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Design of a Safety Device Ultra Violet Light for Mercury Identification in Whitening Cream with Thin Layer Chromatography Method Using Camera OV7670 Based on Arduino Uno

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ABSTRACT Mercury is also called “air raksa” or hydrargyrum which is a chemical element with the symbol Hg and belongs to the heavy metal group with a liquid form and silvery color. Mercury is a heavy metal that is harmful to the skin when added to cosmetics, especially creams on the face, even in small concentrations because it is toxic. Identification of Mercury in the laboratory using the thin layer chromatography method with the help of ultra violet light causes medical personnel to be vulnerable to exposure to ultra violet rays which have a negative impact on eye and skin health. The purpose of this research is to design a safety to minimize exposure to ultra violet rays when identify mercury. OV76070 which can reduce direct contact with ultra violet light identifies the present of Mercury in the whitening cream will be carried out using a thin layer chromatography separation method with the help ultra violet 254nm-366nm. With the help of ultra violet lamps 254nm-366nm, and it is hoped that Mercury inspection using the OV7670 camera will be more efficient and accurate. The tool used in this research is the OV7670 camera with a power of 640 – 460 pixels (VGA) to take photo on thin layer chromatography plate, ultra violet lamps 254nm- 366nm. Overall the design of this tool is controlled by the Arduino Uno microcontroller. Image from the OV7670 camera can be monitored at the Liquid Crystal Display in the form of the appearance fluorescence spot indicating the presence of Mercury in the whitening cream sample.

INDEX TERMS Mercury, Ultra Violet light, OV7670 camera

I. INTRODUCTION

One of The active ingredients used in whitening creams Mercury. Mercury is also called “air raksa” or hydrargyrum which is a chemical element with the symbol Hg and belongs to the heavy metal group with a liquid form and silvery color [1]. Mercury (Hg) is a ubiquitous environmental pollutant of great concern because of the toxicity of its methylated form (MeHg) and bio accumulative and biomagnifying properties, they are not biodegradable [2]. Mercury (Hg) is considered a global pollutant and may exist in many chemical and physical forms in natural waters [3]. In plant, mercury was seen to be the most inhibitory metal which caused complete inhibition of germination of gram seeds

[2]. Cycle presence mercury at atmosphere like the **FIGURE 1**. Perception encourages most women to engage in skin bleaching. Skin-lightening or bleaching has reached epidemic levels in many nations across the world [4]. One of the most widely used cosmetics for women is whitening cream [5]. Mercury added to cosmetics, especially whitening creams in the form of mercury salt HgNH_2Cl_2 and HgCl_2 that functions as a skin whitening agent because it has the potential as a skin color reducing agent with very strong skin Whitening power (Yu et al., 2018. Mercury ions are thought to be able to inhibit the synthesis of skin pigment melamine in melanocytes cells [6]. Other them function to make the

face more be white, Mercury is also dangerous heavy metal although small concentration can be toxic.

The use of Mercury in whitening creams can cause various things, ranging from changes in skin color which can eventually cause dark spot on the skin, allergies, skin irritation, and use in high doses can cause permanent damage to the brain, kidneys, and impaired fetal development and even long-term-exposure [7]. Short doses and high doses can also cause vomiting, diarrhea and lung damage and are carcinogenic substance in human. A radiation creates free radicals that can also damage the DNA in skin cells increasing the risks for malignancy whereas the vaporized mercury is brought into the human body through respiration cause damage to the central nervous system. [8], [10]. The United States Food and Drug Administration (FDA) has a limit of less than 1 ppm of mercury in skin lightening products [10] (FIGURE 1).

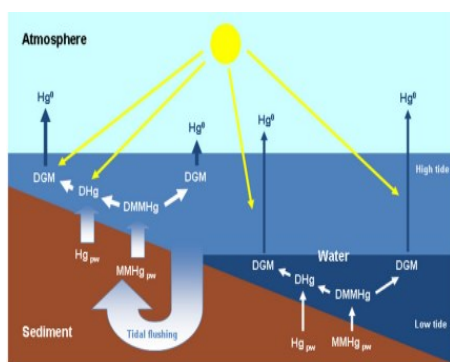


FIGURE 1. Cycle mercury [3]

Water pollution comes from various kinds sources and characteristics different. Increasing water pollution is a global problem. This relates to use of toxic chemicals and synthetic compounds such as the heavy metal mercury. The accumulation of trace metals in environmental archives is controlled by climatic and geochemical processes [11].

Mercury (Hg) is a major global pollutant, is released from the environment via natural and anthropogenic sources. The best method to help prevent the release of mercury into the environment is to keep this product away from landfills and incinerators. If stockpiled, mercury products can end up in groundwater, and have the potential to become a source of drinking water. When burned, mercury can end up in the air. Being susceptible to long range transport, it poses a threat to both human and environmental health.

The Marketing cream cosmetics that not have a batch number and POM number is very crowded so that researchers in particular carry out identification Mercury, which of course the results can provide information to the public so that people are more careful in choosing whitening Cream. One of identifications methods that is often the thin layer chromatography method. Thin layer chromatography method is a chromatographic technique that is useful for separation organic compounds. Thin layer chromatography is a simple, cost relative more cheap and easy to operate

planar chromatograph technique that have been used an general chemistry laboratories to routinely separate chemical and biochemical [6].

Research to identify mercury in whitening cream in the laboratory using UV spectrophotometry or atomic absorption spectroscopy (AAS) requires a long process, reagents, and expensive equipment [12][13]. A simpler research is to use the thin layer chromatography method with the help of an ultraviolet light lamp.

Chromatography is a technique used for separating the solutes or components present in a mixture [14]. Thin layer chromatography is performed using a piece of glass, metal or rigid plastic coated with a thin layer of silica gel or alumina. Silica gel or alumina is the stationary phase. The stationary phase for thin layer chromatography also often contains substances that fluoresce in UV light. Silica gel is an active adsorbent due to the presence of Si-OH groups on the surface. The size of silica gel particles has an average diameter in the range of 5 – 10 micrometers [15].

The mixture of compounds to be separated or the sample to be tested is called the component or mobile phase. The sample in the form of a solution that is spot-spotted on the TLC plate using a capillary tube. The plate that has been given sample and reference spots is then stored in a tank containing the solvent (eluent) or mobile phase which will move on the TLC surface. For the mercury test, the eluent CH₃COOH : toluene (2:8) was used. The thin layer chromatography plate was inserted into the chamber containing the solvent and then allowed to stand until the upper boundary line [16]. On the thin layer chromatography plate, colored lines will appear. It is these lines that will calculate the R_f. After being dried and irradiated with a UV lamp of 254 and 366 nm, the R_f value was calculated and then analyzed.

The difficulty that is usually found by laboratories or researchers in the laboratory is reading the color after the sample is spotted on thin layer chromatography plate, so ultraviolet light to is needed to see the color spots on the thin layer chromatography plate. After the sample was allowed to settle to the upper limit, the thin layer chromatography was dried and irradiated with ultraviolet lamps at 254 nm and 366 nm [17].

Identification of Mercury in the laboratory using the thin layer chromatography method with the help ultraviolet light causes medical personnel to be vulnerable to exposure to ultraviolet rays which adversely affect the health of the eyes and skin. Safety procedure from chemical, physical and rays exposure for researchers should use in order to prevent and limit the health hazards in laboratory [18]. In addition to the benefits for humans, namely to synthesize vitamin D and also function to kill bacteria, ultraviolet rays also have a negative impact on health. The negative impact caused by prolonged exposure to ultraviolet light is redness of the skin, burning skin, which can lead to skin cancer (Isfardiyana & Safitri, 2014). The next explained, ultra violet rays can be classified into ultra violet A with wavelength between 315nm-400nm, ultra violet B with a wavelength between

290nm- 315nm, ultra violet C with wavelenght of 100nm-290nm [19]. All ultra violet A rays are emmited to the earth, while some ultra violet B rays are emitted are to the earth (especially those whose wavelenght are close to ultra violet A). Ultra violet B rays with shorter wavelenght and ultra violet C rays cannot be emitted to the earth because they are absorbed by the ozone layer in the eart's atmosphere. UV-C light is used for irradiation germicidal. Germicidal effectiveness of UV-C peaks at about 260nm corresponds to the peak of UV absorption by bacterial DNA [17]. Difference wafelength UV A, UV B, and UV C in human skin as follow

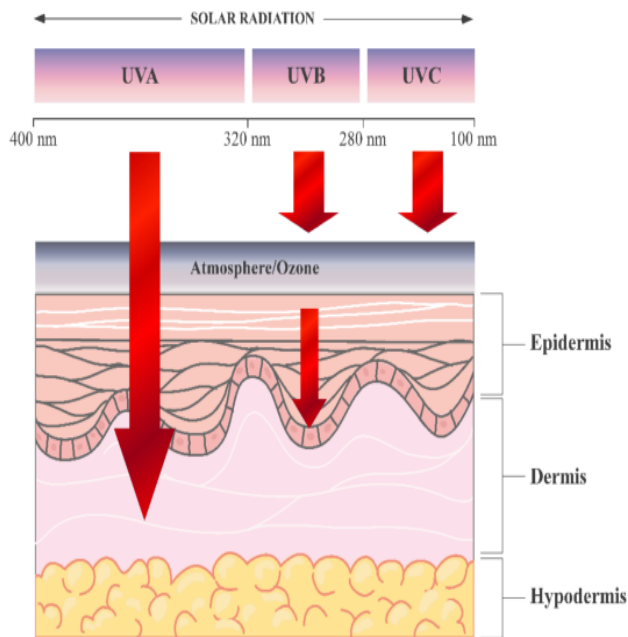


FIGURE 2. Wafelength UV A, UV B, and UV C in human skin [20]

In the would healthy UVA1 (340-400 nm) radiation used in phototherapy is effective in clearing or controlling a variety of skin diseases like atopic dermatitis, scleroderma, cutaneous T-cell lymphoma, urticariapigmentosa, lupus erythematosus, extragenital lichen scleroses [19] (FIGURE 2).

The purpose of this research is to disgn a safety to minimize exposure to ultra violet rays when identify mercury. OV7670 camera is CMOS sensor producing wide range of formats through Seriel Camera Control BUS with Thin Layer Cromatographi medical personnel in the laboratory. The results shown on the LCD are qualitative to identify the presence of mercury content in whitening creams. The Dvice are simpler, cheaper and safer to use.

II. METHODOLOGY

In the research was designed a laboratory tool in the form of camera mounted on a box which function to take picture oN thin layer chromatography. Results the image obtained from the results of the OV7670 camera were examined to identify

the presence of Mercury in the cream with the help of ultra violet light which was monitored to the Liquid Cristal Display so that medical personal or laboratory workers would not be exposed ultra violet rays that harmful to eyes and skin. This research combines two disciplines, electrical and chemical engineering, which are used in medical laboratories. The materials used as samples in this study were five types of cosmetics in the form of whitening creams sold in the market. There are five types of whitening cream used as samples, namely cream A, B, C, D, and cream E. The cream sample is spotted on the TLC plate Thin Layer Chromatography than put into the acrylic cabinet box. After that, the UV lamp and camera are turned on, it appears that there is fluorescence on the LCD if the whitening cream contains mercury. If the whitening cream contains a lot of mercury, the more fluorescence spots will appear on the LCD the materials for designing the device are (FIGURE 3):

1) MICROCONTROLLER ARDUINO UNO

Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more simple and accessible [17],[18] explain more that Arduino Uno is a microcontroller board based on the ATmega328P. The ATmega microcontroller can execute up to 16 million instructions per second [23]. ATMEGA328P has 32 KB of flash memory for code storage, 2 KB of SRAM and 1 KB of EEPROM [24]. Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. AT mega firmware microcode developed at Arduino IDE [25]. Arduino IDE is a cross-platform Java application that serves as a code edit.or and compiler and is also capable of transferring firmware serially to the board [26].

2) ULTRA VIOLET LIGHT

Ultra violet radiation is electromagnetic with respect to wavelengths shorter than visible light, but longer than small X-ray, that has range of wavelengths between 100nm - 400nm, where at this wavelength has an impact to human health, [27]. Traditional ultra violet lamps emit less heat which can cause problems and are replaced UV light emitting diode (LED) more efficient [28]. Ultra violet light emitting diode (UV LED) comprising short and long wavelength UV 310nm, 340nm, and 365nm [[29]. This research use light ultra violet LED 254 nm and 366nm.

3) OV7670 CAMERA

The OV7670 camera is an electronic component that can be applied to image imaging or image processing to obtain an image of an object which is then refracted through the lens to the CCD sensor or using a CMOS sensor. It has inbuilt digital signal processor, analog signal processor, analog to digital converter, image scale [30]. OV7670 camera is

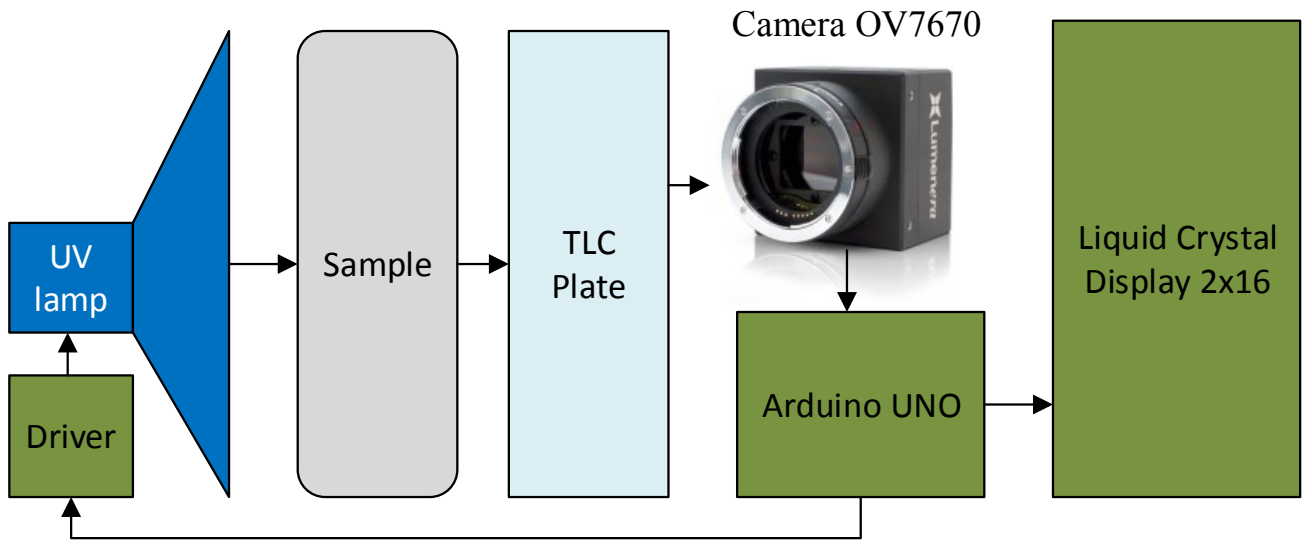


FIGURE 3. The design of a safety device ultra violet light for mercury identification in whitening cream with thin layer chromatography method using camera ov7670 based on Arduino uno.

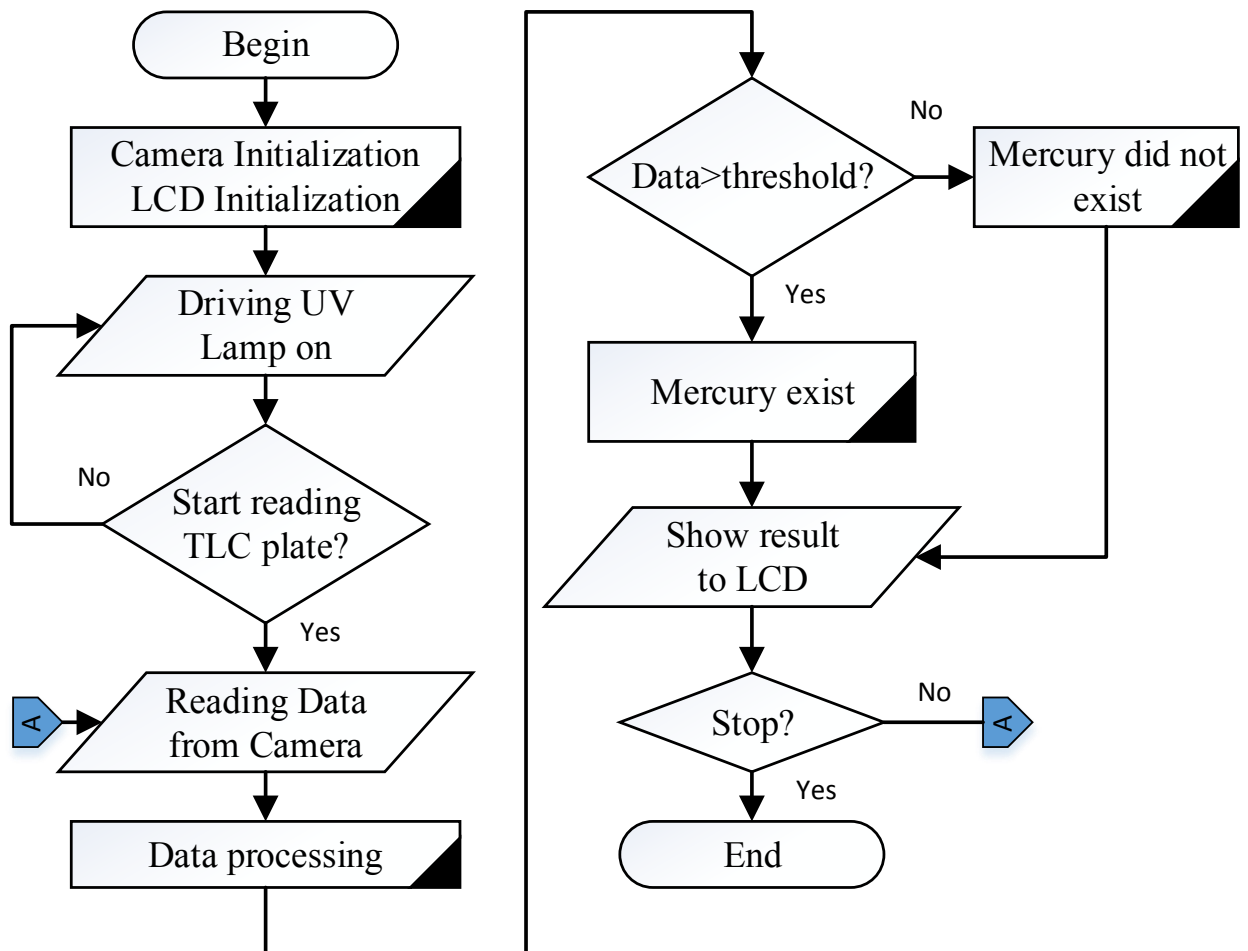


FIGURE 4. Mercury identification in whitening cream with thin layer chromatography method using camera ov7670 based on Arduino uno

CMOS sensor producing wide range of format through Serial Camera Control Bus (SCCB). Image control features like color saturation, gamma, sharpness are present. Some features like noise reduction and defect correction are present. The sensor has an image array of 656 x 488 pixels of which 640 x 480 are active giving about 0.3MP [31]. OV7670 module is an IC chip having 16 pins. They are: Vcc (3.3v supply), ground(GND), b. Serial interface clock and data I/O (SCL and SDA), c. Vsync (active frame), Href(active pixels), PCLK(pixel clock from module), XCLK(master clock into module), and Digital output pins(D7-D0) [30]. Camera chip sensor with Omni Pixel technology Input Voltage: 3.3V DC operating temperature range: 0 to 50 degrees Celsius All glass lenses and lenses (including the seat) are made of Magnesium Alloy[32]. Camera OV7670 send data in parallel synchronous. To get data from module camera, pin XCLK at the module have to be given enter the clock between 10 - 48 MH. The OV7670 camera is an electronic component that can be applied to image imaging or image processing to obtain an image of an object which is then refracted through the lens to the CCD sensor or using a CMOS sensor. It has inbuilt digital signal processor, analog signal processor, analog to digital converter, image scale. Digital image processing technology produce increase the speed of image by using OV7670 sensor like research result [33] [34].

4) LIQUID CRYSTAL DISPLAY

In this research Liquid Crystal Display using technology Liquid Crystal Display Thin Film Transistor technology to improve image quality such as resolution and contrast with specification 128 pixel–160 pixel, to provide best resolution fluorescence spot like the research has been done [34], this research used the Arduino IDE (Integrated Development Environment) for programming of Arduino. Arduino is a controller system in the module. These materials are arranged in an acrylic cabinet box. LCD installed outside the box so that it can monitor OV7670 camera readings that. The device design is shown as block diagram as shown in FIGURE 3. The description of the FIGURE 3 is as follow; 220 V AC is a voltage source, PS is power supply, converts AC to DC at once voltage supply to all existing components, TLC (Thin Layer Chromatography) Sample plat, Camera to monitor TLC, Arduino uno as a microcontroller on the tool, ON/OFF is a button to turn the tool on and off, Driver as an automatic switch, UV lamp : to illuminate the TLC plat.

From 220 Volt AC into power supply to supply voltage to the entire circuit, Arduino Uno as a microcontroller to run a tool, then the on/off button to turn device on and off, then the TFT LCD to display the result received by the microcontroller from the camera than the driver here as automatic switch to activate and turn off the ultra violet lamp, than a ultra violet to illuminate the Thin Layer plat so that the paper is visible, then the camera as a device to record objects on the thin layer chromatography, and the thin layer chromatography as a place to store cream. The design of work procedure device such flow chart like FIGURE 4. The components used are Arduino uno, power supply. OV7670

camera, TFT LCD, jamming cable, ON/OFF button, UV lamp, driver module then this device can be programmed. The program is as follows:

The next step, make a connection the OV7670 camera and TFT LCD to the Arduino uno and attach the USB cable to the laptop. Programs can be uploaded to Arduino uno so that the TFT LCD and the OV7670 camera can be read.

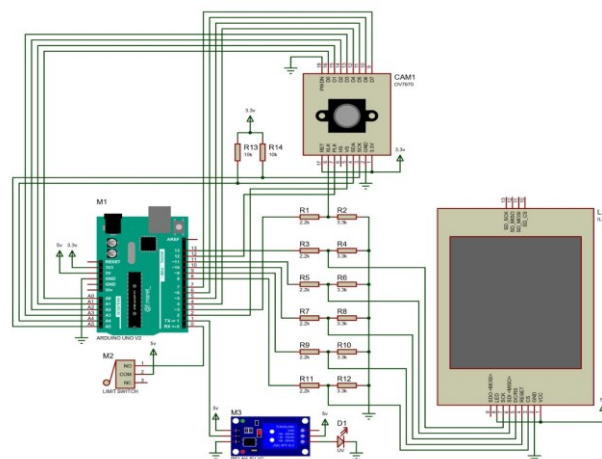


FIGURE 5. The main circuit which consist of Arduino UNO, LCD character, camera sensor, and several passive component.

Microcontroller circuit, driver circuit, ultra violet circuit, and Liquid Cristal Display circuit when combined (FIGURE 5). The above circuit consists of several circuit blocks which are important parts for the device consisting of a microcontroller circuit, OV7670 camera circuit, TFT LCD. circuit, UV circuit, driver circuit and limit switch circuit.



FIGURE 6. The proposed design Safety Device Ultra Violet Light for Mercury Identification in whitening cream with thin layer chromatography method using camera OV7670 based on Arduino Uno

III. RESULT

After the device are installed, they are arranged in a box, then prepare the five samples and spotted them on the TLC plate. Picture of the proposed design is shown in FIGURE 6. The measuring and testing can be described as follows. This equipment works at room temperature in a chemical laboratory. First of all prepare a simple whitening cream that

has been placed on a layered Thin Layer Chromatography plate then put the Thin Layer Chromatography plate into the drawer. After that the device is connected to a 220 V AC voltage source. Then turn on the ultra violet lamp by pressing the ON button. The Thin Film Transistor display lights up, the camera activates, and the ultra violet light activates. If at the time the monitoring process is complete, the tool is turned off monitoring OV7670 camera at the Liquid Crystal Display fluorescence spot of Mercury in the whitening cream sample (FIGURE 7).



FIGURE 7. Fluorescence spot of mercury

Alternately the five samples were examined and the results were as TABLE 1.

III. RESULT

The results of this study are safe tools to use in thin layer chromatography using ultra violet light to identify the presence of mercury in whitening cream. The design only identification mercury has not been able to identify the concentration of mercury content in whitening creams so no numbers can be displayed.

TABLE 1.
Result mercury fluorescence

No	Type	Parameter	Result
1.	Cream A	Hg	Fluorescence
2.	Cream B	Hg	Not fluorescence
3.	Cream C	Hg	Fluorescence
4.	Cream D	Hg	Fluorescence
5.	Cream E	Hg	Many fluorescence

After monitoring based on mercury fluorescence displayed on the LCD, there were whitening creams that were free of mercury, four creams containing mercury and one whitening cream that contained a lot of mercury.

Fluorescence digital image processing technology using the OV7670 camera like this is able to identify mercury. However, sometimes the picture is blurry. If this tool is used as a safety device, then this tool can protect laboratory personnel or researchers from exposure to ultra violet light in the process of separation and identification of substance components in general using the thin layer chromatography method which requires the assistance of ultra violet light.

Compared to research on mercury identification using the atomic absorption spectroscopy method which can determine the concentration of mercury in whitening creams,

The observation result from 3 traditional markets in Palu demonstrated highest sale percentage of whitening cream owned by A (SP) equal to 77.77 % followed by B (UB Ginseng) 61.11 % and C (SJ) 50 %. They need to be analyzed through Atomic Absorption Spectroscopy (AAS) method [12]. Another research using Atomic Absorption Spectroscopy (AAS) method, content of skin toning creams and cosmetic soaps, the mean concentration of total mercury in skin toning creams and cosmetic soaps were 0.098 ± 0.082 and 0.152 ± 0.126 $\mu\text{g/g}$, respectively [4] This method has the disadvantage that it can only identify the presence of mercury, but cannot identify the concentration of mercury. Another drawback is that substances that can glow other than mercury will also appear on the display on the LCD. This device can be expanded to obtain sharp fluorescence images by adding a special mercury sensor. This device can also be developed to function like atomic absorption spectroscopy so that it can produce a device that is simple, inexpensive compared to spectroscopy which can determine the concentration of substances that can fluoresce, not just mercury.

As a safety against exposure to ultra violet light in the separation and identification of substance components by the thin layer chromatography method, the OV7670 camera is also very helpful for laboratory personnel to see the movement of the color spots of the substances to be identified. This device can be developed by measuring the length of the movement of the color spot components of the substance. Thus device can be used laboratory personnel in the laboratory for identification component with TLC method use Ultra violet lamp.

V. CONCLUSION

The purpose of this research is to design a safety to minimize exposure to ultra violet rays when identify mercury. The design of the device can identify mercury in whitening cream by the presence fluorescence on LCD. In general, this tool can be used as a safety device to identify other substances that must use ultra violet light to clarify colors on the movement of color dots on the separation of components of substances using thin layer chromatography methods. Researchers or laboratory assistants are protected from exposure to ultra violet light. The design of this device is relatively cheaper and simpler as well as time efficient. Future researchers can add mercury sensors so that the image recorder on the OV7670 are sharper. The researches can add another components to calculate the concentration of mercury in the sample whitening cream

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