Using Mobile– iPhone as New Visible Colour Detector for Determination of Pharmaceutical (Potassium Permanganate)

**Mustafa Abdulkadhim Hussein[1*], Lamia Abdultef Risan Al-Iessa[1],
Mohauman Mohammed Majeed Alrufaie[1] and K. H. Al–Sowdani[2]**

[1]*Department of Chemistry, Faculty of Science, University of Kufa, Iraq.*
[2]*Department of Chemistry, Education College for Pure Sciences, University of Basrah, Iraq.*

Authors' contributions

*This work was carried out in collaboration among all authors. All authors read and approved the final
manuscript.*

Original Research Article

ABSTRACT

In this work the use of a mobile phone as a spectrophotometer using camera resolution by installing the software (application store AAP) on the phone (i Phone 6), which analyzes the colour images (RGB) in results with a colour length where it was possible to calculate the colour value of each image representing a specific concentration of the solution under study. A calibration curve with a range of (1×10^{-3} - 6.25×10^{-4}) mmole.L-1 using optical image analysis with the concentration of the preparation of potassium permanganate ($KMnO_4$). A calibration curve for statistical correlation range of 0.993 (R^2) was found.

_____

Corresponding author: E-mail: mustafa.rabeea@uokufa.edu.iq;

1. INTRODUCTION

In recent years, there is an increasing attention in developing portable, low-cost optical spectroscopic devices and combine them with mobile phones to leverage the simplicity of accessing and processing data using mobile computing technology [1]. Add to more applications that take advantage of the digital cameras in mobile devices became important parts of scientific work and daily life [2]. Some researchers have recently used a mobile phone to determined mercury based on accurate image analysis [3]. Mobile phone taking the widest range of uses for health care for both adults and children in the field of running, falling and pulse and advising patients with signs of contraindications called e-health [4]. Must be of low-cost materials that are readily available and preferably readable, as is a glucose test [5]. Mobile phones have been applied to driving safety in vehicles equipped with mobile phone sensors to record or test driving data in the event of potential accidents, and have also been used to predict and estimate highway traffic status and cars location information [6]. Researchers have developed a method for both doctors and parents to detect and monitor middle ear fluid in children who have only a smartphone and a piece of paper [7]. Individual color outputs (RGB) were used for smartphones to distinguish chlorine contamination by the interaction of this contaminant with a colored chemical resulting in a change in coloring, it was captured by a smartphone that can be applied to effluent contaminated. Colorist was also estimated using a smartphone in bio metric analysis, as well as in the diagnosis of flame emissions and food characterization [8].

2. MATERIALS AND METHODS

2.1 Chemicals and Reagents

All chemicals used were of analytical grade reagents. Deionized water was used, with conductivity less than 0.2 µS and all measurements were done at 25°C throughout this work. A stock solution of KMnO4 (BDH, 0.01 mmol.L^{-1}) [9]. A range of concentrations (1×10^{-3} - 6.25×10^{-4}) mmol.L^{-1} was prepared for the study and using distilled water Fig. 1.

2.2 Instruments

UV-Vis spectra were recorded on a Espectrofotómetro modelo Spectrumlab 1200RS UV-Visible Spectrophotometer, Mobile phone (iPhone 6) installed App Store (P1, P2).

2.3 Procedure

The anonymous concentration of the sample was measured in two ways.

- Classical method

Using the spectrometer (Spectrum lab 1200RS) by making a calibration curve between the absorbance and concentration at a higher wavelength (620) nm and by reading the absorption of the unknown concentration and applying it to the straight line of the calibration curve we get the concentration [10].

Fig. 1. Prepared concentrations

• The new method

Using the mobile phone (i Phone 6) through the use of two programs App Store (P1, P2) after taking a picture for each concentration prepared by the mobile camera pixels and processed graphically and then draw the calibration curve between the values of color lengths Fig. 1 of the images processed graphically. We then focus on the anonymous focus the same steps above and determine the resulting color length and apply it to the linear calibration curve.

3. RESULTS AND DISCUSSION

The results were validated using a linear calibration curve and conforming to Bear's law.

From the observation of correlation coefficient (R^2), good and statistically acceptable results were obtained [11]. The calibration curve for the classical method was that the correlation coefficient value (0.9997). Fig. 2 shows the calibration curve for a set of concentrations (1 x 10^{-3} - 6.25 x 10^{-4}) mmol.L-1 with absorbance. An unknown sample (3.6 × 10^{-3}) was measured under the same practical conditions and it was found that the absorption was about (0.545) when applied with the titration curve the concentration value was (3.68 × 10 -3 mmol.L^{-1}. The new method (Mobile) was used by taking a color image [12] for a set of concentrations, prepared in the classic method above, setting each concentration of permanganate versus an image and using two App Store programs (P1, P2) for color analysis (RGB) Fig. 3.
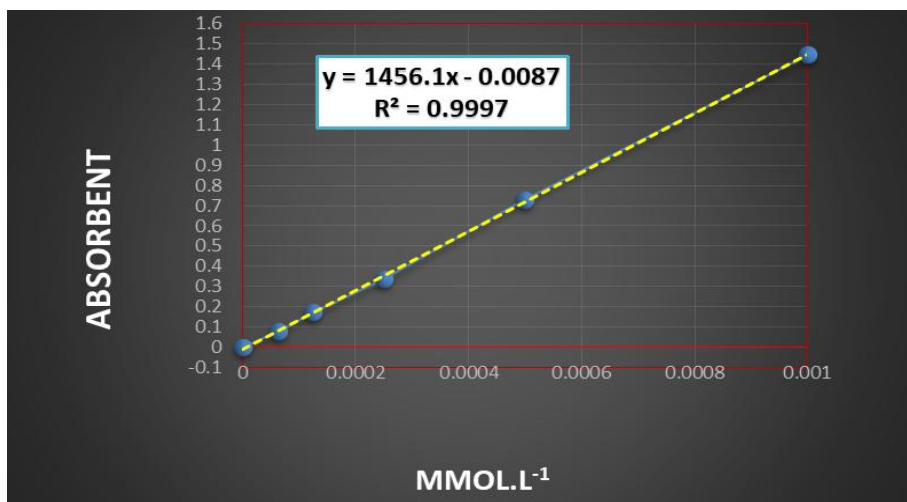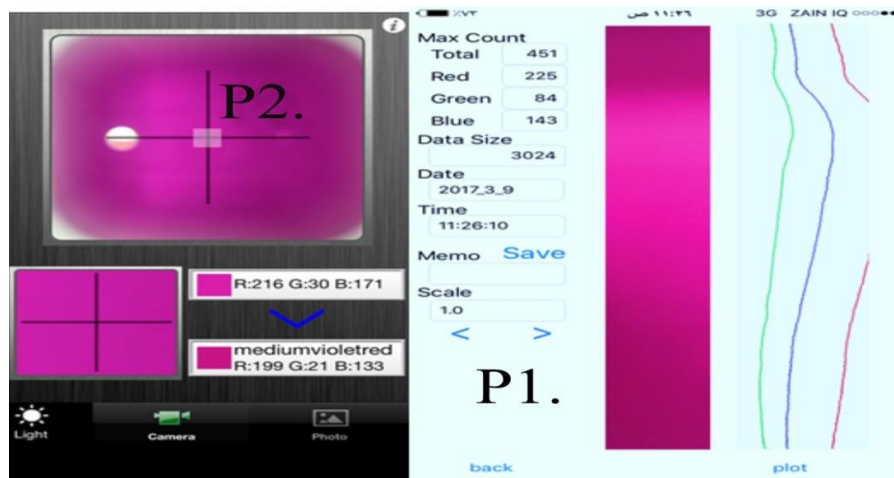

Fig. 2. Calibration curve KMnO4

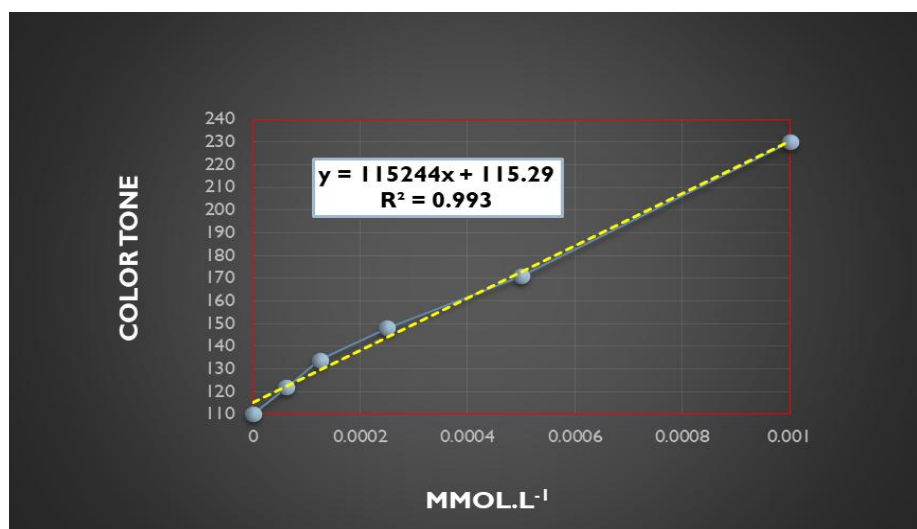**Fig. 3. Graphically processed by(p1,p2)mobile programs**

Fig. 4. Calibration curve using color tone for KMnO$_4$ concentrations

Table 1. Measurement results using both methods

Method	Unknown preparation mmol.L^{-1}	Average 3 measure of the unknown concentration	Absorption / *Color tone in the image	Relative error
Classic	3.6 × 10^{-3}	3.68 × 10^{-3}	0.545	2.22%
Mobile	3.6 × 10^{-3}	3.75 × 10^{-3}	159.5*	4.16%

The calibration curve was drawn between the image color and the concentration of the prepared solution, the linearity of the application of Beer's law was good with a correlation coefficient value (0.993) Fig. 4. A sample of (3.6 x 10^{-3}) mmol.L^{-1} was prepared to represent the unknown sample and analyzed using the software(P1,P2) after taking a picture [13]. It was noted that the unknown concentration is (3.75 × 10^{-3}) mmol.L^{-1}after applying the color value of the image (159.5) on the calibration curve.

4. CONCLUSION

The relative error of the specified representative samples (unknown concentration) and the calibration curve of both methods were studied. It was concluded that standard chemicals within the visible region can be estimated by the mobile phone method (Table 1) [14]. A slight difference was observed between the sample concentration that was prepared and measured by the mobile phone method due to factors that can be overcome in the future, such as the color intensity and accuracy in the camera and the use of the App Store software for free and can be linked to more accurate techniques [15].

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1.   Perry E, Chenji Z, Baigang Z, Xiangqian H, Vivek KN, Bing Y, Zhiwen L. Smartphone

based optical spectrometer for diffusive reflectance spectroscopic measurement of hemoglobin. Scientific Reports. 2017;7: 12224.
DOI: 10.1038/s41598-017-12482-5

2. Jie C, Fuhong C, Rongxiao He, Sailing H. Experimental demonstration of remote and compact imaging spectrometer based on mobile devices. Sensors. 2018;18: 1989.
DOI: 10.3390/s18071989

3. Lutfi FM, Angga A, Nessi M, Marti H, Rina E, Lena R, Renat K. Smartphone coupled with a paper-based colorimetric device for sensitive and portable mercury ion sensing. Chemosensors. 2019;7:25.
DOI: 10.3390/chemosensors7020025

4. Ahsan S, Kiseon K. FallDroid: An automated smart-phone-based fall detection system using multiple kernel learning. IEEE Transactions on Industrial Informatics. 2019;15(1):35–44.

5. Anuradha S, Sandeep K. Jha. A paper strip based non-invasive glucose biosensor for salivary analysis. Biosensors and Bioelectronics. 2015;67:763–768.

6. Wei Z, Jiateng Y, Xiaohan W, Jia H, Bozhao Q, Troy R. Real-time vehicle motion detection and motion altering for connected vehicle: Algorithm design and practical applications. Sensors. 2019;19: 4108.
DOI: 10.3390/s19194108

7. Jennifer A. Smartphone-based detection of middle ear fluid. JAMA. 2019;322(2):107.
DOI: 10.1001/jama.2019.9395

8. Andrew J. S. McGonigle, Thomas C. Wilkes, Tom DP, Jon RW, Joseph MC, Forrest M, Alfio VP. Smartphone spectrometers. Sensors. 2018;18:223.
DOI: 10.3390/s18010223

9. Christian GD. Analytical Chemistry, 6th Ed. Johan Wily and Sons: New York; 2004.

10. Burges C. Valia. Analytical method and procedures. Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB40WF, UK; 2000.

11. Meier PC, Cilag AG, Zund RE, Teranol AG. Statistical methods in analytical chemistry. 2nd Ed, John Wiley and Sons: Inc; 2000.

12. Hassannejad H, Matrella G, Ciampolini P, De Munari I, Mordonini M, Cagnoni S. A new approach to image-based estimation of food volume. Algorithms. 2017;10:66.

13. Diming Z, Qingjun L. Biosensors and bioelectronics on smartphone for portable biochemical detection. Biosensors and Bioelectronics. 2016;75:273–284.

14. Anuradha SI, Sandeep KJ. Smartphone based non-invasive salivary glucose biosensor. Analytica Chimica Acta; 2017.
DOI: 10.1016/j.aca.2017.10.003

15. Zhang C, Kim JP, Creer M, Yang J, Liu Z. A smartphone-based chloridometer for point-of-care diagnostics of cystic fibrosis. Biosens. Bioelectron. 2017;97:164–168.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/54556