Research Article

Comparison of two automated urine cytometry systems: Sysmex® UF-1000i and Beckman Coulter® DxU 850 Iris

Abderrazak Saddari[1,2,3]*, Said Ezrari[1,3], Mohammed Dalli[4], Elmostapha Benaissa[5,6], Yassine Ben Lahlou[5,6], Mostafa Elouennass[5,6], Adil Maleb[1,2,3]

[1]Laboratory of Microbiology, Faculty of Medicine and Pharmacy, University Mohammed the First, Oujda, 60000, Morocco
[2]Laboratory of Microbiology, Mohammed VI University Hospital, Oujda, 60000, Morocco
[3]Laboratory of Bioresources, Biotechnology, Ethnopharmacology and Health, Faculty of Sciences, University Mohammed the First, Oujda, 60000, Morocco
[4]Higher Institute of Nursing Professions and Health Techniques, Oujda, 60000, Morocco
[5]Department of Bacteriology, Mohammed V Teaching Military Hospital, Rabat, 10045, Morocco
[6]Epidemiology and Bacterial Resistance Research Team/BIO-INOVA Centre, Faculty of Medicine and Pharmacy, University Mohammed V, Rabat, 10045, Morocco

Abstract

Background: Urinary tract infection, defined as the presence of bacteria or yeast in the urinary tract, is the most common community-acquired infection after respiratory infections. The cytobacteriological examination of urine (CBEU) remains the primary diagnostic test for urinary tract infections and is the most frequently conducted test in microbiology laboratories. Direct examination is a crucial step of CBEU, enabling the assessment of cytology, including leukocytes and red blood cells, as well as the identification of crystals, epithelial cells, and microorganisms when present in significant quantities. This examination also provides preliminary results that can guide clinical decision-making. While the standard method for urine cytology is a microscopic examination, automation offers several advantages, including standardized results with higher repeatability, improved reproducibility, increased sample throughput, and seamless data transfer to laboratory information systems. **Objectives:** This study aimed to compare the performance of two automated urine cytology systems: Sysmex UF-1000i and the Beckman Coulter DxU 850 Iris. **Methods:** We described the methodology and technology underlying each system and assessed their analytical performance. The UF-1000i uses flow cytometry for the objective characterization and identification of particles based on forward scattering, fluorescence, and adaptive typing analysis. In contrast, the DxU-850 Iris, a urine microscopy analyzer, employs proprietary digital flow morphology technology alongside automatic particle recognition software to isolate, identify, and characterize digital images of particles. **Conclusion:** Our comparison showed that both systems performed exceptionally well, delivering results that are comparable, and, in some cases, superior to, those obtained through the reference method of optical microscopy.

Keywords: Urinary tract infection, UF-1000i, Flow cytometry, DxU 850 Iris, Digital flow morphology

1. INTRODUCTION

The cytobacteriological examination of urine (CBEU) is the principal test for urinary tract infections and is by far the most commonly performed test in microbiology laboratories [1]. A critical component of this examination is the direct assessment, which allows for the detection of leukocytes and red blood cells (RBC), as well as the potential identification of crystals, epithelial cells, and microorganisms in the case of significant abundance [2]. This stage also provides preliminary results that can inform the prescriber's clinical decisions [3]. Although microscopic examination remains the gold standard for urine cytology, automation

***Corresponding author:**
Abderrazak Saddari (abderrazak.saddari@ump.ac.ma)

Received: 03 June 2024; Revision received: 15 August 2024; Accepted: 10 October 2024; Published: 29 November 2024

How to cite this article: Saddari A, Ezrari S, Dalli M, *et al.* Comparison of two automated urine cytometry systems: Sysmex® UF-1000i and Beckman Coulter® DxU 850 Iris. *Bladder.* 2024;11(3):e21200016. DOI: 10.14440/bladder.2024.0004

presents a number of advantages, including standardized results that enhance reproducibility compared to manual techniques, high processing capacity (over 50 samples/h), and the ability to transfer data seamlessly to the laboratory's information system [2]. Various technologies are employed in commercially available urine cytology machines, with flow cytometry and imaging being the most prevalent. Microbiology laboratories must select the best-performing automated system based on several technical and logistical criteria. The aim of our study was to compare the technical characteristics and performance of two automated urine cytology systems: the Sysmex UF-1000i, which uses flow cytometry, and the Beckman Coulter DxU 850 Iris, which is equipped with cameras for the recognition of figurative elements in urine. Our findings will provide biologists and microbiology laboratory managers with valuable insights to guide their selection of automated urine cytology systems.

2. MATERIALS AND METHODS

The microbiology laboratory at Oujda University Hospital processes a large number of CBEU requests every day. Urine samples come from outpatients and are collected in the laboratory, as well as from patients admitted to various hospital departments. Given the high volume of CBEU requests, coupled with workload pressures and staff shortages, our laboratory opted for automated urine cytology from the outset. We initially implemented the Sysmex UF-1000i system upon opening and have recently acquired the Beckman Coulter DxU 850 Iris.

In this work, we aimed to compare the performance and technologies employed by the two automated systems. Our comparison was based on the user manuals, criteria, and data provided during training sessions conducted by the suppliers of both systems, as well as our laboratory's experience in analyzing urine samples. The main criteria studied include the technology used by each analyzer, the parameters analyzed, the processing speed and capacity of analysis, and other technical and logistical performance metrics.

3. RESULTS

The two analyzers, UF-1000i and DxU 850 Iris, utilize different technologies to facilitate the cytological examination of urine (and other fluids), achieving results comparable to the reference technique in microscopy. The UF-1000i employs flow cytometry to identify elements in urine based on size, structure, and fluorescence, processing up to 100 samples/h. This technology effectively detects RBC, leukocytes, bacteria, and additional components such as cylinders and crystals. The analyzer demonstrates satisfactory sensitivity and specificity, with good linearity across various levels. Optimal performance was observed under standard environmental conditions (temperature: 15–30°C; humidity: 30–85%). The volume required for analysis is 4 mL, though manual mode can accommodate as little as 1 mL.

On the other hand, DxU 850 Iris processes urine at a rate of 101 tests/h. It features an advanced camera that identifies elements and particles based on size, shape, contrast, and texture, utilizing digital flow morphology and automatic particle recognition software. In addition to the basic elements (RBC and white blood cells [WBC], bacteria, crystals, and cylinders), this analyzer can detect additional categories for subclassification. It differentiates between types of crystals and cylinders, as well as normal and pathological cells. This device operates under standard conditions, requiring a volume of only 2 mL for analysis.

Table 1 represents a summary of the technical features and specifications of each machine to facilitate a comparative analysis of the two systems.

4. DISCUSSION

The microbiological diagnosis of urinary tract infections is primarily established through CBEU, which is one of the most widely prescribed tests in medical microbiology [1,4]. This examination begins with urine cytology, a crucial step for effective treatment and interpretation of results [2]. Traditionally, manual examination under a light microscope has been the gold standard for urine cytology [5]. However, while this method is straightforward and relatively economical, it often has disadvantages such as time consumption and variability in reliability, which can significantly depend on the experience of the examiner [2,6]. Consequently, many microbiology laboratories are increasingly adopting automated methods that offer numerous advantages, including speed, precision, reproducibility, and enhanced traceability. Automated systems enable direct integration with the laboratory information systems, thereby improving traceability, interpretation, and biological validation of results [6,7].

Over the years, several automated systems have been developed to enumerate urine components, including leukocytes, RBC, bacteria, epithelial cells, crystals, and cylinders [6,8]. The market is mainly dominated by two technologies: flow cytometry, as implemented by the Sysmex UF-1000i, and image analysis following video capture, as utilized by the Beckman Coulter DxU 850 Iris. Both methods have demonstrated performance levels comparable to those achieved with manual microscopy [2,6,8].

The UF-1000i® operates as a flow-through fluorocytometer designed for urinary particle analysis [2]. It quantifies RBC, leukocytes, epithelial cells, bacteria, and cylinders, generating quantitative alerts for pathological cylinders,

Table 1. Specifications and performance of the Sysmex UF-1000i and Beckman Coulter DxU 850 Iris systems

Specifications	Sysmex UF-1000i	Beckman Coulter DxU 850 Iris
Technology	Flow cytometry; Two fluorescent reagents; Separate bacteria channels for better differentiation	Digital flow morphology using automatic particle recognition software
Test parameters	Erythrocytes, leukocytes, epithelial cells, cylinders, bacteria; Pathological cylinders, crystals, small round cells, spermatozoa, yeast, mucus	RBC, WBC, WBC clumps, squamous epithelial cells, non-squamous epithelial cells, hyaline casts, unclassified casts, crystals, bacteria, yeast, sperm, mucus
Additional categories for subclassification	NA	(i) Unclassified casts: Granular, cellular, waxy, broad, RBC, WBC, epithelial cells, fatty casts (ii) Crystals: Calcium phosphate, uric acid, calcium carbonate, leucine, cystine, tyrosine, amorphous calcium oxalate, triple phosphate (iii) Non-squamous epithelial cells: Renal epithelial, transitional epithelial (iv) Yeast: Budding yeast, yeast with pseudohyphae (v) Other: RBC clumps, fat, oval fat bodies, trichomonas, dysmorphic RBCs
Identification characteristics	Size, structure, and fluorescence	Size, shape, contrast, and texture
Flow rate	Up to 100 samples/h	Up to 101 samples/h
Capacity per rack	10 samples	10 samples
Sampler (sample changer)	50 samples (5 racks)	60 samples (6 racks)
Loading/unloading station	NA	Up to 14 racks
Sample volume	Manual mode: 1 mL Sampler mode: 4 mL	Minimum: 2.0 mL
Intake volume	0.8 mL	1.3 mL
Dimensions/Weights W × D × H (mm)/(kg)	579×686×615/67.1	530×645×544/46
Workstation	Windows®-driven main browser	Computer with a touch-screen monitor Windows 10
Data storage (samples)	10,000, with scatter diagrams	10,000
Operating environment	Temperature: 15–30°C (Optimum: 25°C) Humidity: 30–85%	Temperature: 18–28°C Humidity: (20–80%) non-condensing

D: Depth; H: Height, NA: Not available, RBC: Red blood cells, W: Weight, WBC: White blood cells.

yeasts, small round cells, spermatozoa, and crystals. In addition, it provides data on RBC amount, facilitating the identification of hematuria causes [2,9]. The analysis occurs directly on the urine sample, requiring no prior preparation. Urine particles are labeled with two specific fluorochromes – one for bacteria and another for other particles – and are then propelled by a Sheath liquid through a narrow channel traversed by a laser beam. The system analyzes the scattered laser light, fluorescence, and impedance to differentiate between the various urinary constituents. Each particle is characterized by size, structure, and fluorescence, with results displayed on a connected screen as scattergrams and histograms, providing quantitative values for each parameter in units of elements/μL [2,9,10]. Figures 1 and 2 illustrate examples of cytological results of a urine sample analyzed by the UF-1000i.

In contrast, the Beckman Coulter DxU 850 Iris first homogenizes the sample before presenting it as a slide sandwiched between layers of lamina. This configuration, similar to the axial hydrodynamic focusing used in some blood counters and flow cytometers, precisely positions the sample at the optimal focusing distance within the microscope lens' field of view. This layered arrangement also orients particles orthoscopically, ensuring that asymmetric particles present their widest profile for image capture [11]. A charge-coupled device camera attached to the microscope captures 500 images per sample, with each microscopic field illuminated by a strobe lamp. The captured images are digitized and transmitted to an analysis processor. A sample-free image stored in memory is used to deduce the background noise of each capture, thereby enhancing the morphological quality of the identified particles. Subsequently, individual particles are isolated within each image [11,12].

The automatic particle recognition software, a sophisticated neural network, classifies each image based on size, shape, contrast, and texture characteristics. These categories include RBC, WBC, WBC clusters, hyaline cylinders, unclassified cylinders, squamous epithelial cells, non-squamous epithelial cells (NSE), bacteria, yeast, crystals, mucus, and semen. In addition, there are 27 pre-defined subclassifications for identifying specific types of cylinders, crystals, NSE, dysmorphic particles, and other entities [11,12]. Figure 3

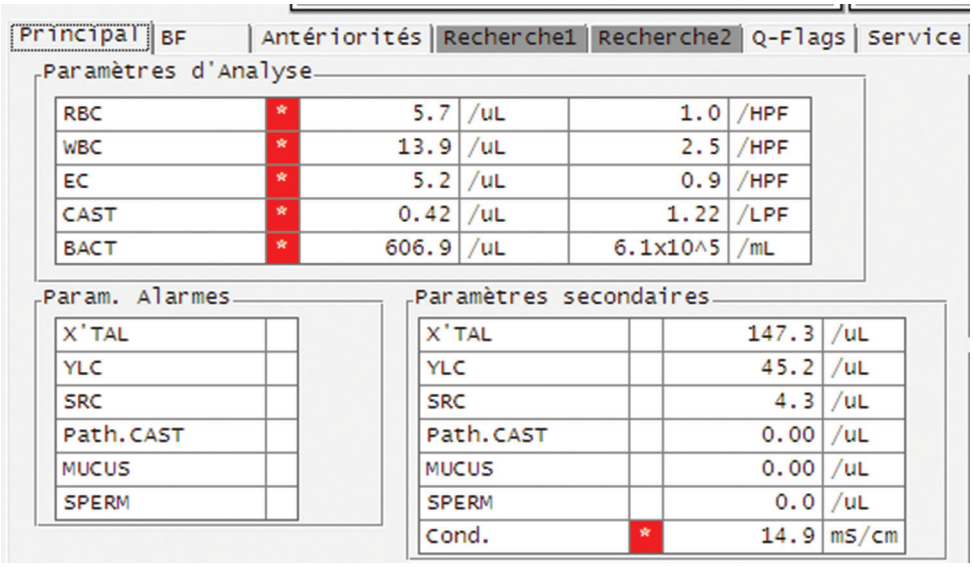

Figure 1. Cytological results from a urine sample. The main parameters (including RBC, WBC, etc.) are presented as elements per microliter and as elements per high-power field (HPF). The results table also includes secondary parameters, such as yeast and small round cells (SRC), expressed in elements per microliter.
BACT: Bacteria, Cond: Conductivity, EC: Epithelial cells, Path. CAST: Pathologic cast, RBC: Red blood cells, WBC: White blood cells, X'TAL: Crystal, YLC: Yeast.

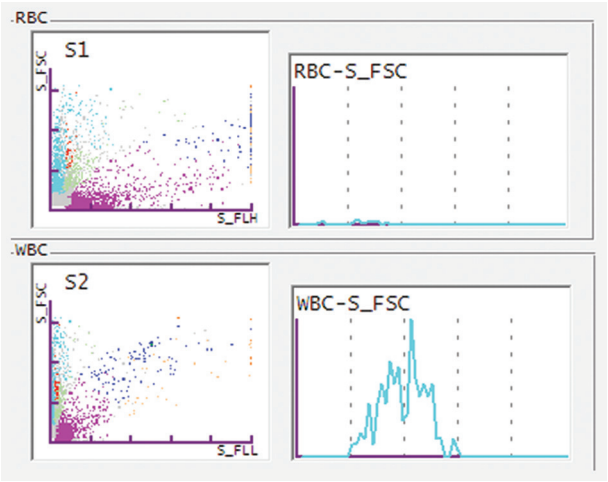

Figure 2. Scattergram results for the same sample. S1 represents red blood cells (RBC), while S2 denotes white blood cells (WBC). Each result is accompanied by a histogram displaying a Gaussian curve based on cell size, expressed in forward scatter (FSC).

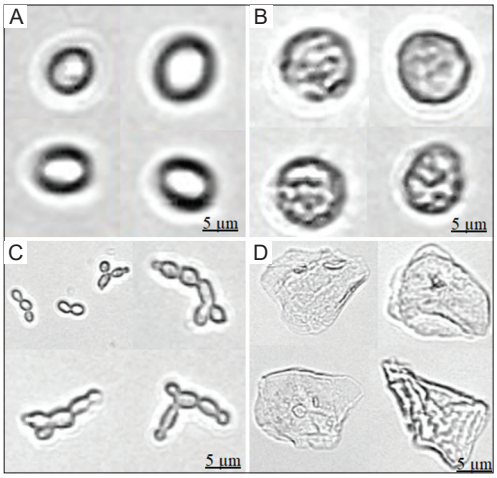

Figure 3. Urine cytology results from the Beckman Coulter® DxU 850 Iris. The camera captures each cell with high performance and classifies them into several categories based on size, shape, and texture: (A) red blood cells, (B) white blood cells, (C) yeast, and (D) squamous epithelial cells (magnification of ×400).

presents examples of images captured by the DxU 580 Iris in our laboratory.

From a quality and performance perspective, our team conducted a prior study involving 1,000 samples to verify the effectiveness of the UF-1000i® automated system [13]. This study demonstrated a strong correlation between automated counts and microscope counts, with a percentage agreement ranging from 94.2% to 96.9%, depending on the measured parameter. Specificity was satisfactory for all parameters, exceeding 96%. While sensitivity decreased for crystals and cylinders, it remained satisfactory for cells (RBC, WBC, and yeasts) [13]. These results yielded a high negative predictive value across all parameters, a high positive predictive value for cells, and a lower positive predictive value for crystals and cylinders.

For the DxU 850 Iris, supplier-reported data indicated a sensitivity of 96% to 100% for most parameters, with the exception of yeasts and non-squamous cells. Specificity also exceeded 96% for the majority of parameters [11]. A comparative study by Dewulf *et al.* [14] on a system similar to ours demonstrated that cytology systems based on image and video capture were highly efficient, with very satisfactory results. In this study, the system's sensitivity for

Table 2. Analytical performance of the two analyzers UF 1000 and Dxu Iris

System and prior study	Sensitivity for cells	Sensitivity for other parameters	Specificity	Concordance
UF-1000i Maleb *et al.* [13]	95–98%	55–83%	96%	94–97%
DxU Iris Dewulf *et al.* [14]	98–100%	>80%	98%	-

cell detection ranged from 98% to 100%, exceeding 80% for other parameters, while specificity consistently surpassed 98% for all measured parameters. Table 2 presents a comparison of the analytical performance of the two analyzers based on studies by Maleb *et al.* [13] and Dewulf *et al.* [14].

In other features, the two systems were comparable regarding throughput (100 samples/h), data storage (10,000 results), dimensions, start-up conditions, and connectivity. In terms of autosampler capacity, the DxU 850 Iris accommodates 6 racks of 10 samples, while the UF-1000i® holds 5 racks. In addition, the DxU 850 Iris can be equipped with a loading station featuring a removable tray that holds up to 14 racks of 10 samples, yielding a total autosampler capacity of 200 samples [10,11]. Beyond loading capacity, the DxU 850 Iris excels in recognizing pathogenic particles and offers subclassification for several parameters, which are notable advantages of its technology. Furthermore, its artificial intelligence allows the system to continuously learn from user corrections and the potential addition of new parameters and recognizable particles [11,12,14].

Despite the significant contributions of this study in comparing the two systems and their respective technologies, several limitations should be considered. Conducting a quality-controlled verification of both methods would provide a clearer understanding of their repeatability and reproducibility. In addition, a prospective study involving a large number of urine samples would facilitate a transferability analysis between the two analyzers and yield more comprehensive comparative results.

5. CONCLUSION

The automation of bacteriological testing, particularly in urine cytology, has revolutionized daily practices in microbiology laboratories. Regardless of the technology employed, these automated systems have significantly increased throughput, improved accuracy and reproducibility, and minimized the risk of human error. Both the Sysmex UF-1000i and Beckman Coulter DxU 850 Iris are high-performance devices that deliver results comparable to, or even better than, those obtained through the reference method of optical microscopy.

ACKNOWLEDGMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Abderrazak Saddari, Adil Maleb
Investigation: Abderrazak Saddari
Methodology: Said Ezrari, Mohammed Dalli
Writing – original draft: Abderrazak Saddari, Adil Maleb
Writing – review & editing: Elmostapha Benaissa, Yassine Ben Lahlou, Mostafa Elouennass

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

The study was conducted on anonymous biological samples. It does not concern any personal data that could directly or indirectly identify a specific person.

AVAILABILITY OF DATA

All the data used are available directly in the article or through the references cited.

REFERENCES

1. Saddari A, Benhamza N, Dalli M, *et al*. Urinary tract infections older adults at Mohammed VI university hospital of Oujda: Case series. *Ann Med Surg* (*Lond*). 2023;85(5):1408-1412. doi: 10.1097/ms9.0000000000000581
2. Maleb A, Sebbar EH, Lahlou YB, *et al*. Cytologie urinaire: UF-1000i versus examen microscopique, dans des conditions réelles d'exercice d'un laboratoire de microbiologie. *IRBM News*. 2017;38(5):150-154. doi: 10.1016/j.irbmnw.2017.07.001
3. García-Coca M, Gadea I, Esteban J. Relationship between conventional culture and flow cytometry for the diagnosis of urinary tract infection. *J Microbiol Methods*. 2017;137:14-18. doi: 10.1016/j.mimet.2017.03.010
4. Maleb A, Lamrabat S, Rifai S, *et al*. A flowchart is always useful: application to the interpretation of the cytobacteriological examination of urine. *Ann Biol Clin*. 2019;77(5): 537-542. doi: 10.1684/abc.2019.1486
5. Twizeyimana E. Automates et uroculture: La cytologie urinaire.

Rev Francoph Lab. 2016;482:25-33.
doi: 10.1016/S1773-035X(16)30169-1

6. Guillou MLJ. Impact de l'automatisation sur l'organisation d'un laboratoire de bactériologie. *Rev Francoph Lab.* 2016;482:67-73.
doi: 10.1016/S1773-035X(16)30174-5
7. Manoni F, Tinello A, Fornasiero L, *et al*. Urine particle evaluation: A comparison between the UF-1000i and quantitative microscopy. *Clin Chem Lab Med*. 2010;48(8):1107-1111.
doi: 10.1515/CCLM.2010.233
8. Ledru S, Canonne JP. Comparison of IRIS IQ ELITE and microscopy for urinalysis and evaluation of performance in predicting outcome of urine cultures. *Ann Biol Clin*. 2008;66(5):555-559.
doi: 10.1684/abc.2008.0267
9. *UF-1000i Une Nouvelle Génération Analyseur Automatisé de Particules d'Urine*. Document Number MKT-10-1079-F 08/2010 1M. Sysmex America, Inc. Available from: https://www.sysmex.com/US/en/brochures/brochure_uf-1000i_mkt-10-1079-f.pdf [Last accessed on 2024 Mar 04].
10. *Analyseur D'urine Entièrement Automatisé UF-1000i. Mode D'emploi*. Japon: De Sysmex Corporation; 2006.
11. *DxU 850m IRIS and DxU 840m IRIS. User's Manual. Reference. C49322AB*; 2022. Available from: https://www.beckmancoulter.com/dxuiris [Last accessed on 2024 Mar 20].
12. *DxU IRIS Automated Urinalysis Solution. Datasheet*. Available from: https://medist-srl.ro/sites/default/files/download/products/852-2021-9530-ua-dxu-iris-workcell-ds-226976-en-glb-a4.pdf [Last accessed 2024 Oct 15].
13. Maleb A, Sebbar EH, Lahlou YB, *et al*. Évaluation des performances de l'automate de cytologie urinaire sysmex UF-1000i. *IRBM News*. 2017;38(6):194-198.
doi: 10.1016/j.irbmnw.2017.09.003
14. Dewulf G, Harrois D, Mazars E, Cattoen C, Canis F. Evaluation of the performances of the iQ(®)200 ELITE automated urine microscopy analyser and comparison with manual microscopy method. *Pathol Biol*. 2011;59(5):264-268.
doi: 10.1016/j.patbio.2009.10.006