure 4. UVC-phenylcalcid spectrum [4] resorcinyl octabenzoate**.**

Curvadiatas show that the ability of phenylcallic compounds [4] resorcinyl octabenzoate to absorb UVC rays is very good. UVC rays are UV rays with the shortest wavelength compared to UVB and UVA rays, which means they have the most energy. Hence, the UVC rays have the greatest power to damage the skin, especially with the current level of ozone damage, UV C rays will pose a serious threat to human skin (Herzog et al., 2009).

The strength of the activity of a material or sunblock product can be seen from the SPF value. The SPF value can be determined from the UV spectrum using the formula; SPF = 10A (average) where A is the absorption value in the wavelength range of 280 nm-320 nm (Ngurah et al., 2017). The results of the calculation of the SPF C-methylcallic value [4] of resorcinyl octabenzoate are 30, and this value is in accordance with the requirements required by the American Academy of Dermatology. Based on the SPF value, it can be inferred that the compound C-phenylkaliks [4] resorcinaryl octabenzoate is very potential to be developed as a sunblock product in the future.

4. CONCLUSION

C-phenylcalcid [4] resorcinaryl octabenzoate compound can be synthesized through one reaction stage that is the reaction of esterification of C-phenylcalcid [4] resorcinarene with benzoyl chloride using pyridine catalyst. The results of in-vitro testing using a UV spectrophotometer showed that C-phenylcalcid [4] resorcinyl octabenzoate can absorb UVB and UVC rays so well that it has the potential to be developed as a sunblock product.

REFERENCES

Autier, P. (2009). Sunscreen abuse for intentional sun exposure. *British Journal of Dermatology*, 161(3), 40-45.

Budiana. (2017). *Kaliksarena Sintesis dan Aplikasinya*. Kupang: PMIPA Press Undana

Chawla, H. M., Pant, N., Kumar, S., Mrig, S., Srivastava, B., Kumar, N., & Black, D. S. (2011). Synthesis and evaluation of novel tetrapropoxycalix [4] arene enones and cinnamates for protection from ultraviolet radiation. *Journal of Photochemistry and Photobiology B: Biology*, *105*(1), 25-33.

Dutra, E. A., Oliveira, D. A. G. D. C., Kedor-Hackmann, E. R. M., & Santoro, M. I. R. M. (2004). Determination of sun protection factor (SPF) of sunscreens by ultraviolet spectrophotometry. *Revista Brasileira de Ciências Farmacêuticas*, *40*(3), 381-385.

Duale, N., Olsen, A. K., Christensen, T., Butt, S. T., & Brunborg, G. (2010). Octyl methoxycinnamate modulates gene expression and prevents cyclobutane pyrimidine dimer formation but not oxidative DNA damage in UV-exposed human cell lines. *Toxicological Sciences*, *114*(2), 272-284.

Gonzalez, H., Farbrot, A., Larkö, O., & Wennberg, A. M. (2006). Percutaneous absorption of the sunscreen benzophenone-3 after repeated whole-body applications, with and without ultraviolet irradiation. *British Journal of Dermatology*, *154*(2), 337-340.

Gutsche, C. D., & Stoddart, J. F. (1989). *Monographs in Supramolecular Chemistry. Calixarenes*. Washington: The Royal Society of Chemistry.

Handayani, D. S. (2011). *Sintesis Poli-5-Allilkaliks [4] arena dan Turunan Ester Serta Asam Karboksilatnya Sebagai Adsorben dan Antidotum Keracunan Logam Berat* (Doctoral dissertation). Yogyakarta: FMIPA UGM

Herzog, B., Wehrle, M., & Quass, K. (2009). Photostability of UV absorber systems in sunscreens. *Photochemistry and photobiology*, *85*(4), 869-878.

Mbanga, L., Mulenga, M., Mpiana, P.T., Bokolo, K., Mumbwa, M., Mvingu, K. (2014). Determination of Sun Protection Factor (SPF) of Some Body Creams and Lotions Marketed in Kinshasa by Ultraviolet Spectrophotometry International Journal of Advanced Research in Chemical Science, 1(8), 7-13.

Nishanthini, A., Ruba, A. A., & Mohan, V. R. (2012). Total phenolic, flavonoid contents and in vitro antioxidant activity of leaf of Suaeda monoica Forssk ex. Gmel (Chenopodiaceae). *International Journal of Advanced Life Sciences (IJALS)*, *1*(5), 34-43.

Ngurah, B., Jumina, J., Anwar, C., Mustofa, M., & Sahadewa, S. (2014). Synthesis of Benzoyl C-Phenylcalix[4]resorcinaryl Octaacetate and Cinnamoyl C-Phenylcalix[4]arene for UV Absorbers. Indonesian Journal of Chemistry, 14(2), 160-167.

Ngurah, B., Jumina, J., Anwar, C., Sunardi, S., & Mustofa, M. (2017). Synthesis and *In Vitro* Evaluation of C-methylcalix[4]resorcinaryl octacinnamate and C-methylcalix[4]resorcinaryl octabenzoate as the Sunscreen. Indonesian Journal of Chemistry, 17(1), 63-70.

Pratama, W. A., & Zulkarnain, A. K. (2015). Uji SPF in Vitro dan Sifat Fisik Beberapa Produk Tabir Surya Yang Beredar Di Pasaran. *Majalah Farmaseutik*, *11*(1), 275-283.

Susanti, M., Dachriyanus & Putra, D. P. (2012). Aktivitas perlindungan sinar UV kulit buah Garcinia mangostana Linn secara in vitro. *Pharmacon*.13(2), 61-61

Wong, C. dan Currie, J. (2011). Teaching With CAChe Molecular Modeling In Chemistry, Pacific University Forest Grove, *Oregon*, 29, 36.

Wright, C. Y., Norval, M., Summers, B., Davids, L., Coetzee, G., & Oriowo, M. O. (2012). The impact of solar ultraviolet radiation on human health in sub-Saharan Africa. *South African Journal of Science*, *108*(11-12), 45-51.