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acta SATECH **3**(1): 76 - 84 (2009)

Bacteriological and antimicrobial screening of some commonly dispensed tablets from pharmacy outlets in three major towns in south-west Nigeria

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ABSTRACT

A bacteriological and antimicrobial susceptibility study of the bacterial contaminants associated with some Piriton, Folic Acid, Ferrous Sulphate, Paracetamol and Chloroquine tablets was carried out with focus on level of contamination and their antimicrobial susceptibility profiles using the disc diffusion technique. Isolated bacteria included different strains of Acinetobacter species, Alcaligenes species, Bacillus species, Citrobacter species, Corynebacterium spp., Flavobacterium species, Enterobacter aerogenes, Enterococcus malodoratus, Micrococcus species, Pseudomonas aeruginosa, Salmonella typhi, Serratia species, Shigella dysenteriae and Staphylococcus species. In all the tablets sampled Bacillus spp. were the most frequently isolated species. Six of the isolated bacteria spp. – Acinetobacter, Bacillus, Corynebacterium, Flavobacterium, Micrococcus and Staphylococcus - from sachet samples were also isolated from both hospital and community Pharmacies' tablets. Piriton tablets from both hospital and community pharmacies were found to be more contaminated than other tablets. All the isolates were susceptible to ciprofloxacin and pefloxacin while exhibiting varying degrees of susceptibility to all other antibiotics used. None of these isolates was susceptible to amoxicillin and ceftriazone. Strict quality control and assurance are suggested during production and packaging of all pharmaceutical tablets while drug dispensers in hospital and community pharmacy outlets should ensure compliance to good hygienic mode of dispensing drugs.

Key words: Pharmaceutical tablets, antibiotics, antimicrobial susceptibility, bacterial species.

INTRODUCTION

Microorganisms form an integral part of the environment and the human body. Therefore, it may be common to find that both raw materials and final medicines will contain microorganisms unless specific measures are adopted to exclude them (Kesley *et al.*, 1975).

The microbiological quality of pharmaceutical products is of significant importance to human health. The microbial quality of these pharmaceutical products, depending on their nutritional and moisture contents, is influenced by the quality of the raw materials used during preparation. Most raw materials used in formulation of tablets support some form of microbial growth, which is dependent on factors like water and mixture of the constituents of the tablets (Grigo, 1976; Knox and Penikette, 1993). However, the problem arises when there is usually no obvious sign of microbial spoilage or contamination (Barson and Bloonfield, 1998).

Several pharmaceutical products have been reported to have microbial contamination. Chlohexidine-containing creams have potential pathogens such as *Enterococci, Staphylococci, Proteus mirabilis, Pseudomonas aeruginosa,* opportunistic *Moraxella spp* and diphtheroids as well as other contaminants such as *Bacillus spp and Micrococcus spp.* (Salveson and Bergan, 1981). Na'was *et al.* (1990) reported on cough syrup contaminated by *Candida albicans.* Other pharmaceutical products such as medicines from both stationary and ambulatory wards (Aslund *et al.,* 1981), storage solutions (Fotos *et al.,* 1990), NaCl (0.95%) and dextrose saline (Lisle *et al.,* 1990), topical creams (Na'was *et al.,* 1994), aerosol solutions containing antibiotics (Oie and Kamiya, 1995), antiseptics and disinfectants (Oie and Kamiya, 1996), pharmaceutical agents and irrigation solutions widely used in optometric and ophthalmology practices (Clark *et al.,* 1997), and medicinal herbal drugs (Czech *et al.,* 2001) have been implicated in microbial contaminations. While the knowledge of microbial content of all drugs and medicines, whether they are required to be of sterile or non-sterile preparations, is essential (Parker, 1984), it is of more

importance to investigate the antibacterial susceptibility of most of these bacterial contaminants. In developing countries such as Nigeria, drug-borne infections may have serious debilitating effects on patients because of low socio-economic lifestyle. This problem may be compounded by the fact that pharmaceutical preparations are frequently stored under uncontrolled conditions and dispensed from large packs that may take an average of four to six weeks to exhaust, depending on the demands, in hospitals and pharmaceutical medicine stores. Therefore, there is the need to identify and evaluate the presence or otherwise of microbial contaminations on tablet dosage forms during dispensing from bulk packs as well as determining their antibacterial susceptibility. Consequently, this study was designed to investigate the numbers and types of organisms in Piriton, Folic Acid, Ferrous Sulphate, Paracetamol and Chloroquine tablets commonly dispensed from newly opened large container packages in some hospitals and community pharmacies in three different locations in South-Western part of Nigeria. This is with the aim of estimating the health hazards to which patients are exposed through the microbial contamination of such tablets dispensed from large packages and the susceptibility patterns of these possible contaminants.

MATERIALS AND METHODS

Media

Nutrient Agar (NA), Nutrient Broth (NB), Eosin Methylene Blue Agar (EMBA), Deoxychollate Citrate Agar (DCA), and Manitol Salt Agar (MSA) used were all Oxoid products.

Preparation of Tablet Dispersion

Ten tablets each of Piriton, Folic Acid, Paracetamol, Chloroquine Phosphate and film coated Ferrous Sulphate from different drug manufacturers were randomly sampled and picked from newly opened containers from hospital pharmacies and actively patronized community pharmacies in different locations in Lagos, Oyo and Ogun State respectively. As a control measure, sachet samples obtained from different pharmacies were investigated. Five (5) tablets each of Piriton, Ferrous Sulphate, Chloroquine, and Folic acid were dispersed in 10ml of sterile distilled water, while Paracetamol was dissolved in 20ml of sterile distilled water. They were allowed to stand for 15 minutes for proper dissolution while Ferrous Sulphate tablets were allowed to stand for 20minutes for the film coat to break open. These solutions were then agitated intermittently for two minutes to dislodge possible microbial cells present while 1ml of the aliquot was serially diluted to a concentration of 10^4 - 10^6. Similar experimental procedures were carried out for samples taken from sachet samples and newly opened containers from both hospital and community pharmacy outlets.

Isolation and identification of Organisms

The microbial count (cfu/ml) for each group of tablet samples obtained from hospital and community pharmacies as well as their respective sachet samples were determined after incubating at 37^{o}C for 48 hours. One millilitre of the original suspension of each of the dissolved sampled tablets was dropped on the surfaces of MSA, EMBA, and DCA respectively, and kept standing for 30minutes to allow the suspension to be absorbed before incubation at 37^{o}C for 24hours during which increase in bacterial growths were monitored. One millilitre of the aliquot from the serial dilutions was also dropped in cooled molten Nutrient Agar in McCartney bottles, mixed thoroughly before pouring into sterile Petri dishes and allowed to set before incubating in an inverted position at 37^{o}C for 24hrs to determine colony forming unit per ml (cfu/ml) for each tablet under investigation. Lactose Broth and Nutrient Broth were also inoculated with the original suspensions before incubation at 37^{o}C for 24hrs while growths were monitored as turbidity in the medium. While discrete colonies from plates containing serially diluted aliquots were counted using bacteriological colony counter, each colonial type seen on the various solid media was sub-cultured and identified as far as possible with the aid of Bergey's Manual of Determinative Bacteriology, (Buchanan and Gibbons, 1974) and Singleton's Bacteria in Biology, Biotechnology and Medicine, (Singleton, 1998) after a wide range of biochemical tests including Gram-staining, indole, motility, starch hydrolysis, oxidase, Vogues-Proskauer as well as some sugar utilization and colonial cultural characterization had been done. Experiments were carried out in duplicates under "Equitron" inoculating hood sterilized with ultraviolet light. As a control measure, sterile plates were exposed in the sterilized inoculating hood before being simultaneously incubated with other specimens.

Susceptibility Testing

Susceptibility testing was performed by a standard agar dilution technique (Washington & Sutter, 1980) using Mueller Hinton agar (Lab. M; International Diagnostic Group Plc., Lancashire, UK). The isolated

organisms were subcultured onto fresh plates of Nutrient Agar (Oxoid, UK) for 24hrs at 37ºC for bacteria. Colonies from these plates were suspended in Mueller-Hinton broth (Oxoid, UK), to a turbidity matching 0.5 mc McFarland standard. The resulting suspension contains approximately 1 X 10^6 cfu/ml. Exactly 100µl (approx.10^6cfu/ml) of these standardized broth cultures of each test organism was dispersed into 20ml volumes of molten Mueller Hinton Agar prepared according to manufacturer's instruction, mixed thoroughly, poured into sterile petri dishes and allowed to set. The following antibiotic discs (drug concentration in (µg)) Ciprofloxacin (Cip) (5), Ofloxacin (Ofl) (5), Pefloxacin (PFX) (10), Streptomycin (STR) (10), Chloramphenicol (CHL) (30), Gentamycin (GN) (10), Erythromycin (ER) (10), Cotrimoxazole (COT) (25), Norfloxacin (NB) (10), Azithromycin (AZ) (10), Cefuroxime (CF) (20), Clindamycin (CD) (10), Cephalexin (CX) (10), Amoxicillin (AMX) and Ceftriazone (CEF). They were aseptically placed on the inoculated agar using flame-sterilized forceps. Zones of inhibitions around each antibiotic disc were measured after 24hrs of incubation.

RESULTS

Table 1 shows the microbial count (cfu/ml) for each type of tablet sampled from community pharmacies, hospital pharmacies and unopened sachets while Table 2 indicates the bacterial species associated with all the tablets sampled. The isolated and identified bacteria included *Pseudomonas aeruginosa, Salmonella typhi, Serratia marcescens, Serratia liquifaciens, Shigella sp., Staphylococcus aureus, Staphylococcus epidermidis, Staphylococcus albus, Enterobacter aerogenes, Enterococcus malodoratus, Citrobacter freundii, Alcaligenes faecalis,* and different strains of *Micrococcus, Acinetobacter, Bacillus, Corynebacterium* and *Flavobacterium* species. The level of contamination was higher in hospital pharmacies' tablets than in community pharmacies's tablets although more bacterial species were isolated from community pharmacies's tablets than hospital pharmacies' tablets. Based on microbial count, Piriton was found to have the highest cfu/ml, followed in descending order by Folic Acid, Paracetamol, Chloroquine, and Ferrous Sulphate. This may be as a result of the fact that Piriton tablets were more prescribed as anti-histamic tablets to prevent itches accompanying some other prescribed drugs.

From Table 2, seven species, nine species and twelve species of bacteria were respectively isolated from the sachets, hospital and community pharmacies' tablets. *Bacillus species* were the most frequently isolated bacterial species followed by *Micrococcus species, Alcaligenes spp.* and *Acinetobacter spp.* in both hospital and community pharmacies' tablets, whereas *Corynebacterium species* were the most isolated bacterial species from tablets of unopened sachets. It was also observed that more bacteria species were isolated from community pharmacies while the bacteria load of hospital pharmacies' tablets were higher than those observed in community pharmacies' tablets.

Based on these results, all the sampled tablets were found to be contaminated with bacteria. Six species of the bacteria isolated from sachet samples were also found in both hospital and community pharmacies' tablets. These include *Acinetobacter, Bacillus, Corynebacterium, Flavobacterium, Micrococcus* and *Staphylococcus*. *Alcaligenes spp.* and *Citrobacter spp.* were isolated from hospital and community Pharmacies' tablets only. In addition to these isolates common to all groups of samples collected, a strain each of *Enterococcus sp.,* and *Salmonella sp.* were respectively isolated from the sachets and hospital pharmacies' tablets while a strain of *Pseudomonas sp., Shigella sp.,* and *Enterobacter sp.* as well as two strains of *Serratia spp.,* were isolated from the community pharmacies' tablets.

The *in vitro* susceptibility of these bacteria to different concentrations of antibiotics used is shown in Table 3 while a graphical representation of their susceptibility patterns is presented in Figures 1- 5. Susceptibility testing showed that all the organisms were susceptible to more than one type of the antibiotics used. All bacteria were susceptible to ciprofloxacin and ofloxacin. They exhibited a varying degree of susceptibility to other antibiotics used. About 90.2% of these bacteria were susceptible to GN, 87.8% to both CD and AZ, 85.4% to ER, 82.9% to NB and PFX, 80.5% to CHL and 70.7% to STR. While 53.7%, 41.5% and 36.6% of these bacteria were, respectively, susceptible to COT, CX and CF, all the isolated contaminants were resistant to both AMX and CEF.

DISCUSSION

The assessment of quality, safety and efficacy constitutes an important component ofpharmaceutical product evaluation. According to Martinez-Bermudez *et al.,* (1991), microorganisms of the genius *Bacillus*, *Bifidobacterium* and *Clostridium* are those most frequently isolated from pharmaceutical raw materials while *Enterococci, Staphylocci, Pseudomonas aeruginosa, Serratia, Shigella, and*

Salmonella are potential pathogens. This may be as result of their spores constantly raised with dust particles.Salveson & Bergan, (1981) suggested that *Corynebacterium, Bacillus* and *Micrococcus* may be opportunists. Tagliavini, (1927) and Meyer, (1964) reported that the presence of large quantities of nonpathogenic microorganisms in drugs may cause serious trouble such as the decomposition of pyramidion by bacteria and alterations in the drug's smell and taste. The isolation of *Pseudomonas aeruginosa, Salmonella typhi, Shigella dysenteriae, Staphylococcus aureus,* and *Serratia liquefaciens* from some of the tablets is worrisome as they can cause infections in both man and animals.

While the physical alterations of these pharmaceutical tablets by bacterial contaminants is significant, the implication of presence of these microbial contaminants on health should not be underestimated as a number of drug-borne infections associated with the use of heavily contaminated pharmaceutical tablets had been reported widely in different parts of the world. Kalling *et al.,* (1966) reported that more than 200 people became ill in Sweden after taking thyroid tablets heavily contaminated with *Salmonella meunchen*. Lang *et al.,* (1967) and Kormany *et al.,* (1967) reported that salmonellosis due to *Salmonella cubana* occurred in hospitals in the USA following the use of infected carmine dye in the investigation of intestinal abnormalities. *Pseudomonas thomasii* has also been implicated in an outbreak of hospital-acquired colonization and infection related to contamination of water purified in a hospital pharmacy by improper autoclaving procedures (Phillips *et al.,* 1972). While *Pseudomonas spp.* resistant to antibiotics including neomycin and polymyxin B caused a number of cases of septicaemia in New York following the use of contaminated solutions for the storage of intravenous catheters (Plotkin and Austria, 1958), patients acquired *Pseudomonas aeruginosa* in the gut from food and medicaments at a London Teaching Hospital (Shooter *et al.,* 1969).

Considering aseptic random picking of tablets from newly opened containers and use of unopened sachets of same as control, the presence of bacteria in unopened sachet tablets sampled and an existence of similarity between these isolates and those obtained from both hospital and community pharmacies' tablets indicated that all groups of tablets of Piriton, Folic Acid, Ferrous Sulphate, Paracetamol and Chloroquine either manufactured, dispensed and/or mostly marketed in Nigeria are contaminated with bacteria. While these imply that the production systems of these drugs' manufacturers might be defective and are therefore advised to ensure quality assurance through inspection rather than through design, the significance of dispensing materials acting as major source of contamination of most of these tablets may not be overlooked.

Although with the exception of few cases, the microbial contaminations of most tablets fall within standard numerical limit of 5 x 10^4bacteria per ml set for oral preparations by NCPB (1999) with the absence of *E. coli*, *Salmonella, Staph. aureus* and *Pseudomonas aeruginosa* in 1g/ml. However, the presence of some of these *Enterobacteriaceae* was still recorded during this study. The presence of these *Enterobacteriaceae spp.* may or may not be as a result of contamination from tablet dispensers alone but may have resulted from the contaminated water used in the procedure of preparation. Hence, apart from the microbial control of pharmaceuticals, attention should be focused on identifying what individual manufacturing steps in large scale production influence the microbial counts of different intermediates and of the final products. On the other hand, drug dispensers in hospital and community pharmacies should ensure proper hygiene as these contaminants are capable of causing drug-borne infections.

While several studies had implicated different microbial contaminants in different pharmaceutical products, no *in vitro* susceptibility studies had been carried out on isolated microbial contaminants from pharmaceutical products which had been earlier reported. However, considering the number of strains of bacterial species isolated from tablets dispensed from both community and hospital pharmaceutical outlets as well as unopened sachets and the possible pathogenic potentials possessed by these microbial contaminants, it becomes imperative to, occasionally, investigate their susceptibility to commonly administered antibiotics in case they are eventually implicated in clinical epidemiology. Based on results obtained from this study, all the bacterial species exhibited varying degrees of susceptibility to various antibiotics used.

While cases of drug borne infections may not have been reported in Nigeria, this study indicated that clinical cases associated with contaminated tablets or drugs could be treated easily with most of the antibiotics readily available in Nigerian markets because of the level of susceptibility exhibited by these bacteria. Although immunocompetent individuals may not express symptoms of infection to these contaminants, it is a known fact that they are dangerous to the immunocompromised. Effort should, therefore, be made toward a significant

reduction, if not total elimination, of bacterial contaminants in drugs.

Table 1: Microbial counts (cfu/ml) for each tablet sample from Community and Hospital pharmacies as well as representative samples in sachets used as control after incubating at 37°C for 48 hours

Community Pharmacies' Tablets (CP)	Average total viable aerobic count at 48 hours.	Hospital Pharmacies' Tablets (HP)	Average viable aerobic count at 48 hours	Tablets in Sachets (TS)	Average total viable aerobic count at 48 hours
CPA1	3×10^3	HPA1	3×10^3	TSA1	1×10^4
CPA2	2×10^5	HPA2	2×10^2	TSA2	7×10^3
CPA3	2×10^3	HPA3	3×10^2	TSA3	3×10^4
CPA4	2×10^3	HPA4	2×10^3	TSA4	2×10^4
CPA5	6×10^3	HPA5	4×10^2	TSA5	1×10^4
CPB1	4×10^3	HPB1	4×10^3		
CPB2	6×10^3	HPB2	2×10^3		
CPB3	3×10^3	HPB3	8×10^3		
CPB4	3×10^3	HPB4	7×10^3		
CPB5	1×10^3	HPB5	3×10^3		
CPC1	3×10^3	HPC1	4×10^2		
CPC2	6×10^3	HPC2	5×10^2		
CPC3	2×10^3	HPC3	2×10^2		
CPC4	3×10^3	HPC4	9×10^3		
CPC5	5×10^3	HPC5	6×10^3		
CPD1	1×10^3	HPD1	3×10^4		
CPD2	4×10^5	HPD2	3×10^4		
CPD3	1×10^3	HPD3	6×10^2		
CPD4	1×10^3	HPD4	8×10^4		
CPD5	1×10^3	HPD5	7×10^4		
CPE1	2×10^4	HPE1	4×10^3		
CPE2	1×10^3	HPE2	3×10^3		
CPE3	4×10^3	HPE3	5×10^4		
CPE4	5×10^2	HPE4	9×10^3		
CPE5	3×10^3	HPE5	13×10^3		
CPF1	5×10^3				
CPF2	2×10^3				
CPF3	2×10^4				
CPF4	9×10^3				
CPF5	1×10^4				

KEY: **CP = Tablets from Community Pharmacies; HP = Tablets from Hospital Pharmacies; TS = Tablets from Unopened Sachets; A, B, C, D, E, F Series represent different Pharmaceutical outlet**

1 Series = Paracetamol; 2 Series = Piriton; 3 Series = Ferrous Sulphate; 4 Series = Folic acid; 5 Series = Chloroquine

Table 2: Bacteria Isolated From Tablets Obtained From Newly Opened Containers In Community And Hospital Pharmacies As Well As Unopened Sachets.

CP		HP		TS	
A1	*Shigella sp.*	A1	*Bacillus subtilis*	A1	*Staphylococcus albus*
A2	*Staphylococcus aureus*	A2	*Alcaligenes faecalis*	A1	*Acinetobacter anitratus*
A2	*Pseudomonas aeruginosa*	A3	*Acinetobacter mallei*	A1	*Bacillus cereus*
A2	*Serratia marcescens*	A4	*Corynebacterium spp*	A2	*Corynebacterium spp*
A3	*Flavobacterium rigense*	A5	*Micrococcus varians*	A3	*Acinetobacter anitratus*
A4	*Flavobacterium rigense*	B1	*Bacillus cereus*	A3	*Flavobacterium rigense*
A4	*Corynebacterium spp*	B1	*Micrococcus varians*	A3	*Micrococcus kristinae*
A5	*Micrococcus varians*	B2	*Bacillus spp*	A4	*Bacillus polymyxa*
B1	*Micrococcus luteus*	B2	*Bacillus subtilis*	A4	*Corynebacterium spp*
B2	*Staphylococcus aureus*	B2	*Bacillus brevis*	A4	*Micrococcus luteus*
B3	*Micrococcus kristinae*	B3	*Acinetobacter mallei*	A5	*Enterococcus malodoratus*

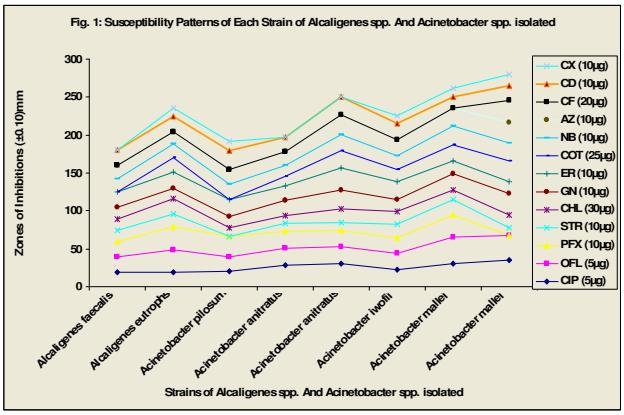
B4	*Alcaligenes spp*	B4	*Flavobacterium rigense*	A5	*Corynebacterium pilosum*
B5	*Acinetobacter mallei*	B4	*Bacillus spp*		
C1	*Micrococcus varians*	B4	*Flavobacterium spp*		
C1	*Bacillus cereus*	B5	*Acinetobacter iwoffi*		
C2	*Citrobacter freundii*	B5	*Micrococcus varians*		
C3	*Bacillus subtilis*	B5	*Micrococcus varians*		
C4	*Corynebacterium spp*	C1	*Micrococcus varians*		
C4	*Alcaligenes faecalis*	C1	*Citrobacter freundii*		
C5	*Micrococcus kristinae*	C2	*Bacillus polymyxa*		
D1	*Alcaligenes faecalis*	C2	*Flavobacterium spp*		
D1	*Corynebacterium spp*	C3	*Bacillus cereus*		
D2	*Enterobacter aerogenes*	C3	*Micrococcus varians*		
D3	*Bacillus megaterium*	C4	*Alcaligenes eutrophs*		
D4	*Bacillus megaterium*	C4	*Bacillus cereus*		
D5	*Acinetobacter sp*	C4	*Acinetobacter pilosum*		
D5	*Flavobacterium sp*	C5	*Bacillus circulans*		
E1	*Micrococcus varians*	C5	*Salmonella typhi*		
E2	*Bacillus spp*	C5	*Alcaligenes faecalis*		
E3	*Bacillus spp*	D1	*Acinetobacter eutrophs*		
E4	*Acinetobacter iwoffi*	D1	*Acinetobacter mallei*		
E4	*Bacillus cereus*	D2	*Citrobacter freundii*		
E4	*Bacillus macerans*	D2	*Staphylococcus epidermidis*		
E5	*Alcaligenes faecalis*	D3	*Acinetobacter anitratus*		
E5	*Bacillus coagulans*	D3	*Bacillus coagulans*		
E5	*Micrococcus luteus*	D4	*Flavobacterium spp*		
F1	*Corynebacterium sp.*	D4	*Bacillus laterosporus*		
F2	*Alcaligenes faecalis*	D4	*Micrococcus roseus*		
F2	*Serratia liquefaciens*	D5	*Bacillus circulans*		
F3	*Micrococcus luteus*	D5	*Bacillus brevis*		
F3	*Flavobacterium gleum*	E1	*Acinetobacter iwoffi*		
F3	*Staphylococcus epidermidis*	E2	*Flavobacterium sp.*		
F4	*Bacillus circulans*	E2	*Bacillus brevis*		
F4	*Corynebacterium spp*	E3	*Micrococcus roseus*		
F5	*Micrococcus varians*	E4	*Staphylococcus aureus*		
		E5	*Alcaligenes faecalis*		
		E5	*Citrobacter freundii*		

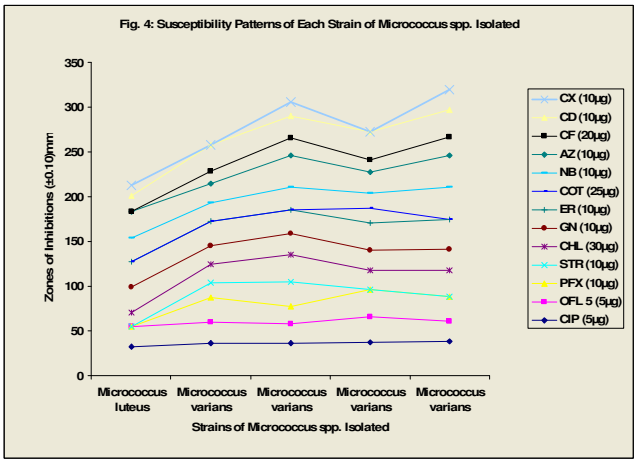
KEY:
CP = Tablets from Community Pharmacies; HP = Tablets from Hospital Pharmacies; TS = Tablets from Unopened Sachets; A, B, C, D, E, F Series represent different Pharmaceutical outlet;
1 Series = Paracetamol; 2 Series = Piriton; 3 Series = Ferrous Sulphate; 4 Series = Folic acid;
5 Series = Chloroquine

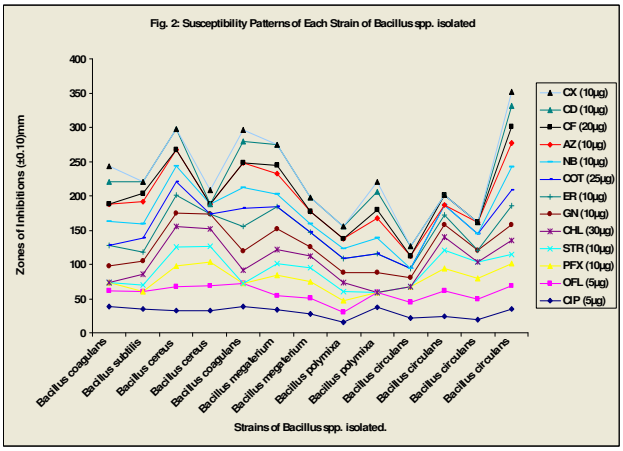
Table 3: Susceptibility pattern of different isolated bacteria to different antibiotics (±0.10)mm

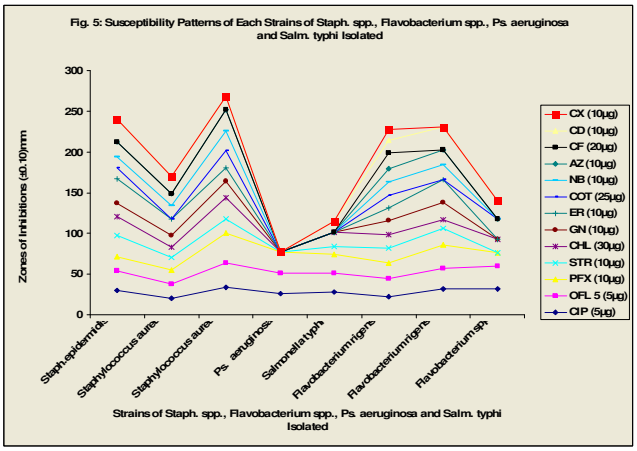
	CIP (5µg)	OFL (5µg)	PFX (10µg)	STR (10µg)	CHL (30µg)	GN (10µg)	ER (10µg)	COT (25µg)	NB (10µg)	AZ (10µg)	CF (20µg)	CD (10µg)	CX (10µg)
Alcaligenes faecalis	19	20	21	15	14	16	20	0	17	18	0	21	0
Alcaligenes eutrophs	19	30	30	17	20	14	21	19	18	16	0	20	12
Acinetobacter pilosum	20	20	27	0	11	14	23	0	20	20	0	24	13
Acinetobacter anitratus	28	23	22	11	10	20	19	12	15	18	0	19	0
Acinetobacter anitratus	30	23	22	10	18	25	29	22	22	26	0	23	0
Acinetobacter iwofii	22	22	20	18	17	16	24	16	18	21	0	21	11
Acinetobacter mallei	30	35	30	20	13	21	17	21	25	24	0	14	12
Acinetobacter mallei	35	33	0	10	17	28	16	27	24	26	30	19	15
Bacillus coagulans	38	23	13	0	0	24	30	0	35	25	0	32	23
Bacillus subtilis	35	25	0	10	15	20	13	20	21	32	13	16	0
Bacillus cereus1	32	35	30	28	30	20	26	20	22	24	0	30	0
Bacillus cereus2	33	36	35	22	26	21	0	0	15	0	0	0	20
Bacillus circulans	22	22	24	0	0	13	13	0	0	18	0	14	0
Bacillus circulans	24	37	33	27	19	18	14	15	0	0	14	0	0
Bacillus circulans	19	30	30	25	0	16	0	24	0	17	0	0	0
Bacillus circulans	35	34	32	13	21	23	28	22	34	35	24	30	21
Bacillus coagulans	38	34	0	0	19	28	36	27	30	36	0	32	16
Bacillus megaterium	34	20	30	17	21	30	32	0	18	30	13	30	0
Bacillus megaterium	28	23	24	20	17	13	22	0	12	18	0	21	0
Bacillus polymixa	16	14	17	13	13	15	21	0	14	14	0	18	0
Bacillus polymixa	37	22	0	0	0	29	28	0	23	28	13	26	14
Citrobacter freundii	25	23	0	0	0	20	20	25	0	18	0	19	0
Citrobacter freundii	36	20	0	0	0	28	28	0	24	35	24	27	14
Corynebacterium pilosum	28	20	18	27	27	20	30	0	13	18	26	32	0
Corynebacterium sp.	38	28	40	30	16	30	26	0	30	32	0	25	17
Corynebacterium sp.	32	34	30	35	32	20	29	24	21	24	30	34	0
Citrobacter freundii	32	25	0	0	0	0	0	13	16	17	0	0	0
Enterococcus malodoratus	38	30	35	22	19	22	27	21	22	30	20	23	13
Flavobacterium rigense	22	22	20	18	16	18	15	16	16	16	20	15	14
Flavobacterium rigense	32	25	29	20	11	21	28	0	18	19	0	28	0
Flavobacterium spp	32	28	16	0	17	0	0	25	0	0	0	22	0
Micrococcus luteus	32	23	0	0	16	28	28	0	27	29	0	18	12
Micrococcus varians	36	24	27	17	21	20	28	0	20	22	13	30	0
Micrococcus varians	36	22	19	28	30	24	26	0	26	35	20	24	16
Micrococcus varians	37	29	30	0	22	22	31	16	17	23	14	32	0
Micrococcus varians	38	23	27	0	30	23	34	0	36	35	21	30	23
Ps. Aeruginosa	26	25	26	0	0	0	0	0	0	0	0	0	0
Salmonella typhi	28	23	23	10	17	0	0	0	0	0	0	14	0
Staph.epidermidis	30	24	17	26	24	16	30	13	14	18	0	28	0
Staphylococcus aureus	20	18	17	15	13	14	21	0	16	15	0	21	0
Staphylococcus aureus	34	30	36	18	26	20	16	22	24	26	0	16	0

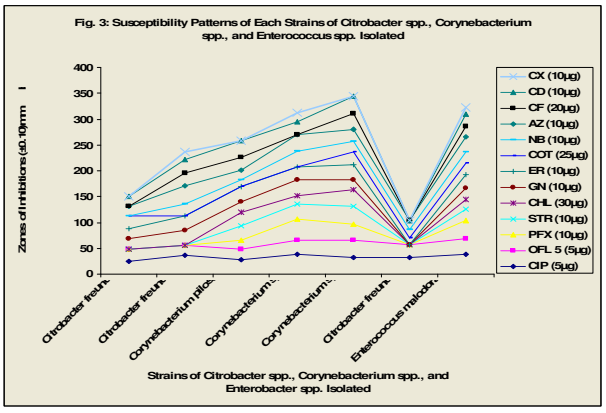
KEY: Cip = Ciprofloxacin, OFL = Ofloxacin PFX = Pefloxacin STR = Streptomycin CHL = Chloramphenicol GN = Gentamicin ER = Erythromycin COT = Cotrimoxazole NB = Norfloxacin AZ = azithromycin CEF = Cefuroxime CD = Clindamycin CX = Cephalexin











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