Al-Muthanna J. For Agric Sci Print ISSN: 2226-4086 Online ISSN:2572-5149
Vol. 12 , Issue 2. 2025

https://muthjas.mu.edu.iq/ http://doi.org/10.52113/mjas04/12.2/26

MART : The Cheapest High-Quality Modified Transilluminator

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Abstract

Background: In molecular biology labooratories, UV transilluminators are employed to observe the separated DNA or RNA by using the agarose gel electrophoresis. The stained gel was exposed to a UV light source, lead to make the DNA fluoresces and visible. The high sensitivity of Fluorescent stains can be actively used in research labooratories to facilitates the quantification of small DNA quantities as bands in agarose gels. This principle is essentially used to make the DNA fragments visible in a transilluminator, which utilized to excite the fluorescent molecules.Statement of the research: designing and producing MART: the high quality cheapest modified Transilluminator ,Objective of the study:To produce a modified machine that can be used as a transilluminator and modification from an expensive device to a device that can be worked on.Methodology: The project starts with searching for the tools or equipment that we need or that are available at the lowest cost began, and that start took place on 11/17/2023. The electrical appliances were sold from the local suppliers, hoping to find things that would benefit us. We searched a lot and in several places and stores, and after

continuous searching for 20 days, we found part What do we need or can be useful to us at work? The first thing is a transformer or battery that we use to operate the light The other thing is an electric button to turn the light on and off. Conclusion: After conducting many experiments on the device, we concluded that the possibility of using our modified equipment as a UV-transilluminator device for DNA visualization.

Keywords: modified Transilluminator ; DNA; **MART**.

Introduction

1.1. General background:

In molecular biology laboratories, UV-transilluminators serve the purpose of visualizing DNA (or RNA) that has been segregated via electrophoresis in an agarose gel. The gel is treated with a fluorescent dye that attaches to nucleic acids either during or right after the electrophoresis process. When illuminated with UVB light, the combination of the dye and DNA emits fluorescence, making the sample visible. Researchers employ this method for various tasks such as measuring PCR products, isolating DNA fragments following enzyme digestion, assessing DNA quantity, or checking the integrity of extracted RNA .

The provided Instructible guide details the construction of a UVB (310nm) transilluminator featuring a viewing window measuring 7 x 7 cm, suitable for observing DNA mini-gels stained with ethidium bromide or SYBR-Safe. Gathering all necessary components, the assembly can be completed within approximately 1-2 hours, with some soldering involved. Despite low-cost DIY UV transilluminators, there is limited quantitative evaluation of their performance and safety. This study quantitatively evaluates a modified design using optical and biological indicators. This study aimed to modify the enclosure geometry and UV shielding efficiency of the MART device, based on an open-source UV transilluminator; these modifications were quantitatively evaluated.

1.2. Safety Considerations:

Due to the hazardous nature of ethidium bromide and its stringent safety requirements, its use is advised only in labs with proper protocols for handling, storage, and disposal. It is highly recommended for others to opt for SYBR-Safe, which is safer to manage and discard.

A protective lid is provided with the transilluminator for safe gel observation. Nevertheless, when the lid is not engaged, it is imperative to wear protective eyewear while operating the UVB light.

For those who wish to steer clear of UVB exposure, alternatives like blue light LED transilluminators, similar to the one mentioned in this guide, are suggested. The cost of a UV transilluminator is about two thousands dolars from Thermofisher.

1.3Aims:

This project aims to produce a cheap UV transilluminator in the Microbiology laboratory of Veterinary Medicine College as the laboratory has no transilluminator to visualize PCR products and the cost of this machine is out of the college financial ability.

1.4.Materials:

UV light

Electrical transformer

Electrical cable

Darkened glass box

Transparent glass Lid

Upon assembling the components of MART, a glass enclosure was crafted. This enclosure is constructed to block any stray light as it travels upward through a clear top. The enclosure's measurements are 30cm in length, 14cm in width, and 10cm in height.

2.1.Methods:

The transilluminator of PCR is used to visualize PCR products either DNA or RNA. The idea of our research is to produce a modified machine that can be used as a transilluminator. The new modified machine is not an expensive device. into a device that can be worked on and we have researched and read all the information related to it after looking at the device it was difficult for the researchers and our doctor that our research be distinguished and carry the essence of the idea and it is a modification from an expensive device to a device that can be worked on

The discussion was made on whether the new modified machine can save the cost of buying a new transilluminator. In addition, the suggested modification has to give at least the same expected results of bought transilluminator. The plan was recorded and the design was designed after a lot of thinking. The ideas also included avoiding the use of any hazardous materials that cause any impairment to the environment. Finally, the last design was put and named as MART which is the abbreviation of the team; Mohenned, Asmaa, and Russel in addition to Transilluminator which was abbreviated as T.

As with any modified work, our designing tools faced difficulties that obligated the researchers to do other modifications. Our team tries to use different sources to do the exact design. After well understanding the idea, Authors found the needed parts of MART that are available at the lowest cost

began on 17/11/2023. The electrical appliances were sold in the local market of Samawah which needs about 20 days of search. Ultimately, the main parts of MART were collected.

The main parts of the UV transilluminator (MART) were bought from of acrylic materials supplier in Samawah market.

2.2 .**Hardware**

Table 1: Electrical appliences

Image	Item Name	Manufacturer
1	BLB UV Fluorescent Tube (Blacklight Blue)	Chinese OEM (Shenzhen UV-Tech, Foshan factories)
2	Rocker Switch	**Songle / XKB / Delixi** (Chinese manufacturers)
3	Polyester Film Capacitors	Shenzhen Yongxing Lighting Electronics Co., Ltd

2.3.

Tools

Philips screwdriver, Soldering iron and solder Wire clippers.

2.4. Image Notes

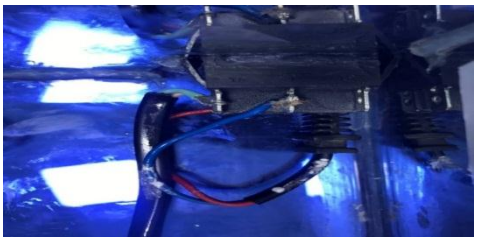
1. 7 x 7 cm U325C transilluminator glass.

2. 312nm Ushio 9W GPX9E UV bulb.

Step 1: Connect AC power to ballast:

Firstly, the power entry was inserted and switched into the laser-cut back section, then fastened using the two 1/2" long 5-40 machine screws. After that, the neutral and live wires were attached to the ballast as depicted in the images. Finally, the neutral and live wires were soldered to the plug connector as illustrated in the images.

A



B

Figure 1: The electrical parts of MART. A: the Polyester Film Capacitors, B: the switch

Step 2: Assemble the enclosure

One of the 1" long 8-32 machine screws was inserted through a rubber foot and a corner hole on the bottom part of the enclosure. On the opposite side, one of the 2.5" long 8-32 standoffs was attached. This process was repeated for all four corners of the enclosure's base. Then, the ballast was positioned in the center of the enclosure and secure it with two 1/4" long 8-32 screws. Ensure the ballast is aligned as depicted in the images. Ultimately, the UVB bulb was inserted into the ballast and fit the remaining enclosure components into the slots on the enclosure's base.

A B

Figure 2: The final view of MART. A: UV lumb B: Electrical switch

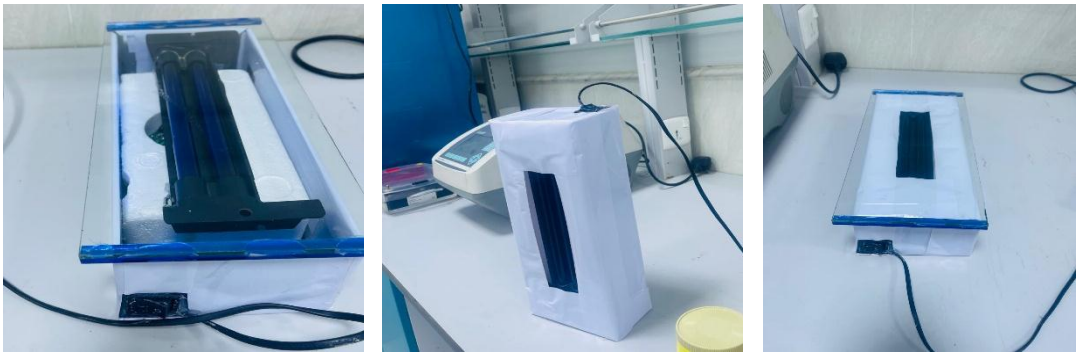
Step 3: Assemble the cover

The upper portion of the transilluminator is equipped with a glass panel that is protected by a solacryl UV-transmissive cover. Firstly, the lower lid on top was placwd, making sure it fits securely over

the tabs located on the sides of the enclosure. Next, the upper lid was positioned on top of the lower lid. The transilluminator glass was slided into the slot provided on the upper lid. The enclosure was covered with the UV-transmissive protective plate. All three top layers and the transilluminator glass were secured by fastening the four 1/2" long 8-32 machine screws into each corner.

Step 4: Assemble the hinged safety lid

In the final assembly steps, a hinged safety lid was added. The top part of the lid is 1/8" clear acrylic which was blocked UV light. (Note: safety glasses were used if the transilluminator was operated at any time without the lid.). Then, the Weld-On acrylic glue and applicator were used, the 1/4" acrylic sides were welded onto the 1/8" base. After that, the two hinges were attached to the lid using four of the 3/16" long 8-32 machine screws. The hinged lid was attached to the top of the enclosure as shown in figure 3 by using the remaining four 1/8" 8-32 machine screws.



A B C

Figure 3: MART after gel preparation

Step 5:

Viewing a gel

The prepared gel was placed onto the transilluminator above the viewing glasses. The hinged safety lid was put down, and switched on the transilluminator. When MART was switched on, DNA bands were seen. The device is protected from UV radiation by foam insulation on the lamp's sides and a protective glass panel on the top.

Results

3.1 Comparing this modified transluminator with the commercial transluminator

UV irradiance for MART was measured with a handheld UV radiometer; for the Bio-Rad system, values were sourced from manufacturer specifications and documentation (Table 2).

Table 2: Comparison between MART and a commercial UV transilluminator

Device	Wavelength (nm)	UV Irradiance (μW/cm²)	Approximate Cost (USD)
MART	312 (UV-B)	~850 ± 120 (measured at gel surface)	~50–70
Bio-Rad UV Transilluminator	302 (UV-B)	~2000–3000 (manufacturer-reported)	~2,000–3,000

The absence of quantitative measurements for electrical input voltage and UV irradiance is a limitation of this device characterization.

Table 3. Electrical and optical parameters of the MART device (as reported in this study)

Parameter	Value
Input voltage	AC mains supply (voltage not specified)
Lamp power	9 W (Ushio 312 nm UV lamp)

3.1.

Viewing a gel

The prepared gel received placement on the transilluminator which exposed the viewing window. The safety lid sealed shut while the transilluminator started its operation. The DNA bands started to show themselves at this stage (Figure 4).

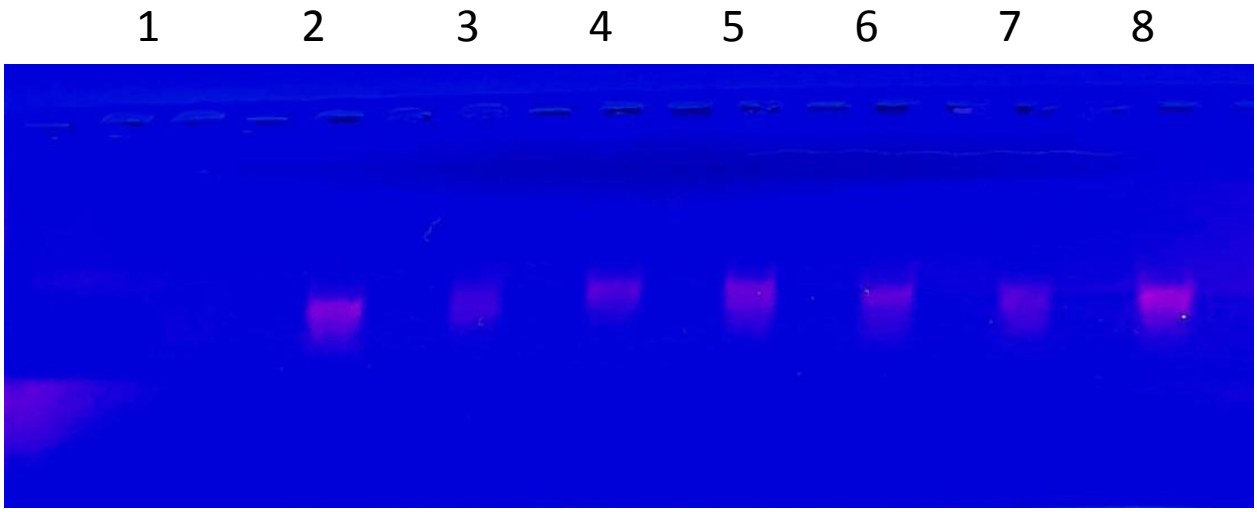


Figure 4: Analyse of PCR products using gel electrophoresis and viewing the bands using MART. Different DNA samples of PCR products. Lane 1 is the negative control.

Safety Risk Assessment and Conditions of Use

Safety Risk Matrix

A qualitative risk assessment was conducted using the device configuration and study data. No direct UV leakage measurements or certified safety tests were performed; the following matrix is a conservative, precautionary evaluation.

Table 4: Safety Risk Matrix

Hazard	Potential Risk	Likelihood	Severity	Risk Level	Mitigation Measures
UVB radiation exposure	Eye and skin damage	Medium	High	High	Mandatory use of hinged safety lid; protective UV eyewear; restricted operation time
Electrical shock	Injury due to exposed wiring or faulty insulation	Low–Medium	High	Medium	Proper insulation of electrical components; use of grounded AC supply;

					periodic inspection
Heat generation	Minor burns or material degradation	Low	Medium	Low	Adequate ventilation; limited continuous operation time
Chemical exposure (dyes)	Contact with fluorescent stains	Low	Medium	Low	Use of safer dyes (e.g., SYBR Safe); gloves and standard laboratory PPE
Improper use by students	Accidental exposure or misuse	Medium	High	High	Supervised use only; clear operating instructions; restricted access

4.1. **Conclusions:**

The research results showed that DNA extraction from agarose gels using UV light depends on the specific wavelength of UV light that is used. The combination of UV B light exposure that lasted more than one minute resulted in lower cloning efficiency and fewer chloramphenicol-resistant colonies because gene mutations caused damage to the cat gene function. The exposure of nucleic acids to UV A light did not cause any damage during two-minute sessions. The use of UV A transilluminators becomes more suitable for preparative DNA work than UV B transilluminators when working with multiple samples that need extended UV exposure. The Multiband transilluminators function as analytical imaging tools because they allow users to select wavelengths through their preparative and analytical imaging capabilities. The Super-Bright-Multiband transilluminator ECP-26.LMX from VilberLourmat provides Multiband technology for preparative work and Super-Bright technology for enhanced analytical imaging performance. The device supports multiple fluorescent dyes including SYBRTM and SYBR Green I which binds between DNA base pairs in double-stranded DNA for quantitative PCR DNA amplification assessment.

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