Antibacterial Activity of Glycerol, Lactose, Maltose, Mannitol, Raffinose and Xylose

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Abstract

In the study antimicrobial activity of adonitol, arabinose, cellobiose, dulcitol, galactose, glycerol, glucose, inositol, lactose, maltose, mannitol, mannose, mellibiose, raffinose, salicin, sorbitol, sucrose, trehalose and xylose was determined on 96 strains of Bacillus anthracoides, 3; Bacillus badius, 5; Bacillus brevis (3), Bacillus circulans (4), Bacillus coagulans (3), Bacillus lentus (6); Bacillus marcerans (3), Bacillus pantothenticus (15), Citrobacter amalonaticus (3), Citrobacter diversus (1), Enterobacter agglomerans (2), Enterobater gregoviae (1), Enterococcus asacchrolyticus (1), Enterococcus avium (4), Enterococcus caecorum (8), Enterococcus gallinarum (2), Enterococcus malodoratus (1), Enterococcus mundtii (1), Enterococcus raffinosus (4), Ervinia ananas (1), Klebsiella oxytoca (2), Micrococcus luteus (2), Morganella morganii (2), Proteus mirabilis (9), Proteus vulgaris (6), Providencia rettgeri (3) and Pseudomonas aeruginosa (1). Of the 19 sugars tested on 96 strains only glycerol, lactose, maltose, mannitol, raffinose and xylose had bacteriostatic effect against 1, 1, 6, 4, 4 and 3 strains, respectively. Of the 18 strains sensitive to one or other sugar none of the strains was sensitive to more than one sugar except a strain of C. diversus sensitive to raffinose and xylose. Sugar sensitive strains belonged to 11 species of Bacillus (5), Citrobacter (1), Enterococcus (3), Proteus (1) and Providencia (1) genus.

Keywords: Sugars, Bactriostatic, Bactericidal, Arabinose, Cellobiose, Dulcitol, Galactose, Glycerol, Glucose, Inositol, Lactose, Maltose, Mannitol, Mannose, Mellibiose, Raffinose, Salicin, Sorbitol, Sucrose, Trehalose, Xylose, Bacillus anthracoides, Bacillus badius, Bacillus brevis , Bacillus circulans, Bacillus coagulans, Bacillus lentus, Bacillus marcerans, Bacillus pantothenticus, Citrobacter amalonaticus, Citrobacter diversus, Enterobacter agglomerans, Enterobater gregoviae, Enterococcus asacchrolyticus, Enterococcus avium, Enterococcus caecorum, Enterococcus gallinarum, Enterococcus malodoratus, Enterococcus mundtii, Enterococcus raffinosus, Ervinia ananas, Klebsiella oxytoca, Micrococcus luteus, Morganella morganii, Proteus mirabilis, Proteus vulgaris, Providencia rettgeri,Pseudomonas aeruginosa

1. Introduction

Antimicrobial activity of sugars is not novel but ill understood fact (Mondoa and Kitei, 2001). Honey, a best blend of sugars, is known since ancient time for its topical antimicrobial activity and has been used to treat ulcers and wounds (Molan 1992; Cooper et al., 1999). At first osmolarity of honey was thought to exert lethal effect on microbes but antimicrobial action of honey even after decimal dilution ward off the hypothesis (Cooper et al., 1999). Thereafter, release of hydrogen peroxide from honey was thought to be important reason behind the antimicrobial activity but that too is too low to cause the death of microbes (Molan, 1992). Heated solutions of glucose and fructose have shown antimicrobial activity however, furfural and 5-hydroxymethylfurfurla, the sugar derivatives resulting on heating, had no antimicrobial effect (Suortti and Malkki, 1984). Mannose, a simple sugar, is known to cure urinary tract infections but not due to its antimicrobial activity, it interferes with mannose receptor based binding of bacteria with uroepithelial cells (Mulvey et al., 2000). This study was conducted to determine antimicrobial activity of adonitol, arabinose, cellobiose, dulcitol, galactose, glycerol, glucose, inositol, lactose, maltose, mannitol, mannose, mellibiose, raffinose, salicin, sorbitol, sucrose, trehalose and xylose.

2. Materials Methods

In the study a total 96 strains of bacteria belonging to 27 species of 11 genera (Table. 1) pro-

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cured from Microbiology laboratory were tested for sensitivity to 19 sugars through disk diffusion assay. Sugar disks used in the study were prepared from adonitol, arabinose, cellobiose, dulcitol, galactose, glycerol, glucose, inositol, lactose, maltose, mannitol, mannose, mellibiose, raffinose, salicin, sorbitol, sucrose, trehalose and xylose by dissolving the sugars in appropriate evaporating solvent (Singh, 2009) and 20 micro l solution containing 1 mg of sugar was aseptically poured on to each disk, disks were dried at 60C in hot air oven for 6 h. The test was conducted in the same way as for antimicrobial drug sensitivity assay on bacteria inoculated on Muller Hinton agar (BBL, Difco, USA) plates using Kirbey Bauer methods (Bauer et al., 1966). All tests were performed in triplicate. To confirm the activity of sugars in disc diffusion assay, test was also conducted in broth medium using 0.1% of sugar in buffered peptone water (BBL, Difco). Two ml of sterile medium in glass tubes was inoculated with 2 micro l of overnight growth of bacteria grown in buffered peptone water (BPW). Inoculated tubes were incubated for 24 h to observe for any appreciable turbidity / surface pellicle/ sediment in the medium, if any or all of the three changes were detected the bacteria was considered not sensitive to the particular sugar. If no change was observed in the inoculated tube after incubation, the contents of the tube were transferred to tubes containing 20 ml of sterile fluid thioglycollate (FT) medium (BBL, Difco) and incubated for 24-48 h at 37C. No growth in FT medium indicated sterility, i.e., bactericidal effect of the sugar while turbidity/ sediment/ pellicle in the medium indicated that the sugar had only bacteriostatic effect. As control gentamicin (30 mcg) discs (BBL Diffco) and gentamicin 50 mcg/ ml in BPW were used for disc diffusion and liquid medium assays for antimicrobial activity in the study.

Bacteria	Strain tested	Inhibited by Glycerol	Lactose	Mannitol	Maltose	Raffinose	Xylose	Total of sensitive strins
Bacillus anthracoides	3	0	0	0	0	0	0	0
Bacillus badius	5	0	0	0	0	0	0	0
Bacillus brevis	3	0	0	0	1	0	0	1
Bacillus circulans	4	0	0	1	0	0	0	1
Bacillus coagulans	3	0	0	1	1	0	0	2
Bacillus lentus	6	0	0	3	0	0	0	3
Bacillus marcerans	3	0	0	0	0	0	0	0
Bacillus pantothenticus	15	0	0	1	2	0	0	3
Citrobacter amalonaticus	3	0	0	0	0	0	0	0
Citrobacter diversus	1	0	0	0	0	1	1	2
Enterobacter agglomerans	2	0	0	0	0	0	0	0
Enterobater gregoviae	1	0	0	0	0	0	0	0
Enterococcus asaccharolyticus	1	0	0	0	0	0	1	1
Enterococcus avium	4	0	0	0	0	0	0	0
Enterococcus caecorum	8	0	0	0	0	0	0	0
Enterococcus gallinarum	2	1	0	0	0	0	0	1
Enterococcus malodoratus	1	0	0	0	0	0	0	0
Enterococcus mundtii	1	0	0	0	0	0	0	0
Enterococcus raffinosus	4	0	0	0	0	0	1	1
Ervinia ananas	1	0	0	0	0	0	0	0
Klebsiella oxytoca	2	0	0	0	0	0	0	0
Micrococcus luteus	2	0	0	0	0	0	0	0
Morganella morganii	2	0	0	0	0	0	0	0
Proteus mirabilis	9	0	0	0	0	0	0	0
Proteus vulgaris	6	0	0	0	0	1	0	1
Providencia rettgeri	3	0	1	0	0	2	0	3
Pseudomonas aeruginosa	1	0	0	0	0	0	0	0

Fig. 1: Sensitivity of bacteria to sugars.

3. Results and Discussion

A total of 65 Gram positive (belonging to 16 species of three genera) and 31 Gram negative (belonging to 11 species of 8 genera) bacteria were tested for their sensitivity to 19 sugars. The study revealed that none of sugar had bactericidal effect on any of the 96 strains of bacteria in the study. Neither bacteriostatic effect nor zone of growth inhibition was observed around disks of adonitol, arabinose, cellobiose, dulcitol, galactose, glucose, inositol, mannose, mellibiose, salicin, sorbitol, sucrose and trehalose. Glycerol, lactose, mannitol, maltose, raffinose and xylose inhibited growth of 1, 1, 6, 4, 4 and 3 strains, respectively (Table. 1). Diameter of zone of inhibition of bacteria around sugar disks ranged from 10 mm to 20 mm. Maximum growth inhibition zone diameter was around raffinose disks for Proteus vulgaris while mininmum was for Providencia rettgeri. None of the strain was inhibited by more than one type of sugar except a strain of citrobacter diversus which was sensitive to raffinose and xylose both. Of the 18 strains sensitive to one or other sugar, five strains belong to gram negative and 13 strains to Gram positive group. All the three strains of Providencia rettgeri were sensitive to one or other sugars. All the four strains sensitive to lactose and raffinose were gram negative while all strains sensitive to glycerol, mannitol and maltose were Gram positive. Difference in sensitivity to sugars among Gram positive and negative bacteria might be either due to less number of isolates of different bacteria tested or due to some other reason not determined in the study. Thus more elaborate studies are needful to understand the phenomenon. On the other hand there appeared no association between sensitivity to xylose and Gram reaction indicating its wide spectrum of activity but only few strains were affected. Sugars might have bacteriostatic activity but it is neither uniform on all bacterial strains, even of the same species, nor very potent. Bacteriostatic property

of sugars can either be exploited for clinical use or not is matter of future studies but it is clear that when you rely on sugar fermentation tests for identification of bacteria false results may result due to sensitivity of the particular strain to one or other sugar.

4. References

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