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Original Article

DESIGN OF HYDROQUINONE INDICATOR STRIP BASED ON POLYMETHYLMETHACRYLATE (PMMA) FOR IDENTIFICATION OF HYDROQUINONE IN WHITENING COSMETICS: CASE STUDY IN BANDUNG INDONESIA

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ABSTRACT

Objective: The objective of this research was to developing an indicator strips made from polymer polymethylmethacrylate (PMMA) to detect hydroquinone in whitening cosmetics.

Methods: The strips were prepared by reagent blending method with a polymer PMMA that mixed with a chemical reagent for hydroquinone based on chemical structure: ferric chloride ($FeCl_3$), Benedict, and ammoniacal silver nitrate. PMMA were varied with concentrations of 5%, 7.5%, and 10%. The ratios of ethyl acetate and the reagents were off 6:4; 7:3; and 8:2.

Results: The results showed that the following concentration was an optimum mixture of chemical reagent-polymer and ethyl acetate $FeCl_3$-PMMA 7.5% 7:3; benedict-PMMA 5% 6:4; and ammoniacal silver nitrate-PMMA 5% 7:3. 22 samples of whitening cream were not contained hydroquinone based on strip indicator analysis. These results are appropriate with a confirmatory test using UV spectrophotometry and thin layer chromatography. The indicator strips showed a positive result in detect the samples that had been spiked by hydroquinone but has a limitation when applied to cream dosage forms. The limit of detection (LOD) and stability of the indicator strip $FeCl_3$-PMMA 7.5% 7:3 was 20.05 mg/l and stable up to 157 d, Benedict-PMMA 5% 6: 4 was 0177 mg/l and stable up to 123 d, and ammoniacal silver nitrate-PMMA 5% 7:3 was 0.025 mg/l and stable up to 174 d. The selectivity test results showed that indicator strip did not give false positive results.

Conclusion: Based on the tests, the indicator strip has limitations to detect hydroquinone in whitening cream cosmetics that required further modifications to the detection process.

Keywords: Hydroquinone, UV-Vis spectrophotometry, Thin Layer Chromatography (TLC), Indicator strip, Polymethylmethacrylate (PMMA)

INTRODUCTION

Beauty skin whitening cosmetics is considered important for women's beauty [1]. This is because of an assumption that beauty means having a smooth and white skin [2]. In 2013, Nielsen Indonesia conducted a survey of cosmetic using in Indonesian women, that concluded the women's use of cosmetics in Indonesia has increased [3]. The large market share of the cosmetic product makes some manufacturers produce the product with an addition of hazardous ingredients and without the distribution license. One of the frequently used hazardous ingredients for whitening cosmetics was hydroquinone [4]. Hydroquinone is a substance that can be used as the depigmenting agent [5]. Hydroquinone uses as skin lightening agent through the mechanism of inhibition of the enzyme tyrosine in melanin formation. Hydroquinone competes with tyrosine as a substrate for tyrosinase; then hydroquinone is oxidized by tyrosinase and produce benzoquinone which is toxic to melanocytes [6]. FDA proposes that whitening cosmetics contain hydroquinone should not be available as over the counter (OTC) drugs and should be restricted use with doctor's prescription only. The patient that use hydroquinone product should be monitored by a medical supervisor [4].

The analytical methods for hydroquinone analysis that has been studied were using a visible spectrophotometer, Thin Layer Chromatography (TLC), High-Performance Liquid Chromatography (HPLC) [7-9]. The instrumental analytical method needs a long time for analysis, not simply to do especially in the field, and should be done by trained person. The instrumental analytical method is not practical and not effective to be applied to common people. To facilitate public for detection hydroquinone in whitening cosmetics, this study designed a method for detection hydroquinone in whitening cosmetics using indicator strip that already contain a specific reagent for hydroquinone. Indicator strip is polymer based material. The polymer is selected as a raw material in the manufacture of the indicator strip because the polymer form pores that the specific reagent of hydroquinone can penetrate and enter.

To ensure the quality of indicator strip, it was tested to some whitening cosmetic samples that were marketed in Bandung, West Java, Indonesia. The results were compared with the identification method using an ultraviolet-visible spectrophotometer and TLC).

MATERIALS AND METHODS

Materials

This study used some materials, such as concentrated ammonia (Merck), aqua dest, acetone (CV. Rachmat Putra), Cera alba (Bratacho Chemistry), cera flava (Bratacho Chemistry), ethanol 96% (Bratacho Chemistry), ethyl acetate (Bratacho Chemistry), ferric chloride hexahydrate (Merck), hydroquinone (CV. Dwi Putra Utama), lanoline (CV. Rachmat Putra), sodium carbonate anhydride (Merck), sodium citric (Merck), nipagin (Merck), nipasol (Merck), copper sulfate (Merck), n-hexane (Bratacho Chemistry), silver nitrate (Merck), polymethylmethacrylate (PMMA) (Aldrich Chemistry), spermaceti (Bratacho Chemistry), triethanolamine (Bratacho Chemistry), resorsinol (Merck), and samples whitening cream with or without registration number.

Instruments

The instruments that used for this study were UV254 lamp (Camag UV Betrachter), magnetic stirrer (Cimarec), micropipette (Socorex), oven (Memmert), silica gel 60 F254(Merck), scanning electron microscope-energy dispersive X-ray (SEM-EDX) (Hitachi TM300),