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Entitled

ELECTRICAL CHARACTERIZATION AND DETECTION OF BLOOD CELLS AND STONES IN URINE

by

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Abstract

Urine, which contains an immense amount of information related to its physical, chemical, and biological components; is a promising tool in detecting various diseases. Available methods for detecting hematuria (blood in the urine) are not accurate. As results are influenced by many factors in patients and the lab settings, leading to false positive or false negative results. This necessitates the development of new, accurate and easy-access methods that save time and effort. This study demonstrates a label-free and accurate method for detecting the presence of red and white blood cells (RBCs and WBCs) in urine by measuring the changes in the dielectric properties of urine upon increasing concentrations of both cell types. The current method could detect changes in the electrical properties of fresh urine over a short time interval, making this method suitable for detecting changes that cannot be recognized by conventional methods. Correcting for these changes enabled the detection of a minimum cell concentration of 102 RBCs per ml which is not possible by conventional methods used in the labs except for the semi-quantitative method that can detect 50 RBCs per ml, but it is a lengthy and involved procedure, not suitable for high volume labs. This ability to detect a very small amount of both types of cells makes the proposed technique an attractive tool for detecting hematuria, the presence of which is indicative of problems in the excretory system. Furthermore, urolithiasis is also a very common problem worldwide, affecting adults, kids, and even animals. Calcium oxalate is the major constituent of the urinary tract stones in individuals, primarily due to the consumption of high-oxalate foods. The occurrence of urinary oxalate occurs by endogenous synthesis, especially in the upper urinary tract. In a normal, healthy individual, the excretion of oxalate ranges from 10 to 45 mg/day, depending on the age and gender, but the risk of stone formation starts at 25 mg/day depending on the health history of the individual. This study also addresses the detection of the presence of calcium oxalate in urine following same label free approach. This can be done by measuring the changes in the dielectric properties of urine with increasing concentrations of calcium oxalate hydrate ($CaC_2O_4.H_2O$). The current method could detect dynamic changes in the electrical properties of urine over a time interval in samples containing calcium oxalate hydrate even at a concentration as low as 10 µg/mL of urine, making this method suitable for detecting changes that cannot be recognized by conventional methods. The ability to detect very small amount of stones makes it an attractive tool for detecting and quantifying stones in kidney. Using a non-invasive method which also works as a precautionary measure for early detection of some severe ailments, hold a good scope. It forms the basis of the cytological examinations and molecular assays for the diagnosis of several diseases. This method can be considered a point-of-care test because the results can be instantaneously shared with the members of the medical team. Based on these results, we anticipate our present approach to be a starting point towards establishing the foundation for label-free electrical-based identification and quantification of an unlimited number of nano-sized particles.

Keywords: Biological analysis, blood cells, calcium oxalate, capacitance–voltage method, detection, dielectric constant, label free, urine.