

Short Abstract

Water is one of the most important substances on Earth and is essential for all forms of life. It covers about 71% of the Earth's surface and about 60% of the human body. Water is essential for human survival and the environment. It is getting polluted because of the contaminants such as heavy metals etc., and because of this human health and the environment is getting worse day by day. This raises the need for the detection of heavy metals in aquatic water for several detections are available that can broadly classify into two broad categories. Namely laboratory methods and portable methods. Laboratory methods are generally more expensive and time-consuming and require specialized equipment and trained personnel; on the other hand, portable methods are more user-friendly and accessible to non-specialists, allowing for on-site testing of water samples; less expensive and faster but may have lower accuracy and precision. However, there is still a need to develop point-of-care test (POCT) devices and digital sensors that can monitor the water continuously and accurately and precisely detect contaminants in water, eatable and drinkable items accurately and precisely.

Initially, a rapid, user-friendly POCT device is developed to detect arsenic. The developed method involves the conversion of arsenic to arsine gas, which is then detected using a paper sensor. The sensor was made of impregnated gold chloride (NaAuCl_4) on a paper strip, which produces a characteristic color due to the specificity of the reaction. The device demonstrated a low response time, detecting arsenic concentrations of (10-20) $\mu\text{g/L}$ in nearly 4 minutes and concentrations above 20 $\mu\text{g/L}$ up to (20-500) $\mu\text{g/L}$ in just 2 minutes. The device also efficiently detected arsenic in the river and groundwater samples collected from the field.

Further, the work has been extended to develop an indigenous hybrid sensor kit for assessing arsenic in liquid samples, including portable water, soft drinks, and fruit juices. In the kit in situ, hydrogen is generated by electrolysis to convert all arsenic compounds to arsine gas, which reacts with impregnated Au^{3+} on a paper strip. The paper strip changes color from light yellow to a range of grey-red depending on the arsenic concentration. An indigenous smartphone App was developed based on the RGB values of the paper sensor's responses. The App can display the digital value of concentration on the mobile screen. The developed sensor is capable of detecting arsenic concentrations ranging from (04-100) $\mu\text{g/L}$ with a response time of 5 min for concentrations of 04-30 $\mu\text{g/L}$ and 3 min for 30-100 $\mu\text{g/L}$.

Additionally, this study introduces colorimetric sensors for the on-site quantitative liquid-phase detection of arsenic in water, vegetables, and rice. Through the LDR sensor, this sensor can measure the change in color intensities of different arsenic concentrations. The sensor was transformed into a POCT prototype and calibrated with known samples before testing with real samples. The calibration plot showed that the intensity of the color change was proportional to the resistance change of the LDR. The prototype was further developed into a portable device, which can detect arsenic in the range of 8-100 $\mu\text{g/L}$ and can be used to monitor arsenic in real samples.

Finally, the present study developed the E-Eye, a colorimetric sensor-based POCT device capable of detecting multiple pollutants in water, including arsenic, Iron, Chromium, Fluoride, Lead, and Phosphate. For that, the liquid-based colorimetric sensors was targeted. An LED and a light-dependent resistor were used to measure the color fluctuations. Based on this different calibration curve was developed for the corresponding pollutants. The unknown quantities of pollutants in water samples can be measured using these calibration charts. The sensors were then integrated with an Arduino platform to create a portable and user-friendly POCT device that can monitor water quality. The developed POCT device is stable, user-friendly, and affordable, allowing for on-site detection of contaminants in potable water. Water is one of the most important substances on Earth and is essential for all forms of life. It covers about 71% of the Earth's surface and about 60% of the human body. Water is essential for human survival and the environment. It is getting polluted because of the contaminants such as heavy metals etc., and because of this human health and the environment is getting worse day by day. This raises the need for the detection of heavy metals in aquatic water for several detections are available that can broadly classify into two broad categories. Namely laboratory methods and portable methods. Laboratory methods are generally more expensive and time-consuming and require specialized equipment and trained personnel; on the other hand, portable methods are more user-friendly and accessible to non-specialists, allowing for on-site testing of water samples; less expensive and faster but may have lower accuracy and precision. However, there is still a need to develop point-of-care test (POCT) devices and digital sensors that can monitor the water continuously and accurately and precisely detect contaminants in water, eatable and drinkable items accurately and precisely.

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