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Multivariate analytical approach of dry-reagent biostrips: a next-gen cost-effective and quick method

Abstract

Dry reagent strip technology is known for carrying the controlled application of reagents in the manufacture of the reagent pads. These reagents contain indica- tor dyes, metals, enzymes, polymers, antibodies, and various other chemicals dried onto chosen carriers. Diagnostic dry reagent strips are mostly used in clinical chemical analysis of urine and blood, led to monitoring glucose concentration. Results are obtained instrumentally or visually as thresholds and quantitative outputs. Dry reagents are used in preparing various multivariate strips whose mechanisms are operational to review their performance, limitations and benefits of reagent strips by manufacturers. Pasteurizing milk is first public health requirement and quality assurance in the dairy industry. The present study takes a step forward in evolving dry reagent fabric biostrips as an immediate rapid and cost-effective solution for detecting pasteurization through the detection of alkaline phosphatase (ALP). It is most conventional biomarker for testing the efficacy of procedure of milk pasteurization in dairy industries. Hence, quantitative wet-chemical analysis is gradually being replaced by quick and cost-effective dry reagent strip methods for quantifying clinical chemistry parameters and therapeutic drug monitoring in serum, plasma, or whole blood in various small and referring laboratories. Their analytical precision was found to be satisfactory including dry-chemistry measurements. The precision levels of such evaluation of dry chemistry reagent strip technology can be very efficient in terms of reference values because of their led matrix conditions.

Keywords: dry-reagent chemistry, biostrips, dry reagent strip technology, milk pasteurization

Volume 13 Issue 2 - 2025

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Received: May 28, 2025 | **Published:** June 13, 2025

Introduction

Dry reagent chemistry methods utilize reagents solution mixture on strips which react with a sample to initiate a chemical reaction and detect the target analyte. These strips are prepared by impregnations of reagents in controlled manner onto a carrier material like paper, membrane, or polymer. The process involves multiple reagent layers for different reactions, enabling reactions to occur in distinct areas of the strip. Hence, dry chemistry based analytical methods were found to be advanced next-Gen diagnostic approach which involved various chemical reactions to be carried out by using prepared dry reagents on compatible chosen matrices. Unlike most conventional wet chemistry practices are reported for their chemical dependence on mandatory liquid reagents. Accordingly, proposed dry chemistry practices are also cut-down hands-on labour which help in conducting desired laboratory protocols. Dry reagent strips, also well known as dipsticks which were found to be convenient method for performing chemical analysis, particularly in diagnostics and clinical chemistry. Previously well-known dipstick molecular diagnostics method was developed to determine actin, as a reference gene for carrying molecular detection of seven chromosomal translocations which found to associate with chronic and acute leukemia. Hence, this invented dipstick method was found to be effective appropriate probes used to identify the chimeric RNA or transcripts that involved in the targeted gene translocation.[1,2]

Pasteurizing milk is first public health requirement and quality assurance in the dairy industry. The present study takes a step forward in evolving dry reagent fabric biostrips as an immediate quick and cheap solution mixtures of chromogen and pNPP substrate for confirming the state of pasteurization through the biochemical presence of alkaline phosphatase (ALP) in milk samples which sometimes left in milk if pasteurization procedure may be improper. It is most conventional biomarker for testing the efficacy of procedure of milk pasteurization in dairy industries.[3,4]

Earlier reported efficient invented analytical approaches of dry reagent strips in determination of various biochemical components

Previously, test strips were used to screen ethanol levels in saliva samples of drivers who were caught in drink and driving cases.[5-7] Its reliability and efficacy were found notable when compared with other available methods. Earlier smartphone-based colorimetric analysis was done for quantifying concentration of alcohol in saliva by using ideal color intensity measurement with the help of AI-enabled codes-based algorithms. The observed intensity of color of prepared dry-reagent strips were found to change with varied salivary alcohol concentration that was captured by smartphone camera. Cross-validation of noted observations were explored to obtain methodical statistical execution by interpreting the anticipated values and AI-enabled virtual approach was restructured.[8] New invented throwaway biosensor dry-reagent strip was prepared utilizing method of screen-printing that made up of Meldola's blue mediated carbon electrode as working electrode combined with Ag/AgCl reference electrode printed fabricated on activated choses PVC matrices. Stability of enzyme system is further improved by using trehalose as enzyme/cofactor coating that led to increased efficiency of detection of alcohol content in beverages.[9]

Blood glucometer is a type of biosensor including prepared strips which are known to have their diagnostic importance for diabetic patients to monitor their routine blood glucose level to avoid further associated lethal clinical complications.[10,11] It is found to reported to effectively aid in medical management of diabetes by using improved

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blood glucose monitoring system (BGMS) platform consists of modified CONTOUR® NEXT (CN) test strip for self-monitoring of blood glucose.[12]

Revolutionized reagent strip was prepared to determine serum/plasma phenytoin and phenobarbital concentrations which mediated by chemical basis of Apoenzyme Reactivation Immunoassay System and the used of Seralyzer reflectance photometer.[13,14] Clinical use of instrumentation named Apoenzyme Reactivation Immunoassay System (ARIS) and Ames Seralyzer reflectance photometer were reported for rapid quantification of serum and plasma theophylline by using dry-reagent dipstick. This dry-reagent dipstick procedure was found to more reliable and rapid when compared other conventional methods like, fluoroimmunoassay, enzyme immunoassay and liquid chromatography which have been proposed for quantifying blood theophylline concentration with prescribed therapeutic drug monitoring procedures for hospital admitted patients.[15]

Enzyme tracer-based biosensor was prepared called, point-of-care dry-reagent dipstick biosensor which consists of mobile strip reader device to perform easy, affordable and efficient detection of protein in biological samples. The proposed models were Rabbit IgG (R-IgG) and Horseradish Peroxidase (HRP) to describe concept of mechanism along with sandwich-type immunoreactions on the DRSB and the HRP tracers which were captured on the test zone of the biosensor. Hence, excess HRP tracers were captured on the control zone of the biosensor through the immobilized secondary antibody. Subsequent enzymatic reaction in the presence of the substrate produced insoluble enzymatic products which deposited on both test and control zones of the DRSB with notable two characteristics blue bands. The enzyme-based DRSB was used to detect Carcinoembryonic Antigen (CEA) biomarker in human plasma offering a simple and fast tool for point-of-care protein assay including potential substituent for the traditional Enzyme-linked Immunosorbent Assay (ELISA).[16-18]

A novel diagnostic device was prepared called, lateral flow assay strip sensor to measure wide range of target proteins named, C-reactive protein (CRP) concentrations in human sera. The strip sensor was found to determine a linear detection limit of C-reactive protein concentration ranging from 1 ng/mL to 500 µg/mL per 10 minutes in 50 clinical samples with detection range of 0.4-84.7 µg/mL. So, this reported docile C-reactive protein (CRP) sensor will be a potent affordable, quick and reliable portable tool to measure serum C-reactive protein (CRP) concentration in clinical samples.[19]

Bio-strip fabricated material was used to determine whether pasteurization of milk was done right by studying alkaline phosphatase activity in dairy samples. The development of the dry reagent dipstick is quick, affordable and portable so that it can be easily prepared in any rural dairy industry with less laboratory facilities without requirement of sophisticated instrumentations. After pasteurization, the colour is purple.[20] Other reported dry reagent based rapid method is cost-effective to test alkaline phosphatase presence in dairy samples which prepared by using activated *Bombyx mori* silk fabric impregnated with bromocresol green chromogen and pNPP substrate solution mixtures. Upon testing raw milk samples, prepared strips showed visual color change from light blue to green that indicated the presence of the enzyme alkaline phosphatase in milk to confirm it was not pasteurized properly. Hence, it was not considered safe for consumption.[21] In both previous reports, colour changes to bluish-grey and green were developed in less than two minutes in raw milk or unpasteurized milk samples at room temperature. Those observations can be even captured easily with bare eye to be considered as potent qualitative rapid test method and make this dry reagent-based method cost effective before preceding confirmatory quantitative test procedures. The storage span of the prepared dry-reagent strip is found to lasts for 9-10 months when preserved in brown bottle in low-moisture environment.[20-22]

Conclusion and future perspectives

So, it was concluded that dry reagent based biostrip/dipstick method endured to explore potent doorway preliminary analytical approach to obtain instant and reliable quantitative estimations of many clinical and biological analytes in biological samples. These procedures will further need to improve the test zone patches of chosen matrices (e.g. Whatman filter paper, fabric, or activated filter papers) by fabricating reagents contain indica- tor dyes, metals, enzymes, polymers, antibodies, and various other chemicals dried onto carriers. So, these proposed dry-reagent dipstick based analytical assays are found to poses notable medical diagnostic decision limits in regard to vast amplified outcomes of studied clinical interpretations of pathogenesis like, albuminuria and human chorionic gonadotropin associated complications. Cost-effective dry reagent biostrips based methods would be helpful to prepare more reliable qualitative biosensor to confirm quick proper pasteurization by detecting alkaline phosphatase in milk samples. Hence, various dry reagent strip technologies may involve well controlled, cost-effective and easy multivariate approaches of reagents and chromogens in manufacturing of proposed dipsticks.[22-25]

Acknowledgments

I would like to express my cordial appreciation to Amity University Uttar Pradesh, Noida (India).

Conflicts of interest

The author declares that there are no conflicts of interest.

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Citation: Rani K. Multivariate analytical approach of dry-reagent biostrips: a next-gen cost-effective and quick method. *J Bacteriol Mycol Open Access*. 2025;13(2):101–103. DOI: 10.15406/jbmoa.2025.13.00406