Sindh Univ: Res: Jour:( Sc: Ser:) Vol: 31 (1) 7-26 (1999).

# BACTERIO FLORA OF DRINKING WATER OF SINDH UNIVERSITY CAMPUS, JAMSHORO

Abdul Qayyum Soomro, Abdul Sattar Porgar Abdul Latif Soomro*

Department of Botany, University of Sindh, Jamshoro

## Abstract

Fifty five bacterial species belonging to different families, like. Rhodospirillaceae, Chromatiaceae, Beggiatoaceae, Achromatiaceae, Pelonemataceae, Pseudomanadaceae, Azotobacteraceae, Halobacteriaceae, Enterobacteriaceae, Veillonellaceae, Nitrobacteracea, Siderocapsaceae, Micrococaceae, Streptococcaceae, Peptococcaceae and Bacillaceae etc. were isolated from water supply of Jamshoro( mainly Sindh University Campus).

**Key words; bacterio flora, drinking water,**

## Introduction

Water is mostly polluted with flora and fauna of great diversity, (Rheinheimer 1985). Water pollution, on the other hand play an important role in the spreading of water borne diseases like, dysentery, typhoid, paratyphoid, cholera, urinary tract infections, liver disorders etc. (Pelczar and-chan 1981, Brooks, *et al* 1991, Johnson *et al* 1993).

The campus of Sindh University gets water from Kalri-Baghar feeder (commonly known as K.B.Feeder). The water of said canal is prepolluted with the waste from Sandoz Pharmaceutical Ltd; Jamshoro, irrigation department's workshop, R.B. Barrage Colony, M.P.O Colony and few villages. This work is aimed at study of the quality of water (from bacteriological view point), utilized by the residents of Sindh University Campus.

## Material and Method

Water samples were collected from different sites (K.B.feeder, Sindh University filter plant, main tank, tapes of some departments and from different containers (Naadies, tanks etc. at Sindh University boys, girls – Hostels and Sindh University Colony) in the sterilized test tubes under maximum aseptic conditions.

The samples were brought to the laboratory at the earliest. Each sample was streak-inoculated in four replicates of the petridishes containing various sterilized media ( eg Nutriat Synthtic, differential and specific media) and the were incubated. at $37^0$C for two days. After incubation, the culture grown on streak (s) were purified (Beisher 1987; Wistreich and-Lechttman 1980) The pure cultures in turn were then preserved for further studies.

## Identification and Experimental Results

Colonial, cellular and physiological characters of the purified cultures were studied by conventional and quick methods (Collee *at al* 1989; Levine 1954; Salle 1954 & Soomro *et al*) and the data was recorded. In some cases the physiological results were verified by using various kits (such as API, Systek etc.)

The species were identified by comparing the aforesaid recorded data, with the data of species in various manuals of Bergey's Determinative/systematic Bacteriology (1957, 1974, 1984).
The species so far identified from water of various sites are as under:

* Department of Physiology, University of Sindh, Jamshoro.

CamScanner

## 1- K.B FEEDER (MAIN SOURCE OF WATER OF CAMPUS)

| S.NO | NAME(S)OF SPECIES | | FAMILY |
|---|---|---|---|
| 1 | *Rhodospirillum rubrum* | (Esmarch)Molisch | Rhodospirlaceae |
| 2 | *R.fulvum* | Van Niel | -do- |
| 3 | *Rhodopseudomonas palustris* | (Molisch)Van Niel | -do- |
| 4 | *Chromatium warmingii* | (Cohn) Migula | Chromatiaceae |
| 5 | *C.minus* | Winogradsky | -do- |
| 6 | *Thiocystis violacea* | Winogradsky | -do- |
| 7 | *Chlorobium vibrioforme* | Pelsh | Chlorobiaceae |
| 8 | *Beggiatoa arachnoidea* | (Agardh)Rabenhorst | Beggiatoaceae |
| 9 | *B.mirabilis* | Cohn | -do- |
| 10 | *Achromatium oxaliferum* | Schewiakoff | Achriomatiaceae |
| 11 | *Pelonema tenue* | Lauterborn | Pelonematiaceae |
| 12 | *Pseudomonas aeruginosa* | (Schroeter) Migula | Pseudomonadaceae |
| 13 | *Azotobabcter chroococcum* | Beijerinck | Azotobacteraceae |
| 14 | *A beijerinckii* | Lipman | -do- |
| 15 | *Escherichia coli* | (Migula) Castellani and Chalmers | Enterobacteriaceae |
| 16 | *Salmonella typhi* | (Schroeter)Warren and Scott | -do- |
| 17 | *Erwinia-herbicola* | (Lohnis) Dye | -do- |
| 18 | *Aeromonas punctata* | (Zimmermann) Snieszko | Vibrionaceae |
| 19 | *Neisseria gonorrhoeae* | (Zopf) Trevisan | Neisseriaceae |
| 20 | *N meningitidis* | (Albirecht and Ghon) Murray | -do- |
| 21 | *N.Sicca* | (Von Lingelsheim) Bergeys *et al* | -do- |
| 22 | *Branhamella catarrhalis* | (Frosch and Kolle) Catlin | -do- |
| 23 | *Acinetobacter calcoaceticus* | (Beijerinck) Baumann, Doudoroff and Stanier | -do- |
| 24 | *Naumanniella elliptica* | Beger | Siderocapsaceae |
| 25 | *Micrococcus luteus* | (Schroeter) Cohn | Micrococcaceae |
| 26 | *Desulfotomaculum nigrificans* | (Werkman and Weaver) Campbell and Postgate | Bacillaceae |

CamScanner

## 11. UNIVERSITY FILTER PLANT

| S.NO | NAME (S) OF SPECIES | | FAMILY |
|---|---|---|---|
| 1 | *Rhodospirillum rubrum* | (Esmarch)Molisch | Rhodospirillaceae |
| 2 | *Chromatium warmingi* | (Cohn)Migula | Chromatiaceae |
| 3 | *C.minus* | Winorgadsky | -do- |
| 4 | *Thiocystis violacea* | Winoagrdsky | -do- |
| 5 | *Beggiatoa mirabilis* | Cohn | Beggiatoaceae |
| 6 | *Azotobacter Chroococumm* | Beijerinck | Azotobacteraceae |
| 7 | *A. beijerinckii* | Lipman | -do- |
| 8 | *Erwinia herbicola* | (Lohnis) Dye | Enterobacteriaceae |
| 9 | *Aeromonas punctata* | (Zimmermann)Snieszko | Vibrionaceae |
| 10 | *Neisseria Sicca* | (Von Lingelsheim) Bergeyes *et al* | Neissriaceae |
| 11 | *Desulfotomaculum nigrificans* | (Werkman and Weaver) Campbell and postgate | Bacillaceae |

## III. TAPE WATER OF VARIOUS DEPARTMENTS

| S.NO | NAME(S) OF SPECIES | FAMILY |
|---|---|---|
| 1 | *Rhodospirillum rubrum (Esmarh) Molisch* | Rhodospirillaceae |
| 2 | *Thiocysitis violacea Winogradsky* | Chromatiaceae |
| 3 | *Thiocapsa pfennigii Emhjellen* | - do - |
| 4 | *Azotobacter chroococcum Beijerinck* | Azotobacteraceae |
| 5 | *Hallococcus morrhuae (Farlow ) Kocur and Hodgkiss* | Hallobacteriacea |
| 6 | *Escherichia coli (Migula) Castellani and Chalmers* | Enterobacteriaceae |
| 7 | *Salmonella typhi (Schroeter) warren and scott* | - do - |
| 8 | *Shigella dysenteriae (Shiga) Castellani and Chalmers* | - do - |
| 9 | *Klebsiella pneumoniae (Schroeter) Trevisan* | - do - |
| 10 | *Neisseria gonorrhoeae (Zopf) Trevisan* | Neisseriaceae |
| 11 | *N. meningitidis (Albrecht and Ghon) Murrey* | - do - |
| 12 | *N. sicca (Von Lingelsheim) Bergey et al* | - do - |
| 13 | *N. subflava (Flugge) Trevisan* | - do - |
| 14 | *Branhamella catarrhalis (Frosch and Kolle) Catlin* | - do - |
| 15 | *Acinetobacter calcoaceticus (Beijerinck) Baumann, Doudoroff and Staner.* | - do - |
| 16 | *Paracoccus denitrificans (Beijerinck) Davis in Davis, stanier, doudoroff and Mandel.* | - do - |
| 17 | *P. halodenitrificans (Robinson and Gibbons) Davis in Davis et al.* | - do - |
| 18 | *Acidaminococcus fermentans Rogosa* | Veillonellaceae |
| 19 | *Nitrosococcus nitrosus (Migula) Buchanan* | Nitrobacteraceae |
| 20 | *Micrococuss luteus (Schroeter) Cohn* | Micorcoccaceae |
| 21 | *M. varians Migula* | - do - |
| 22 | *M. Colpogenes Campbel and Williams* | - do - |
| 23 | *M. cryophilus Mclean, Sulzbacher and Mudd* | - do - |
| 24 | *Staphylococcus aureus Rosenbach* | - do - |

CamScanner

| | | |
|---|---|---|
| 25 | *S. epidermidis (Winslow and winslow) Evans* | - do - |
| 26 | *S. saprophyticus (Fairbrother) Shaw, Stitt and Cowan.* | - do - |
| 27 | *Streptococcus pyogenes Rosenhach* | Streptococcaceae |
| 28 | *S. equisimilis Frost and Engelbrecht* | - do - |
| 29 | *S. dysgalactiae Diernhofer* | - do - |
| 30 | *S. pneumoniae (Klein) Chester* | - do - |
| 31 | *S. mits Andrewes and Horder* | - do - |
| 32 | *S. faecalis Andrewes and Horder* | - do - |
| 33 | *S.faecium orla – Jenesen* | - do - |
| 34 | *S. lactis (Lister) Lohnis* | - do - |
| 35 | *Peptococcus niger (Hall) Kluyver and Van Niel* | Peptococcaceae |
| 36 | *P. asaccharolyticus (Distaso) Douglas* | - do - |
| 37 | *P. anaerobius (Hamm) Douglas* | - do - |
| 38 | *Peptostreptococcus parvulus (Weinberg et al) smith* | - do - |
| 39 | *Sarcina ventriculi Goodasir* | - do - |

CamScanner

**TABLE**
**COMPARATIVE CHARACTERISTIC FEATURES OF THE ISOLATED BACTERIAL SPEICES**

| | | (1) ⟶ Rhodospirillaceae ⟵ | | |
|---|---|---|---|---|
| | | *Rhodospirullum rubrum* | *R. fulvum* | *Rhodopseudomonas palutris* |
| 1. | Form, arrangement and measurement | Vb.–sp.7-10µmL 8-10µmw 1 comp. turn of sp. 1.5-5µm | Sp.0.5 7µmW | Rod/OV Sph.6-.9µmW |
| 2. | Gram reaction | - | - | - |
| 3. | Motility | + | + | + |
| 4. | Sporulation | | | |
| 5. | Capsule | | | |
| 6. | $O_2$ requirement | F.aer | anae | Anae/f.aer |
| 7. | pH | 6.8-7 | 6-8.5 | 5.5-8.5 |
| 8. | Temperature | 30-35°C | 30°C | 30-37°C |
| 9. | Nutrition | | | |
| 10. | Color-individual | | | |
| 11. | Color-colonyor suspesion | Deep.pl. | Org. Rds Br. | R.Dark Br. |
| Acid production from | Glucose | | | |
| | Lactose | | | |
| | Succrose | | | |
| | Maltose | | | |
| | Galactose | | | |
| | Fructose | | | |
| | Mannose | | | |
| | Arabinose | | | |
| | Xylose | | | |
| | Glycerol | | | |
| | Mannitol | | | |
| 13. | Nitrate reduction | | | |
| 14. | $H_2S$ production | | | |
| 15. | Ammonia production | | | |
| 16. | Amylase | | | |
| 17. | Gelatinase | | | |
| 18. | Catalase | | | + |
| 19. | Oxidase | | | |
| 20. | Urease | | | |
| 21. | Casease | | | |
| 22. | Lipase | | | |
| 23. | Indole | | | |
| 24. | V.P. Test | | | |
| 25. | M.R. Test | | | |

CamScanner

| | | (2) → Chromatiaceae ← | | | (3) → Chlorobiaceae ← | |
|---|---|---|---|---|---|---|
| | | *Chromatium warmingi* | *C. minus* | *Thiocystis violaceae* | *Thiocapsa pfenningii* | *Chlorobium vibrioforme* |
| 1. | Form, arrangement and measurement | Ft. tuft 1.5-2 times the CellL.3.54.5µmW 7-9µm L | OV., bean 2µmW 2.5-6µmL | Sph. Ov 2.5-3µm diam. | Sph.slight Ov. 1.2-1.5µm diam. | Short Vb., rod, slightly Cur. 0.5-7µmW. 1-2µmL. |
| 2. | Gram reaction | - | - | - | - | - |
| 3. | Motility | + | + | + | - | - |
| 4. | Sporulation | | | | | |
| 5. | Capsule | | | | | |
| 6. | $^{O}2$ requirement | anae | anae | anae | anae | anae |
| 7. | $P^{H}$ | 6.5-7.6 | 6.5-7 | 7—7.5 | 6.5-7.5 | 6-7 |
| 8. | Temperature | 30°C | 30°C | 25-30°C | 25°C | 25-30°C |
| 9. | Nutrition | Ob.Pht. | Ob.Pht. | Ob.Pht. | Op.Pht. | Ob.Pht. |
| 10. | Color-individual | | | | | Lt.Gr. |
| 11. | Colorcolonyor suspesion | Pl.rd to Vt. | | | Colorless Lt.Org,Br. | Gr. |
| Acid production from | Glucose | | | | | |
| | Lactose | | | | | |
| | Succrose | | | | | |
| | Maltose | | | | | |
| | Galactose | | | | | |
| | Fructose | | | | | |
| | Mannose | | | | | |
| | Arabinose | | | | | |
| | Xylose | | | | | |
| | Glycerol | | | | | |
| | Mannitol | | | | | |
| 13. | Nitratereductin | | | | | |
| 14. | $H_2S$production | | | | | |
| 15. | Ammoniaproduction | | | | | |
| 16. | Amylase | | | | | |
| 17. | Gelatinase | | | | | |
| 18. | Catalase | | | + | + | |
| 19. | Oxidase | | | | | |
| 20. | Urease | | | | | |
| 21. | Casease | | | | | |
| 22. | Lipase | | | | | |
| 23. | Indole | | | | | |
| 24. | V.P. Test | | | | | |
| 25. | M.R. Test | | | | | |

CamScanner

| | | (4) **Beggiatoaceae** | | (5) **Achromatiaceae** | (6) **Pelonemataceae** |
|---|---|---|---|---|---|
| | | *Beggiatoa archnoidea* | *B.mirabilis* | *Achromatium oxaliferum* | *Palonema tenue* |
| 1. | Form, arrangement andmeasurement | Fts, rods, 15-21µmW, 45-13µmL | Fts, rods, 15-21 µmW, 5-13-µmL | Sph, Ov, Ocryl 5-100µml | Fts, St. or Slightly flexous;slightly constricted at cross walls 1.9-2.2x3-19µmL |
| 2. | Gram reaction | - | - | - | ± occasionally |
| 3. | Motility | + gl | + | ±gl. | |
| 4. | Sporulation | N.K. | N.K. | N.K | |
| 5. | Capsule | | | | |
| 6. | $^{O}2$ requirement | Aer-Micaer | Aer-M.aer | M.aer. | |
| 7. | $1P^{H}$ | | | | |
| 8. | Temperature | | | | |
| 9. | Nutrition | Myxt. | Myxt. | | |
| 10. | Color-individual | Colorless | Colorless | | Colorless |
| 11. | Color-colonyor suspesion | | | | |
| Acid production from | Glucose | | | | |
| | Lactose | | | | |
| | Succrose | | | | |
| | Maltose | | | | |
| | Galactose | | | | |
| | Fructose | | | | |
| | Mannose | | | | |
| | Arabinose | | | | |
| | Xylose | | | | |
| | Glycerol | | | | |
| | Mannitol | | | | |
| 13. | Nitratereduction | | | | |
| 14. | $H_2S$ production | | | | |
| 15. | Ammonia production | | | | |
| 16. | Amylase | | | | |
| 17. | Gelatinase | | | | |
| 18. | Catalase | | | | |
| 19. | Oxidase | | | | |
| 20. | Urease | | | | |
| 21. | Casease | | | | |
| 22. | Lipase | | | | |
| 23. | Indole | | | | |
| 24. | V.P. Test | | | | |
| 25. | M.R. Test | | | | |

CamScanner

| | | (7) Pseudomondaceae | (8) Azotobacteriaceae | | (9)Halobacteraceae |
|---|---|---|---|---|---|
| | | *Pseudomonas aeruginosa* | *Azotobacter Chroococcum* | *A.bejerinckii* | *Hallococcus morrhuae* |
| 1. | Form, arrangement and measurement | Rod, single/pairs 5-8x1.5-3µm short chains | L,Ov, rods, pairs | Ov., Rods, single/chains/ pairs | CCd,/pairs/tetrads; 0.6-1.5µm diam. |
| 2. | Gram reaction | - | - | - | - |
| 3. | Motility | + | + | -- | -- |
| 4. | Sporulation | N.K | - | - | - |
| 5. | Capsule | | | | |
| 6. | $O_2$ requirement | Ob.aer | aer | aer | aer |
| 7. | 12pH | | | | 7.2 |
| 8. | Temperature | 37-41$^{O}$C | | | 30-37$^{O}$C |
| 9. | Nutrition | Ch.o | Het.t.Ch.o | Het.ch.o | Ch.o |
| 10. | Color-individual | | | | |
| 11. | Color-colonyor suspesion | | | | |
| Acid production from | Glucose | | | | - |
| | Lactose | | | | - |
| | Succrose | | | | - |
| | Maltose | | | | - |
| | Galactose | | | | - |
| | Fructose | | | | - |
| | Mannose | | | | - |
| | Arabinose | | | | - |
| | Xylose | | | | - |
| | Glycerol | | | | - |
| | Mannitol | | | | |
| 13. | Nitrate reduction | | +ut | -N.ut | + |
| 14. | $H_2S$ production | | | | + |
| 15. | Ammonia production | | | | - |
| 16. | Amylase | - | + | -N.ut. | +/- |
| 17. | Gelatinase | + | | | + |
| 18. | Catalase | + | + | + | + |
| 19. | Oxidase | + | | | + |
| 20. | Urease | | | | - |
| 21. | Casease | | | | ±we |
| 22. | Lipase | | | | + |
| 23. | Indole | | | | + |
| 24. | V.P. Test | | | | |
| 25. | M.R. Test | | | | |

CamScanner

| | | (10) ← Enterobacteriaceae → | | | |
|---|---|---|---|---|---|
| | | Escherichia coli | Salmonella typhii | Shigilla dysentriae | Klebsiella penumoniae |
| 1. | Form, arrangement and measurement | St., rods, 1.1-2.5 x 2-6 µm single/pairs | Rods | Rods | Rods 13-1.5x.6-6µm single/pairs short Chains |
| 2. | Gram reaction | - | - | - | - |
| 3. | Motility | + | + | - | |
| 4. | Sporulation | - | - | - | - |
| 5. | Capsule | +? | | - | + |
| 6. | $O_2$ requirement | F.anae/aer | F.anae/aer | F.aae/aer | F.anae/aer |
| 7. | pH | | | | 7.2 |
| 8. | Temperature | | | | 35-37$^{O}$C |
| 9. | Nutrition | Cho.o | Ch.o | Ch.o | Ch.o |
| 10. | Color-individual | | | | |
| 11. | Colorcolonyorsuspesin | | | | |
| 12 | Acid production from Glucose | + | + nogass | + | +Gass |
| | Lactose | +/x | D | D | + |
| | Succrose | d | - | D | + |
| | Maltose | +/x | D | D | D |
| | Galactose | | | | |
| | Fructose | | | | |
| | Mannose | | | | |
| | Arabinose | + | + | | D |
| | Xylose | d | + | - | + |
| | Glycerol | | | | |
| | Mannitol | + | + | - | + |
| 13. | Nitrate reduction | + | + | + | + |
| 14. | $H_2S$ production | - | + | - | - |
| 15. | Ammonia production | d | + | - | - |
| 16. | Amylase | | | | |
| 17. | Gelatinase | - | D | - | - |
| 18. | Catalase | + | + | ± | + |
| 19. | Oxidase | - | - | - | - |
| 20. | Urease | - | - | - | D+ |
| 21. | Casease | | | | |
| 22. | Lipase | | | | |
| 23. | Indole | + | - | d | D |
| 24. | V.P. Test | - | - | - | D+ |
| 25. | M.R. Test | + | + | + | D- |

**X = Late reactions,**
**D = different reactions given by different species of genus**
**d = Different reactions given by different strains of species**

CamScanner

| | | (10) ⟶ Enterobacteriaceae ⟵ | (11) Vibrionaceae |
|---|---|---|---|
| | | *Erwinia herbicloa* | *Aeromonas punctata* |
| 1. | Form, arrangement and measurement | St. rods. Single 1-4µm | St. Rods, round ends. CCd./Single/Pairs/chains 1-4.4µm. |
| 2. | Gram reaction | - | - |
| 3. | Motility | + | + |
| 4. | Sporulation | - | - |
| 5. | Capsule | | |
| 6. | $O_2$ requirement | F.anae/aer | F.anae |
| 7. 12 | pH | | 5.5-9 |
| 8. | Temperature | 27-32$^{O}$C | 37$^{O}$C |
| 9. | Nutrition | Ch.o | Ch.o |
| 10. | Color-individual | | |
| 11. | Color-colonyor suspesion | | |
| Acid production from | Glucose | + | + gass |
| | Lactosé | D+ | F.anae/aer |
| | Succrose | + | d |
| | Maltose | + | |
| | Galactose | + | + |
| | Fructose | + | + |
| | Mannose | + | |
| | Arabinose | + | d |
| | Xylose | + | |
| | Glycerol | | |
| | Mannitol | + | **d** |
| 13. | Nitrate reduction | + | + |
| 14. | $H_2S$ production | + | + |
| 15. | Ammonia production | | |
| 16. | Amylase | - | + |
| 17. | Gelatinase | + | + |
| 18. | Catalase | + | + |
| 19. | Oxidase | - | + |
| 20. | Urease | ± | - |
| 21. | Casease | - | + |
| 22. | Lipase | ± | |
| 23. | Indole | | + |
| 24. | V.P. Test | - | - |
| 25. | M.R. Test | d | |

CamScanner

| | | ← (12) Neisseraceae → | | | | |
|---|---|---|---|---|---|---|
| | | *Neisseria gonorrhoea* | *N.meningitidis* | *N. Sica* | *N.subflava* | *Branhamella catarrhalis* |
| 1. | Form. arrangement and measurement | Ced. single/pairs. Adj-sides Ftd. 6-1μm diam | Ced. single/pais .6-1.00 μm dia adj-sides Ftd. | Ced. single/pas 6-1.00 μm diam adj. Sides Ftd. | Ced. single/pairs . 6-1.00 μm diam adj.-sides Ftd. | Ced. pairs adj-sides Ftd. |
| 2. | Gram reaction | - | - | - | - | - |
| 3. | Motility | - | - | - | - | - |
| 4. | Sporulation | - | - | - | - | - |
| 5. | Capsule | - | ± | ± | + | + |
| 6. | $O_2$ requirement | aer/F.anae | aer/F.anae | aer/F.ane | aer/F.anae | aer |
| 7. | pH | | | | | |
| 8. | Temperature | 30-38°C | 37°C | 37°C | 37°C | 22-37°C |
| 9. | Nutrition | Ch.o. | Ch.o | Ch.o | Ch.o | Ch.o |
| 10. | Color-individual | | | | | |
| 11. | Color-colonyor suspesion | | | | | |
| 12 | Acid production from Glucose | + gass | + | + | + | |
| | Lactose | | | | | |
| | Sucerose | - | - | + | ± | |
| | Maltose | | + | + | + | |
| | Galactose | - | | | | |
| | Fructose | - | - | + | ± | |
| | Mannose | | | | | |
| | Arabinose | - | | | | |
| | Xylose | | | | | |
| | Glycerol | | | | | |
| | Mannitol | - | | | | |
| 13. | Nitrate reduction | - | - | - | - | + |
| 14. | $H_2S$ production | - | - | + | + | - |
| 15. | Ammoniaproductin | | | | | |
| 16. | Amylase | - | - | ± | ± | |
| 17. | Gelatinase | | | | | |
| 18. | Catalase | + | + | + | + | + |
| 19. | Oxidase | + | + | + | + | + |
| 20. | Urease | + | | | | - |
| 21. | Casease | - | | | | |
| 22. | Lipase | | | | | + |
| 23. | Indole | + | | | | - |
| 24. | V.P. Test | - | | | | |
| 25. | M.R. Test | | | | | |

↑ No acid from Carbohydrates ↓

CamScanner

| | | ← (12) Neisseriaceae → | | |
|---|---|---|---|---|
| | | *Acinetobacter calcoaceticus* | *Paracoccus denitri ficans* | *P.halodenitrificans* |
| 1. | Form, arrangement and measurement | Rods, short plump. Pairs/ short chains 1-1.5 x 1.1-2.5µm | Ced, Coco bacilli single/pairs aggregates 1.1x1.3 µm | Ced, single/pairs aggregate 0.5µm dia. |
| 2. | Gram reaction | - | - | - |
| 3. | Motilit | - | - | - |
| 4. | Sporulation | - | - | - |
| 5. | Capsule | ± | | |
| 6. | $O_2$ requirement | aer | aer | aer |
| 7. | pH | f | | |
| 8. | Temperature | 30-32 $^{O}$C | 5-37 $^{O}$C | 20-32 $^{O}$C |
| 9. | Nutrition | Ch.o | Ch.o/F.ch | Ch.o |
| 10. | Color-individual | | | |
| 11. | Color-colonyor suspesion | | | |
| 12 | Acid production from: Glucose | May/May not acid from produce Carbohydrates | May/May not produce acid from Carbohydrates | |
| | Lactose | | | |
| | Sucerose | | | |
| | Maltose | | | |
| | Galactose | | | |
| | Fructose | | | |
| | Mannose | | | |
| | Arabinose | | | |
| | Xylose | | | |
| | Glycerol | | | |
| | Mannitol | | | |
| 13. | Nitrate reduction | - | + | + |
| 14. | $H_2S$ production | - | | |
| 15. | Ammonia production | | - | - |
| 16. | Amylase | | ± | ± |
| 17. | Gelatinase | ± | - | |
| 18. | Catalase | + | + | + |
| 19. | Oxidase | - | + | + |
| 20. | Urease | - | | |
| 21. | Casease | | | |
| 22. | Lipase | | | |
| 23. | Indole | - | | |
| 24. | V.P. Test | | | |
| 25. | M.R. Test | | | |

CamScanner

| | | (13) Veillonellaceae | (14) Nitrobacteraceae | (15)Siderocapsaceae |
|---|---|---|---|---|
| | | *Aidaminococcus fermentus* | *Nitrosococcus nitrosus* | *Naumannilla elliptica* |
| 1. | Form, arrangement and measurement | Ccd/dip.Ccd,, Ov Kidney 6-1.00µm diam | L.,sph.,single/pairs/tetr ads. 1.5-1.7.00µm diam. | Ellipsoid 2x2.5µm |
| 2. | Gram reaction | - | - | - |
| 3. | Motilit | - | - | - |
| 4. | Sporulation | - | - | |
| 5. | Capsule | | - | + |
| 6. | $O_2$ requirement | anae | aer . | aer. |
| 7 12 | pH | 6.2-7.5 | 6-8 | |
| 8. | Temperature | 30-37 $^0$C | 20-30 $^0$C | |
| 9. | Nutrition | Ch . o | Ob . Ch . I | Ch . • |
| 10. | Color-individual | | | |
| 11. | Color-colonyor suspesion | | | |
| Acid production from | Glucose | | | |
| | Lactose | | | |
| | Succrose | | | |
| | Maltose | | | |
| | Galactose | | | |
| | Fructose | | | |
| | Mannose | | | |
| | Arabinose | | | |
| | Xylose | | | |
| | Glycerol | | | |
| | Mannitol | | | |
| 13. | Nitrate reduction | - | | |
| 14. | $H_2S$ production | - | | |
| 15. | Ammonia production | + | | |
| 16. | Amylase | | | |
| 17. | Gelatinase | ± | | |
| 18. | Catalase | - | | |
| 19. | Oxidase | - | | |
| 20. | Urease | | | |
| 21. | Casease | | | |
| 22. | Lipase | | | |
| 23. | Indole | - | | |
| 24. | V.P. Test | | | |
| 25. | M.R. Test | | | |

CamScanner

| | | (16)→ Micrococcaceae ← | | | | |
|---|---|---|---|---|---|---|
| | | *Mocrococcus luteus* | *M. varians.* | *M.colpogenes* | *M.cryophilus* | *Staphylococcs aureus* |
| 1. | Form,arrangemen and measurement | Sph.,single/pairIrregular Clusters. 1-2µm diam. | Sph.single/pairs tetrads Clusters 1-1.5µm diam | Sph. pairs | Sph.single/pairs/chains/ 1-3.6µm diam | Sph. Single/pairs/ Clusters 8-1µm diam. |
| 2. | Gram reaction | + | + | + | + | + |
| 3. | Motility | - | - | - | - | - |
| 4. | Sporulation | - | - | - | m | - |
| 5. | Capsule | | | | | ± |
| 6. | $O_2$ requirement | aer. | aer. | aer. | aer. | aer./f.anae |
| 7. | pH | 6.4-8.2 | | | 5.5-9.5 | 7-7.5 |
| 8. | Temperature | 25-30 ° C | 22-37°C | 25-30 ° C | 25-30 ° C | 30 ° C-37 ° C |
| 9. | Nutrition | Ch.o | Ch.o | Ch.o | Ch.o. | Ch.o |
| 10. | Color-individual | YI. | | | | |
| 11. | Color-colonyor suspesion | | YI. | | | |
| Acid production from | Glucose | - | + | | | + |
| | Lactose | | + | | | + |
| | Succrose | | + | | | |
| | Maltose | | + | | | ± |
| | Galactose | | + | | | |
| | Fructose | | + | | | |
| | Mannose | | | | | |
| | Arabinose | | | | | - |
| | Xylose | - | + | | | - |
| | Glycerol | | | | | |
| | Mannitol | | | | | + |
| 13. | Nitrate reduction | | + | + | - | + |
| 14. | $H_2S$ production | | + | - | | ± |
| 15. | Ammonia production | - | - | + | | + |
| 16. | Amylase | | - | | - | - |
| 17. | Gelatinase | | + | | - | - |
| 18. | Catalase | + | + | + | + | + |
| 19. | Oxidase | | | | | |
| 20. | Urease | | | + | + | |
| 21. | Casease | | ± | + | - | + |
| 22. | Lipase | | ± | | + | + |
| 23. | Indole | | | - | | - |
| 24. | V.P. Test | | | | | |
| 25. | M.R. Test | | | | | |

CamScanner

| | | (16) ⟶ Micrococcaceae ⟵ | | (17) Streptococcaceae | |
|---|---|---|---|---|---|
| | | *S. epidermidis* | *S. saprophyticus* | *Streptococcus pyogones* | *S. equisimilis* |
| 1. | Form, arrangement and measurement | Sph.single/pairs 5-1.5µm diam. | Sph. Single/pairs/tetrads 5-1.5µm diam. | Sph. Ov./pairs 6-1. 00µm dia or less than 0.2µm | Sph. Pairs/chains |
| 2. | Gram reaction | + | + | + | + |
| 3. | Motility | - | - | - | - |
| 4. | Sporulation | - | - | - | - |
| 5. | Capsule | | | | |
| 6. | $O_2$ requirement | aer/F. anae. | aer/F. anae. | F.anae | F.anae |
| 12 | pH | 7-7.5 | 7-7.5 | | |
| 8. | Temperature | 35-40 ° C | 35-40 ° C | 37°C | 37°C |
| 9. | Nutrition | Ch.o | Ch.o | Ch.o | Ch.o |
| 10. | Color-individual | | | | |
| 11. | Color-colonyor suspesion | Wht./yI. | Wht./ye Org. | | |
| Acid production frame | Glucose | + | + | + | + |
| | Lactose | + | - | + | - |
| | Succrose | | + | + | + |
| | Maltose | + | ± | + | + |
| | Galactose | | | | |
| | Fructose | | | | |
| | Mannose | | | | |
| | Arabinose | - | - | - | - |
| | Xylose | - | - | | |
| | Glycerol | + | + | - | + |
| | Mannitol | ± | ± | | - |
| 13. | Nitrate reduction | + | + | | |
| 14. | $H_2S$ production | + | | | |
| 15. | Ammonia production | + | + | | |
| 16. | Amylase | - | - | - | ± |
| 17. | Gelatinase | | + | ± | - |
| 18. | Catalase | + | + | - | - |
| 19. | Oxidase | | | | |
| 20. | Urease | | + | | |
| 21. | Casease | | + | ± | |
| 22. | Lipase | | + | | |
| 23. | Indole | - | - | | |
| 24. | V.P. Test | | | | |
| 25. | M.R. Test | | | | |

CamScanner

| | | (17) → Streptococcaceae ← | | | |
|---|---|---|---|---|---|
| | | *S. dysgalactiae* | *S.pneumoniae* | *S.mitis* | *S.faecalis* |
| 1. | Form,arrangemet and measurement | Sph./Ov.in chains | Sph. Ov. Ccd.in Pairs/chains 5-1.25 µm diam | Sph ellipsoid 0.6-8µm diam | Ov.in chains/pair .5-1.00µm diam |
| 2. | Gram reaction | + | + | + | + |
| 3. | Motility | - | - | - | - |
| 4. | Sporulation | - | - | - | - |
| 5. | Capsule | | | | |
| 6. | $O_2$ requirement | F. anae. | F. anae. | F.anae | F.anae |
| 12 | pH | | | | |
| ω. | Temperature | 37°C | 25-42 ° C | 37°C | 37-42 °C |
| 9. | Nutrition | Ch.o | Ch.o | Ch.o | Ch.o |
| 10. | Color-individual | | | | |
| 11. | Color-colonyor suspesion | | | | |
| Acid production from | Glucose | + | + | + | + |
| | Lactose | ± | + | - | + |
| | Succrose | + | + | + | + |
| | Maltose | + | + | + | + |
| | Galactose | | | + | - |
| | Fructose | | + | | + |
| | Mannose | | | | + |
| | Arabinose | | ± | - | - |
| | Xylose | | ± | - | |
| | Glycerol | - | ± | - | + |
| | Mannitol | | ± | - | + |
| 13. | Nitrate reduction | | + | | |
| 14. | $H_2S$ production | | | | |
| 15. | Ammonia production | | um | | |
| 16. | Amylase | - | - | - | - |
| 17. | Gelatinase | - | - | - | - |
| 18. | Catalase | - | - | - | - |
| 19. | Oxidase | | | | |
| 20. | Urease | | | | |
| 21. | Casease | | | | |
| 22. | Lipase | | | | |
| 23. | Indole | | | | |
| 24. | V.P. Test | | | | |
| 25. | M.R. Test | | | | |

CamScanner

| | | (17)→ Streptococcaceae ← | | (18) Peptococcaceae | |
|---|---|---|---|---|---|
| | | S. faecium | S.lactis | Peptococcus niger | P.asaccharolyticus |
| 1. | Form, arrangement and measurement | Ov.in chains/pairs. 5-1.0 µm diam. | Ov.in chains/pairs 5-1.00µm diam. | Spn.Single/tetrad irregular 5-1.00µm diam | Sph. Single/tetrads/irregular .5-1.00µm diam |
| 2. | Gram reaction | + | + | + | + |
| 3. | Motility | ± | - | - | - |
| 4. | Sporulation | - | - | - | - |
| 5. | Capsule | | | | |
| 6. | $O_2$ requirement | F. anae. | F. anae. | anae | anae |
| 7. | 12 H | | | 6-8 | |
| 8. | Temperature | 37-47 °C | 30-37 °C | 35-37°C | |
| 9. | Nutrition | Ch.o | Ch.o | Ch.o | Ch.o |
| 10. | Color-individual | | | | |
| 11. | Color-colonyor suspesion | | | | |
| Acid production from | Glucose | | + | | |
| | Lactose | + | + | | |
| | Succrose | + | + | | |
| | Maltose | + | + | | |
| | Galactose | + | | | |
| | Fructose | + | | | |
| | Mannose | | | | |
| | Arabinose | ± | + | | |
| | Xylose | | + | | |
| | Glycerol | | - | | |
| | Mannitol | ± | + | | |
| 13. | Nitrate reduction | | | | + |
| 14. | $H_2S$ production | | | | + |
| 15. | Ammonia production | + | | + | + |
| 16. | Amylase | - | - | | |
| 17. | Gelatinase | - | - | - | - |
| 18. | Catalase | - | - | +w | +w |
| 19. | Oxidase | | | | |
| 20. | Urease | | | | - |
| 21. | Casease | | | | - |
| 22. | Lipase | | | | |
| 23. | Indole | | | | + |
| 24. | V.P. Test | | | | |
| 25. | M.R. Test | | | | |

CamScanner

| | | → (18) Peptococcaceae ← | | → (19) Bacillaceae ← | |
|---|---|---|---|---|---|
| | | S.anaerobicus | Peptostreptococcus parvulus | Sarcina ventriculi | Desulfoto maculum nigrificans |
| 1. | Form. arrangement and measurement | Sph.single/ tetrads. Irregular 5-1.00µm diam | Sph. (small) short Chains/pairs. 3-4µm diam | Sph.in packets of 8 cells 1.8-2.4µmdiam | RodsSt.-Cur.Round ends3-5x3-6. |
| 2. | Gram reaction | + | + | + | + |
| 3. | Motility | - | - | - | + |
| 4. | Sporulation | - | - | - | + |
| 5. | Capsule | | | | |
| 6. | $O_2$ requirement | anae. | anae. | anae. | ob.anae. |
| 12 | pH | | 6-8 | | |
| .. | Temperature | | 25-38 ° C | 30-37°C | 35-55°C |
| 9. | Nutrition | Ch.o | Ch.o | Ch.o | Ch.o |
| 10. | Color-individual | | | | |
| 11. | Color-colonyor suspesion | | Bl | | Bl |
| Acid production from | Glucose | | + | + | |
| | Lactose | | + | + | |
| | Sucrose | | - | + | |
| | Maltose | | - | + | |
| | Galactose | | - | + | |
| | Fructose | | - | + | |
| | Mannose | | -m | + | |
| | Arabinose | | ± | - | |
| | Xylose | | - | - | |
| | Glycerol | | | - | |
| | Mannitol | | | - | |
| 13. | Nitrate reduction | - | - | | |
| 14. | $H_2S$ production | + | + | | + |
| 15. | Ammoniaproductn | + | + | | |
| 16. | Amylase | | | | |
| 17. | Gelatinase | - | - | | |
| 18. | Catalase | +w | - | - | |
| 19. | Oxidase | | | | |
| 20. | Urease | | | | |
| 21. | Casease | | | | |
| 22. | Lipase | | | | |
| 23. | Indole | - | - | | |
| 24. | V.P. Test | | | | |
| 25. | M.R. Test | | | | |

CamScanner

aer = Aerobic, anae = Anaerobic,
BI=Black,Br =Brown,
Ch.I= Chemolithotrophic
Ch.o. = Chemoorganotrophic, Ccd = coccoid, Cur= Curved, Cyl = cylindrical
Diam = Diameter,
F.aer = Facultative aerobic, F.anae = Facultative anaerobic
Ft/Fts = Filaments/Filamentous, Fl = Flagella/Flagellar, Ftd. = Flattended
gl = Gilinding, Gr = Green, Lth = Length, It = Light, L = Long
M.aer = Microaerophilic, Myxt. = Myxotrophic, N.K. = Not Known
N.ut = Not utilized, Ob = Obligate, Org = Orange, Ov = Ovoid, Pht. Aut = Photoautotrophic,
Poht. = Photrophic, Pk = Pink, Pl = Purple, Rd = Red, Rds = Reddish, Sg = Segment
Sph = Spherical, Sp. = Spiral, St. = Straight, Ut. = Utilized, Vb.= Vibrio
Vt. = Violet, We = Weak, Wht = White, W. =Wide, Yd. = Yellow.

## Discussion /conclusion

The present investigation indicates that the main source is highly polluted (M.P.N 2 x 10") and the degree of pollution goes on decreasing to the extent of (M.P.N54x$10^{8}$)when it comes out of the tape .But when it is stored in the containers (Naadies etc.)at the hostels the degree of pollution is raised (M.P.N 17x$10^{12}$) The reason for this is manily attributed to the unhygienic conditions at the canteens, employees and containers.

Our results indicate that the water of Sindh University specially of the hostels is not up to the standard of W.H.O (Ahmed Khurshid 1998), is highly contaminated and potentially hazardous for human consumption.

## References

1. Ahmed khurshid (1998) "Environmental engineering laboratory" A-one publication Lahore p.208.
2. Beisher L.(1987) "Microbiology in practiece"(4th Edition). Harper and Row New York.
3. Brooks G.Butel J.S & omstan L.N (1991)"Medical Microbiology "prentice–hall international inc.
4. Buchanan R.E and Gibbons N.E (1974) Berge'y manual of determinative Bacteriology"(8th Edition). The William and wilkins company Baltimore.
5. Collee J.G; Duguid J.p;Fraser A.G and Marmion B.P (1988)"practical Microbiology"(13thEdition). Churchill living stone Edinburgh London.
6. Johnson A.G,Zeigler R.J Fitzgerald T.J. Lukasewycz A and Hantey L.B (1993). Microbiology and Immunology "(2nd Edition). Harwal publishing.
7. Levine Max (1954)"An introduction to laboratory Techniques in Bacteriolgy "(3rd Edition) The Macmillan Company New York.
8. Pelczar M.J and Chan E.C.S (1981) "Elements of Microbiology (International student Edition )
9. Rheinheimer G.(1985) "Aquatic Microbiology"(2rd Edition). Johan Willey and sons
10. RoseF.C"introductory Microbiology" (2nd Edition ). Charles E.Merril publishing Company.

CamScanner

11. Salle A.J (1954) "laboratory Manual on Fundamental principles of Bachteriology"(4th Edition).Mc Graw Hill Book Company. Inc. New York.

12. Soomro A.Q; Progar A.S; H. Naseem and Soomro A.L "Quick and Economical Methods for Monitoring Biochemical activities of Bacteria; Sindh university Research Journal (in Press).

13. Stalley J.T;Bryant M.P;Pfennig N and Hott (1989)"Bergey's Manual of systematic Bacteriology "(Vol.1-1V).Williams and wilkins Company Baltimore.

14. Wistreich G.A; Lechtman M.D(1980)"Laboratory exercises in Microbiology" (4th Edition). Mcmillan publishing Co. New York.

CamScanner