Evaluation of BBL CHROMagar Orientation Medium for Detection and Presumptive Identification of Urinary Tract Pathogens

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The microbiological performance of BBL CHROMagar Orientation medium and CPS ID2 agar was compared to that of Columbia agar with 5% sheep blood and MacConkey agar without crystal violet for the enumeration and presumptive identification of bacteria responsible for urinary tract infections. Of a total of 658 clinical urine specimens, 118 specimens yielded no growth, 402 specimens yielded growth with cell counts of $\geq 10^5$ CFU/ml, and 138 specimens yielded growth with cell counts of $< 10^5$ CFU/ml. Of the specimens with cell counts of $\geq 10^5$ CFU/ml, 163 were pure cultures and 239 were mixed cultures. A total of 266 *Escherichia coli* organisms were isolated on both chromogenic media, 260 were isolated on blood agar, and 248 were isolated on MacConkey agar. One strain (0.4%) failed to develop the expected pink color on CHROMagar Orientation medium, and 23 strains (8.7%) failed to develop the expected pink color on CPS ID2 agar. Enterococci (CHROMagar Orientation medium, $n = 266$; CPS ID2 agar, $n = 265$) produced small blue-green colonies on both chromogenic media. Fifty of the mixed cultures contained enterococci that were detected only on the chromogenic media. The *Klebsiella-Enterobacter-Serratia* (KES) and the *Proteus-Morganella-Providencia* (PMP) groups could be identified on both chromogenic media. Of 66 isolates of the KES group, 63 grew with the expected color on CHROMagar Orientation medium and 58 of 64 isolates grew with the expected color on CPS ID2 agar. Other microorganisms required further identification. The use of chromogenic medium formulations offers a time-saving method for the reliable detection, enumeration, and presumptive identification of urinary tract pathogens. One of the greatest advantages of these media is the easy recognition of mixed cultures.

For several years chromogenic media that allow for the direct identification of the most frequently isolated bacterial and fungal species, such as CPS ID2, SMID agar, and Albicans ID (BioMérieux), Rambach agar (CHROMagar), and BBL CHROMagar Candida (Becton Dickinson), have been available for use with either urine samples or stool specimens or for the identification of yeasts (1, 2, 9, 12, 19, 22, 24–26).

Since the diagnosis of urinary tract infections contributes significantly to the daily workload in a microbiology laboratory, any innovation that tends to reduce the workload is always welcome when a high-quality standard is still maintained.

Our objectives were to evaluate the accuracy of BBL CHROMagar Orientation medium and CPS ID2 agar compared to those of conventional media (Columbia agar with 5% sheep blood and MacConkey agar without crystal violet) for the detection and enumeration of the organisms commonly involved in urinary tract infections and to compare the ability of both chromogenic media to correctly identify the more frequently occurring organisms or organism groups with only a minimum of confirmatory tests.

Apart from specimens with clinically significant organism counts ($\geq 10^5$ CFU/ml), we included specimens with $< 10^5$ CFU/ml in order to evaluate the sensitivity of the media.

MATERIALS AND METHODS

Specimens. Six hundred fifty-eight urine specimens, most of which were mid-stream urine specimens, were included in the study. A total of 394 specimens came from general practitioners and internal disease specialists, 74 came from dialysis centers, 86 came from pediatricians, 28 came from gynecologists, and 18

came from miscellaneous physicians, whereas 58 specimens were obtained from hospitals.

Of the 402 clinically significant urine specimens (organism count, $\geq 10^5$ CFU/ml), 78 contained antimicrobial agents and 324 were negative for antimicrobial agents. Two hundred twenty-three of 402 specimens were sent refrigerated to our laboratory within 3 to 4 h, while vials with borate as a stabilizer (ExactoBac; Nerbe, Winsen, Germany) were used for the remaining 179 urine specimens. Concerning the 138 urine specimens with cell counts of $< 10^5$ per ml, 104 did not contain antimicrobial agents, while 34 were positive for antimicrobial agents. Vials with stabilizer were used for 110 specimens, and 28 specimens were sent refrigerated. The specimens with no growth were positive for antimicrobial agents in 40 cases; 78 specimens with no growth were negative for antimicrobial agents. Vials containing borate were used for 83 specimens, and 35 specimens were sent refrigerated.

Inoculation of media and incubation. The specimens were inoculated in parallel on BBL CHROMagar Orientation medium (Becton Dickinson, Heidelberg, Germany) and CPS ID2 medium (bioMérieux, Nürtingen, Germany). Columbia agar with 5% sheep blood (Becton Dickinson) and MacConkey agar without crystal violet (Unipath, Wesel, Germany), which allows for the detection of both gram-negative and less fastidious gram-positive bacteria like enterococci and staphylococci, served as reference plates. The two chromogenic media were obtained from the manufacturers as prepared plated media; all other media were prepared from the dehydrated media according to the manufacturers' instructions. Each plate was inoculated with 0.01 ml of the specimen by an approved dilution technique (3, 4). The plates were incubated at $35 \pm 2^\circ\text{C}$ for 18 h.

Presumptive identification and enumeration. Determination of the colors of the colonies on the two chromogenic media was performed according to the manufacturers' instructions. BBL CHROMagar Orientation and CPS ID2 media allow for the detection, enumeration, and presumptive identification of the microorganisms commonly involved in urinary tract infections. The identification is based on chromogenic substrates incorporated into the media to detect certain bacterial enzymes. The respective organisms react with the chromogenic substrates in such a way that the colonies take on a characteristic color and colony morphology. Both media contain two different chromogenic substrates: one allows for the detection of β -glucuronidase (CPS ID2 medium) or enzymes of the lactose metabolism (CHROMagar Orientation medium) and releases a pink to red dye, whereas the other chromogen detects the presence of β -glucosidase and releases a blue to blue-green dye. The respective colonies are stained red, blue to blue-green, or purple, or they appear in their natural color when none of these enzymes is present. Additionally, tryptophan deaminase, an enzyme characteristically found in the *Proteus-Morganella-Providencia* (PMP) group of organisms,

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TABLE 1. Recovery of isolates from mono- and polymicrobial urine specimens on four media^a

Group ^b	No. of urine specimens with the following colony counts:	
	≥10 ⁵ per ml	<10 ⁵ per ml
Group I	163	26
Group II	86	24
Group III	148	42
Group IV	5	46
Total	402	138

^a The four media were BBL CHROMagar Orientation, CPS ID2, blood, and MacConkey agars.

^b Group I, monomicrobial specimens with identical recovery from each medium; group II, polymicrobial specimens with identical recovery from each medium; group III, polymicrobial specimens with different recovery results for the four media; group IV, mono- and polymicrobial specimens with strains that could never be isolated from all four media together.

is detected on both media by the production of a brownish, diffusible pigment that stains the medium around the respective colonies.

According to the manufacturers, the two media allow for the identification of *Escherichia coli* (pink colonies) and enterococci (tiny blue to blue-green colonies) and allow for the detection and presumptive identification of the *Klebsiella-Enterobacter-Serratia* (KES) group (large blue to blue-violet colonies on CHROMagar Orientation medium and pale blue colonies on CPS ID2 medium) and the PMP group (colonies of β-glucosidase-negative strains are colorless to beige, whereas β-glucosidase-positive strains produce blue colonies; both types stain the surrounding medium with a diffusible, brownish pigment on both media), with only a very few confirmatory tests required. Only CHROMagar Orientation medium allows for the detection of *Staphylococcus saprophyticus*, whose colonies give a light rose color.

In order to evaluate the sensitivities of the media, every isolate was enumerated without regard to its possible clinical significance or its assignment to normal flora.

Confirmatory tests and final identification. An indole test was performed with all pink colonies on both chromogenic media, as recommended by the manufacturers. ID indole (bioMérieux) was used for colonies from CPS ID2 medium, and DMACA Indole Dropper reagent (Becton Dickinson) was used for colonies from BBL CHROMagar Orientation medium. Both tests were performed on filter paper. If there were no discrepancies, the diagnosis of *E. coli* was accepted. Colonies of strains presumptively identified as enterococci were confirmed by streaking on D-Coccosel-agar (bioMérieux), a selective differential medium for *Enterococcus* spp.

All other isolates, including those of the KES group and the PMP group and any isolates with questionable or discrepant results, were subjected to standard

biochemical identification methods, i.e., by means of ATBstaph, IDGN, API 20 NE, and API 20 E systems (bioMérieux) or the Micronaut E-System (Merlin, Bornheim, Germany). Confirmatory tests such as the catalase (3% H₂O₂), oxidase (PathoTec-CO; Organon, Eppenheim, Germany), Staphaurex plus, and coagulase (bioMérieux) tests were performed according to the manufacturers' instructions.

RESULTS

During the study a total of 658 clinical urine specimens were plated in parallel on the four media described above. One hundred eighteen specimens yielded no growth on any medium; of the remaining 540 urine specimens, 402 yielded growth on at least one of the plates with counts of ≥10⁵ CFU/ml; 138 specimens yielded <10⁵ CFU/ml (Table 1).

Of the specimens with counts of ≥10⁵ CFU/ml, 163 yielded pure cultures of organisms and 239 yielded mixed cultures of organisms; 143 of the latter group of cultures contained two strains, with both strains in all cultures being clinically significant isolates with high counts. Seventy-two cultures contained three isolates, with 49 of them containing one predominant isolate with counts of ≥10⁵ CFU/ml and two other isolates that were present at low counts (10³ to 10⁴ CFU/ml). Four strains were isolated from 24 specimens, of which 19 contained additional isolates with low counts. Accordingly, 216 of the 239 urine specimens yielding mixed cultures were considered clinically significant, and only 23 were probably contaminated. In routine processing of urine specimens the isolates with low counts would have been assigned to the urethral flora. Eighty-six polymicrobial cultures yielded identical results with all media. Of the cultures with counts of <10⁵ CFU/ml, 26 were pure cultures and 112 were mixed cultures, with most of them having very low counts (Table 1).

Enterococci (*n* = 281) and *E. coli* (*n* = 278) were the predominant isolates in this study (Table 2). The isolation rates on the four media (BBL CHROMagar Orientation medium, CPS ID2 medium, Columbia blood agar, and MacConkey agar) were comparable for all isolates except for the enterococci, which were detected more often on the chromogenic media (Table 2). In total, 50 of the mixed cultures with counts of ≥10⁵ CFU/ml contained enterococci which were not detected on blood agar and MacConkey agar but which were detected on both chromogenic media, on which they pro-

TABLE 2. Number of isolates recovered from 540 urine specimens with counts of ≥10⁵ CFU/ml (high) and <10⁵ CFU/ml (low) on the four media

Species	No. (%) of strains isolated at high and low viability counts									
	CHROMagar Orientation medium (<i>n</i> = 926) ^b		CPS ID2 medium (<i>n</i> = 912)		Blood agar (<i>n</i> = 888)		MacConkey agar without crystal violet (<i>n</i> = 733)		Any medium ^a (<i>n</i> = 1,092)	
	≥10 ⁵ CFU/ml	<10 ⁵ CFU/ml	≥10 ⁵ CFU/ml	<10 ⁵ CFU/ml	≥10 ⁵ CFU/ml	<10 ⁵ CFU/ml	≥10 ⁵ CFU/ml	<10 ⁵ CFU/ml	≥10 ⁵ CFU/ml	<10 ⁵ CFU/ml
<i>Escherichia coli</i>	239	27	240	26	230	30	228	20	245	33
KES group	61	5	58	6	48	7	49	7	63	9
PMP group	42	9	42	8	52	8	42	4	60	10
<i>Enterococcus</i> spp.	209	57	208	57	142	56	122	37	213	68
<i>Staphylococcus saprophyticus</i>	11	1	11	2	9	3	8	2	12	3
Other bacteria ^c	153	97	143	96	158	130	128	82	206	160
<i>Candida</i> spp.	11	4	11	4	11	4	4	0	14	5
All species	726	200	713	199	650	238	581	152	804	288

^a Any medium, BBL CHROMagar Orientation, CPS ID2, blood, or MacConkey agar.

^b *n* indicates total number of isolates obtained on that medium.

^c Other bacteria were *Acinetobacter* species, *Agrobacterium radiobacter*, *Alcaligenes xylosoxidans*, *Comamonas acidovorans*, *Comamonas testosteroni*, *Flavimonas oryzae*, *Pseudomonas aeruginosa*, *Pseudomonas diminuta*, *Pseudomonas putida*, *Sphingomonas paucimobilis*, *Sphingobacterium multivorum*, *Stenotrophomonas maltophilia*, *Aeromonas hydrophila*, *Citrobacter* species, *Hafnia alvei*, *Kluyvera cryocrescens*, *Neisseria perflava*, *Corynebacterium* species, staphylococci other than *Staphylococcus saprophyticus*, *Streptococcus agalactiae*, α-hemolytic streptococci, *Lactobacillus* species, and *Bacillus* species.

TABLE 3. Recovery of colored isolates and observed color of colonies on BBL CHROMagar Orientation and CPS ID2 agars

Organism	CHROMagar Orientation medium		CPS ID2 medium	
	No. of isolates stained described color/total no. of isolates (%)	Description	No. of isolates stained described color/total no. of isolates (%)	Description
<i>Escherichia coli</i>	265/266 (100)	Pink to red	243/266 (91)	Pink to red
<i>Klebsiella</i> spp.	39/39 (100)	Blue-violet	41/44 (93)	Pale blue
<i>Enterobacter</i> spp.	21/24 (88)	Blue-red	16/19 (84)	Pale blue
<i>Enterobacter</i> spp.	1/24 (4)	Rose ^a		
<i>Serratia</i> spp.	2/3 (66)	Blue	1/1 (100)	Pale blue
<i>Citrobacter freundii</i>	13/15 (87)	Blue-violet	3/17 (18)	Blue
<i>Citrobacter freundii</i>	1/15 (7)	Rose ^a	1/17 (6)	Rose ^a
<i>Citrobacter koseri</i>	4/4 (100)	Blue-violet		
<i>Morganella morganii</i>	8/8 (100)	Colorless to beige on brown agar	7/7 (100)	Colorless to beige on brown agar
<i>Proteus mirabilis</i>	32/33 (97)	Colorless to beige on brown agar	34/34 (100)	Colorless to beige on brown agar
<i>Proteus mirabilis</i>	1/33 (3)	Rose ^a		
<i>Proteus vulgaris</i>	2/5 (40)	Blue on brown agar	2/5 (40)	Blue on brown agar
<i>Proteus vulgaris</i>	3/5 (60)	Colorless to beige on brown agar	3/5 (60)	Colorless to beige on brown agar
<i>Providencia rettgeri</i>	2/5 (40)	Blue on brown agar	2/4 (50)	Blue on brown agar
<i>Providencia rettgeri</i>	3/5 (60)	Colorless on brown agar	2/4 (50)	Colorless on brown agar
<i>Enterococcus</i> spp.	266/266 (100)	Small, blue-green	265/265 (100)	Small, blue
<i>Staphylococcus saprophyticus</i>	9/12 (75)	Small, light rose	1/13 (8)	Small, light rose
<i>Staphylococcus saprophyticus</i>			1/13 (8)	Small, pale blue
<i>Streptococcus agalactiae</i>	3/12 (25)	Tiny, blue	4/20 (20)	Tiny, blue
<i>Streptococcus agalactiae</i>			6/20 (30)	Tiny, rose to red

^a These isolates were indole negative.

duced small blue-green colonies. One *E. coli* strain on BBL CHROMagar Orientation medium and 23 *E. coli* strains on CPS ID2 medium did not develop the expected pink to red colony color (Table 3). *Proteus mirabilis* isolates produced colorless to light beige colonies with a diffusible, beige-brownish pigment around each colony; except for one rose strain on BBL CHROMagar Orientation medium, they were all correctly identified compared to the identifications from standard biochemical reactions. On both chromogenic plates, *Proteus vulgaris* was isolated twice with blue colonies and twice with colorless colonies on a brown agar. *Klebsiella* spp., *Enterobacter* spp., and *Serratia marcescens* developed a blue-red or blue-violet colony coloration on BBL CHROMagar Orientation medium with or without a purple halo. On BBL CHROMagar Orientation medium, 63 of 66 isolates that were later identified as KES group organisms produced the expected color, whereas 58 of 64 isolates on CPS ID2 medium produced the expected pale blue color. *S. saprophyticus* was isolated 13 times on CPS ID2 medium with colorless colonies and 12 times on BBL CHROMagar Orientation medium, with 9 strains (75%) showing the expected opaque rose color and the remaining 3 strains being colorless.

Generally, *Citrobacter freundii* produced blue-violet-pigmented colonies on BBL CHROMagar Orientation medium (13 of 15 colonies), but on CPS ID2 agar we found that only 3 of 17 strains had this color. One strain showed a pink to red pigmentation similar to that of *E. coli* on both agar formulations, but it was indole negative.

It was not possible to distinguish between other different organisms including *Pseudomonas* spp. and *Acinetobacter* spp., with all of them growing as colorless colonies on both agar media, and therefore, they had to be identified by other biochemical reactions.

DISCUSSION

Although blood agar is considered the optimal medium for the isolation and counting of bacteria from urine specimens

(3), it has several disadvantages, such as the minimal differentiation of the organisms recovered and its complete failure when swarming *Proteus* strains are present. Compared to blood agar, cystine-lactose-electrolyte-deficient (CLED) agar and MacConkey agar without crystal violet have several advantages, such as the inhibition of *Proteus* swarming, but both have only minimal differential potencies because they differentiate only lactose-positive and lactose-negative bacteria. The disadvantage of CLED agar and MacConkey agar without crystal violet is that they do not recover all of the organisms involved in urinary tract infections. In particular, the more fastidious strains of *Streptococcus agalactiae* either will not grow or will grow only as tiny colonies after 18 h of incubation. Media with chromogens, on which the colonies rather than the surrounding medium is stained, easily allow for the detection of the target organisms even in mixed cultures and at low colony counts (17). However, most of the studies performed with these media did not investigate the recovery of rarer organisms (15, 18–23).

The present investigation shows that the quantitative recovery of bacterial growth on the two chromogenic media corresponded well to that in previous studies (18, 19, 21–23, 27). The total number of organisms recovered was higher on both chromogenic media than on blood agar and MacConkey agar without crystal violet (Table 2). Concerning the number of species or groups isolated from the individual media, most of the clinically significant species were recovered more frequently from the chromogenic media than from the conventional formulations. In particular, enterococci were isolated much more frequently from both chromogenic media because the blue coloration of these isolates made it easier to detect them on the chromogenic media than on blood and MacConkey agars, on which they were sometimes hidden by the colonies of gram-negative bacteria and were therefore not detected. Only the PMP group was isolated less frequently from the chromogenic media than from blood agar. All nonfermentative gram-negative rods were well recovered on both agar formulations but had to be identified by conventional biochemical tests.

Concerning the ability to stain the respective colonies in the expected colors, the numbers of isolates differed only slightly between the chromogenic media. *E. coli*, *Enterobacter* spp., *Citrobacter* spp., and *S. saprophyticus* were detected more frequently on CHROMagar Orientation medium, whereas *Streptococcus agalactiae* was isolated more frequently on CPS ID2 medium. No or only minor differences were detected for the other organisms.

The production of β -glucuronidase, which is used to identify *E. coli* on CPS ID2 medium, has been evaluated in many studies (5–8, 10, 11, 13–16) and about 95 to 98% of *E. coli* isolates are reported to produce this enzyme (18, 19, 22, 23, 27), while we found that only 91.3% of the *E. coli* isolates were positive. BBL CHROMagar Orientation medium, which contains a chromogenic substrate for the detection of an enzyme of lactose metabolism, stained all but one (99.6%) of the *E. coli* strains in the expected color. On both media, the identities of all pink to red colonies should be confirmed by an indole test, since certain *Citrobacter* strains may also be stained pink to red but are indole negative (Table 3). Our results with CHROMagar Orientation medium compare well with those described previously (20, 21).

Enterococci were correctly identified on both chromogenic media, which is in accordance with the results of many other studies (12, 20–22). The colonies of the two most common enterococcal species, *E. faecalis* and *E. faecium*, gave similar color results and were therefore indistinguishable at the species level, which has also been shown in earlier studies (20, 21, 27). Although *S. agalactiae* like enterococci may produce blue colonies, both are easily distinguished from each other, because the enterococcal colonies are larger than those of the streptococci and are blue-green rather than blue.

The two chromogenic media reduced the spreading of most *Proteus* isolates and performed identically in the detection and presumptive identification of the KES group. The presumptive identification of the KES group by the formation of large blue colonies was slightly better on BBL CHROMagar Orientation medium than on CPS ID2 medium, needing further biochemical reactions in order to reach the species level with both media, whereas the recovery rate of *Klebsiella* spp. was slightly better on CPS ID2 medium than on BBL CHROMagar Orientation medium (44 versus 39 isolates).

Additionally, 9 of 12 strains (75%) of *S. saprophyticus* were correctly identified on BBL CHROMagar Orientation medium by their rose-white colonies, whereas no special coloration on CPS ID2 medium is indicated by the manufacturer. However, we found one rose and one pale blue *S. saprophyticus* strain on this CPS ID2 agar.

Since *E. coli* and enterococci are the predominant isolates involved in both community-acquired and nosocomially transmitted urinary tract infections, BBL CHROMagar Orientation and CPS ID2 media are attractive and easy-to-use screening media that considerably reduce the daily workload and the number of identification kits needed.

An additional important advantage of BBL CHROMagar Orientation and CPS ID2 media is the easy recognition of mixed cultures, as was also demonstrated in previous studies (20–22, 27). Thus, we detected more mixed cultures on both chromogenic media than on our conventional plates. The purpose of the present study was not only to determine the clinical value of the two chromogenic media but also to assess their microbiological performance relative to the total recovery of all strains, including normal resident flora. Compared to blood agar, more isolates were obtained on both chromogenic media. This might be attributed to the easy discrimination of the different colonies by color.

The presumptive identification results at the species, genus, or group level compared favorably with those obtained by proven biochemical identification methods (18, 19, 21, 22, 27).

In summary we believe that the use of chromogenic medium formulations offer an excellent and time-saving method for the reliable detection, enumeration, and presumptive identification of bacteria isolated from patients with urinary tract infections. Due to the slightly better identification rate of *E. coli*, the more intense blue coloration of the β -glucuronidase-positive organisms, and the ability to detect most of the *S. saprophyticus* isolates by colony coloration, the BBL CHROMagar Orientation medium was slightly superior to CPS ID2 medium.

Further studies are needed to evaluate the suitability of using these chromogenic media with specimens other than urine specimens.

REFERENCES

- Baumgartner, C., A. M. Freydiere, and Y. Gille. 1996. Direct identification and recognition of yeast species from clinical material by using Albicans ID and CHROMagar Candida plates. *J. Clin. Microbiol.* **34**:454–456.
- Beighton, D., R. Ludford, D. T. Clark, S. R. Brailsford, C. L. Pankhurst, G. F. Tinsley, J. Fiske, D. Lewis, B. Daly, N. Khalifa, V. Marren, and E. Lynch. 1995. Use of CHROMagar Candida medium for isolation of yeasts from dental samples. *J. Clin. Microbiol.* **33**:3025–3027.
- Clarridge, J. E., M. T. Pezzlo, and K. L. Vostl. 1987. Cumitech 2A, Laboratory diagnosis of urinary tract infections. Coordinating ed., A. S. Weissfeld. American Society for Microbiology, Washington, D.C.
- Clint, F. 1992. Initial processing, inoculation, and incubation of aerobic bacteriology specimens, p. 1.4.1–1.4.19. In H. D. Isenberg (ed.), *Clinical microbiology procedures handbook*, vol. 1. American Society for Microbiology, Washington, D.C.
- Dalet, F., and T. Segovia. 1995. Evaluation of a new agar in Uricult-trio for rapid detection of *Escherichia coli* in urine. *J. Clin. Microbiol.* **33**:1395–1398.
- Dealler, S. F., D. Law, J. Collins, and P. Parnell. 1992. *Escherichia coli*: rapid identification by chromogenic tests. *Med. Lab. Sci.* **49**:12–15.
- Delisle, G. J., and A. Ley. 1989. Rapid detection of *Escherichia coli* in urine samples by a new chromogenic β -glucuronidase assay. *J. Clin. Microbiol.* **27**:778–779.
- Döller, P. C., W. R. Heizmann, and W. Werner. 1990. Rapid identification of *Escherichia coli* in monomicrobial urine specimens by a fluorogenic assay. *J. Microbiol. Methods* **12**:51–55.
- Dusch, H., and M. Altwegg. 1993. Comparison of Rambach agar, SM-ID medium, and Hectoen Enteric agar for primary isolation of non-typhi salmonellae from stool samples. *J. Clin. Microbiol.* **31**:410–412.
- Edberg, S. C., and C. M. Kontnick. 1986. Comparison of β -glucuronidase based substrate systems for identification of *Escherichia coli*. *J. Clin. Microbiol.* **24**:368–371.
- Freydiere, A. M., and Y. Gille. 1993. A new CPS medium for rapid identification and enumeration of bacteria in urine samples, abstr. P.14/5, p. 107. In *Rapid methods and automation in microbiology and immunology*.
- Freydiere, A. M., and Y. Gille. 1994. Yeasts: appearance of colonies on CHROMagar Candida. In *IUMS Congress 94, 7th International Congress of Mycology Division*.
- Geiss, H. K. 1990. Comparison of two test kits for rapid identification of *E. coli* by a beta-glucuronidase assay. *Eur. J. Clin. Microbiol. Infect. Dis.* **9**:151–152.
- Heizmann, W., P. C. Döller, B. Gutbrod, and H. Werner. 1988. Rapid identification of *Escherichia coli* by Fluorocult media and positive indole reaction. *J. Clin. Microbiol.* **26**:2682–2684.
- Kodaka, H., M. Ishikawa, M. Iwata, F. Kashitani, S. Mizuochi, and K. Yamaguchi. 1995. Evaluation of a new medium with chromogenic substrates for members of the family *Enterobacteriaceae* in urine samples. *J. Clin. Microbiol.* **33**:199–201.
- Larinkari, U., and M. Rantio. 1995. Evaluation of a new dipslide with a selective medium for the rapid detection of beta-glucuronidase-positive *Escherichia coli*. *Eur. J. Clin. Microbiol. Infect. Dis.* **14**:606–609.
- Manafi, M., W. Kneifel, and S. Bascomb. 1991. Fluorogenic and chromogenic substrates used in bacterial diagnostics. *Microbiol. Rev.* **55**:335–348.
- Martin, C., S. Orenge, F. Doleans, and F. Denis. 1995. Intérêt des milieux contenant des substrats chromogènes pour l'identification et la numération des bactéries urinaires. *Pathol. Biol.* **43**:749–753.
- Mazoyer, M. A., S. Orenge, F. Doleans, and J. Freney. 1995. Evaluation of CPS ID2 medium for detection of urinary tract bacterial isolates in specimens from a rehabilitation center. *J. Clin. Microbiol.* **33**:1025–1027.
- Merlino, J., S. Siarakas, G. J. Robertson, G. R. Funnell, T. Gottlieb, and R. Bradbury. 1995. Evaluation of CHROMagar Orientation for the differentiation and presumptive identification of gram negative bacilli and *Enterococ-*

- cus* species, poster 17. In Abstracts of the Annual Meeting of the Australian Society for Microbiology.
21. **Merlino, J., S. Siarakas, G. J. Robertson, G. R. Funnell, T. Gottlieb, and R. Bradbury.** 1996. Evaluation of CHROMagar Orientation for differentiation and presumptive identification of gram-negative bacilli and *Enterococcus* species. *J. Clin. Microbiol.* **34**:1788–1793.
 22. **Núñez, M. L., J. Díaz, I. Lorente, I. Pérez, and J. Ruiz.** 1995. Evaluation of CPS ID2 medium for diagnosis of urinary infections. *Eur. J. Clin. Microbiol. Infect. Dis.* **14**:1111–1113.
 23. **Orenga, S., L. Barbaux, L. Berenguer, F. Doleans, D. Monget, C. Moser, and F. Villeval.** 1993. Urinary tract infections: improved CPS ID, a new ready-to-use medium for enumeration and identification of *Escherichia coli*, *Proteae*, and *Enterococcus*: J. Rapid Methods Automat. Microbiol. Immunol. **1993**:32–33.
 24. **Pfaller, M. A., A. Houston, and S. Coffmann.** 1996. Application of CHROMagar Candida for rapid screening of clinical specimens for *Candida albicans*, *Candida tropicalis*, *Candida krusei*, and *Candida (Torulopsis) glabrata*. *J. Clin. Microbiol.* **34**:58–61.
 25. **Rambach, A.** 1990. New plate medium for facilitated differentiation of *Salmonella* spp. from *Proteus* spp. and other enteric bacteria. *Appl. Environ. Microbiol.* **56**:301–303.
 26. **Ruiz, J., L. M. Núñez, C. Climent, M. A. Sempere, and J. Gomez.** 1995. Utilización del agar Rambach para la detección de *Salmonella* en heces a partir de un caldo de enriquecimiento. Comparación con nuestra metodología. *Enferm. Infecc. Microbiol. Clin.* **13**:213–217.
 27. **Willinger, B., and M. Manafi.** 1995. Evaluation of a new chromogenic agar medium for the identification of urinary tract pathogens. *Lett. Appl. Microbiol.* **20**:300–302.