

# Homologous Resistant Groups (HRGs) in Multidrug Resistant *Staphylococcus aureus* Isolated from Retail Foods in Vadapalani, Chennai

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## Citation

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## Abstract

The present study investigated the prevalence of multiple antibiotic resistant *Staphylococcus aureus* strains in different food sources collected from retail shops and markets in Vadapalani, Chennai. All *S. aureus* isolates were resistant to methicillin, and 93.75 % of them were multidrug resistant. The *S. aureus* isolates were typed by UPGMA method based on antibiotic resistance pattern observed. Approximately five homologous resistance groups (HRGs) were observed in typing the isolates.

## INTRODUCTION

Food borne diseases are of major concern worldwide. To date, around 250 different food-borne diseases have been described and bacteria are the causative agents for two-thirds of the food-borne disease outbreaks. Among the predominant bacteria involved in these diseases, *Staphylococcus aureus* is the leading cause of gastroenteritis resulting from consumption of contaminated food (Loir et al., 2003). Occasionally, *S. aureus* acts as opportunistic pathogen and cause infections of the urinary tract, respiratory tract and intestinal tract (Coltman, 1981). The pathogenicity of *S. aureus* as indicated by Stokes and Ridgway (1980) include abscesses, boils, conjunctivitis especially in newborn, cross-infections in hospitals septicemia, mastitis and food poisoning (of meats, milk and milk products). Also *S. aureus* is an etiological infection agent responsible for significant levels of morbidity and mortality (Vieira et al., 2007).

*S. aureus* is an important pathogen due to the combination of toxin-mediated virulence, invasiveness and antibiotic resistance (Fast et al., 1989; Bohach et al., 1990; Hiramatsu, 1995; Murray et al., 1995). The evolution of methicillin resistant *Staphylococcus aureus* (MRSA) and other drug resistant pathogens has been linked to extensive antibiotic use in medicine and food animal production (Leonard and Markey, 2007; Mathew et al., 2007). Outbreaks of *Staphylococcal* food poisoning (SFP) are very common

across the world; however, there is only one report on SFP from the Indian subcontinent (Nema et al., 2007). The aim of this study was to investigate the prevalence and multiple antibiotic resistance of *Staphylococcus aureus* strains isolated from different food samples collected from retail shops and markets in Vadapalani, Chennai and also to type the isolates based on antibiotic resistance pattern. This study brings insight into the predominance of multiple drug resistant *S. aureus* in marketed food samples in Chennai.

## MATERIALS AND METHODS

### BACTERIAL ISOLATION

A total of 40 different food samples collected from retail shops and markets in Vadapalani, Chennai were subjected to *S. aureus* isolation. All the samples were aseptically handled and processed. The samples were plated onto Mannitol Salt Agar (HiMedia). The characteristic yellow colored, round colonies were isolated and stored on Nutrient Agar (HiMedia) slants. The isolates were examined by Gram staining for Gram positive cocci in clusters and biochemical characteristics such as catalase positive, oxidase negative, indole negative, urease positive, citrate negative, Methyl red and Voges-Proskauer positive. All isolates were confirmed as *S. aureus* by their positive nature for tube coagulase test using rabbit plasma. The standard type strain *S. aureus* MTCC 1144 was used in each of the steps for the comparative identification of *S. aureus*.

**ANTIBIOTIC ASSAY**

Antibiotic resistance test was carried out for all the strains by the disc diffusion method (Bauer et al., 1966). The cultures were enriched in Brain Heart Infusion Broth (BHIB, HiMedia) for 6 - 8 hr. The enriched cultures were then swabbed on the surface of Mueller Hinton Agar (HiMedia) using sterile cotton swabs. Using the antibiotic disc dispenser, the discs were placed on the agar surface sufficiently distanced to avoid overlapping of the inhibition zones. The concentration of each antibiotics used is listed in Table 1. The plates were incubated at 37 ° C for 18 - 24 hr. After the incubation period, the diameter of the inhibition zones were measured and compared with the performance standards for antimicrobial disc susceptibility tests (Zone size interpretative chart, HiMedia) and classified accordingly as resistant, intermediate and sensitive.

**MULTIPLE ANTIBIOTIC RESISTANCE (MAR) INDEXING OF THE ISOLATES**

The MAR index of a single isolate is defined as a / b, where 'a' represents the number of antibiotics to which the isolate was resistant and 'b' represents the total number of antibiotics to which the isolate was subjected (Krumperman, 1985).

**TYPING OF S. AUREUS ISOLATES**

All the *S. aureus* isolates were typed based on their similarity index in antibiotic resistance pattern. Similarity index (S.I.) was calculated by Dice's coefficient as,

**Figure 1**

$$S.I. = \frac{2 * N_{AB}}{(N_A + N_B)}$$

Where  $N_{AB}$  is number of similar antibiotics resistant to both strains;  $N_A$  is the total number of antibiotics resistant to strain 1; and  $N_B$  is the total number of antibiotics resistant to strain 2.

Cluster analysis was performed using the unweighted pair-group method with average linkages (UPGMA, Sneath and Sokal, 1973). The isolates showing similar antibiotic resistance pattern and S.I. value of 1 were grouped as

homologous resistance group (HRG).

**RESULTS  
INCIDENCE**

About 80% (32 / 40) of the food samples collected from retail shops and markets in Vadapalani, Chennai were positive for contamination with *S. aureus*. Of the strains isolated, 50% was observed in seafood, 18.75% in fruits and 12.5% in packaged milk samples.

**ANTIBIOTIC RESISTANCE**

All the *S. aureus* isolates were resistant to methicillin. More than 80% of the strains were resistant to ampicillin (93.75%), novobiocin (93.75%) and amoxyclav (84.38%). The isolates showed intermediate resistance towards bacitracin (62.5%) and kanamycin (59.38%). About 31.25% of the isolates were resistant to vancomycin. All the isolates were sensitive to gentamicin and norfloxacin (Table 1).

**Figure 2**

Table 1 Percentage of antibiotic resistance of isolates from food samples

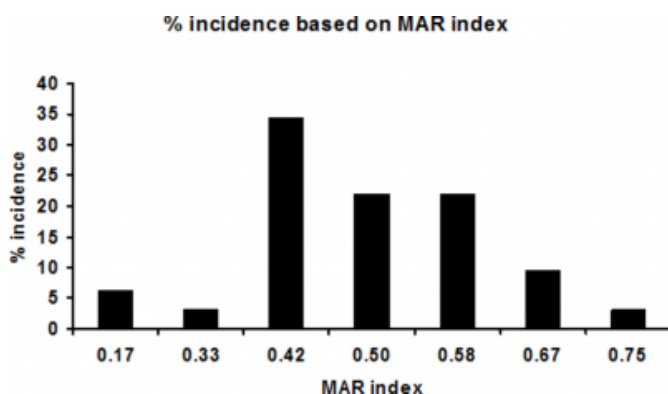
Antibiotics	Concentration	No. of Strains (n= 32)	% resistance
Methicillin (M)	5mcg	32	100
Ampicillin (A)	30mcg	30	93.75
Novobiocin (Nv)	30mcg	30	93.75
Amoxyclav (Am)	30mcg	27	84.38
Bacitracin (B)	10units	20	62.5
Kanamycin (K)	30mcg	19	59.38
Vancomycin (V)	30mcg	10	31.25
Nitrofurantoin (Nf)	300mcg	10	31.25
Erythromycin (E)	15mcg	8	25
Tetracycline (T)	30mcg	3	9.38
Gentamicin (G)	10mcg	0	0
Norfloxacin (Nx)	10mcg	0	0

**MAR**

About 93.75% of the *S. aureus* isolates showed multiple antibiotic resistance. The MAR index value was in the range of 0.17 – 0.75. Only 2 strains did not show multiple antibiotic resistance. One of the *S. aureus* isolate showed resistance to 9 of the 12 antibiotics tested. Notably, 34.38% of the isolates had a MAR index value of 0.42 (Fig. 1).

**Figure 3**

Fig. 1 Percentage occurrence of MAR index of isolates from food samples (n=32)



**ANTIBIOTIC RESISTANCE TYPING**

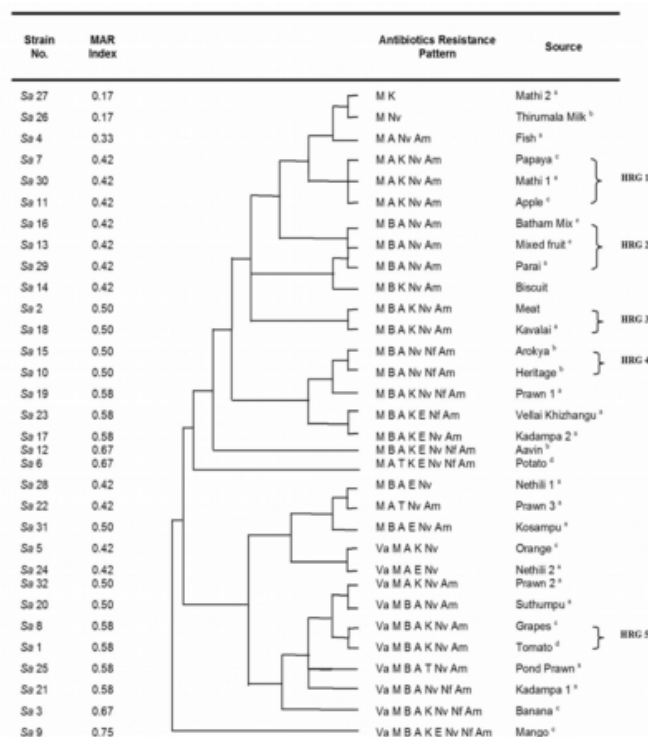
All the *S. aureus* isolates were typed based on their antibiotic resistance pattern. Approximately 5 HRGs (homologous resistance groups) were observed in the present study. Notably, 4 / 5 HRG consist of *S. aureus* isolated from similar sources. Only 1 HRG was observed in the isolates resistant to vancomycin (Fig. 2).

**DISCUSSION**

This is the first report on the prevalence of multiple antibiotic resistant *S. aureus* isolated from marketed food samples in Vadapalani, Chennai. About 80% incidence of *S. aureus*

**Figure 4**

Fig. 2 Typing of isolates from food samples based on antibiotics resistance pattern



HRG – Homologous Resistance Group

<sup>a</sup> seafood samples collected from Vadapalani; <sup>b</sup> milk samples collected from Vadapalani; <sup>c</sup> fruit samples collected from Vadapalani; <sup>d</sup> vegetables collected from Vadapalani; <sup>e</sup> juice samples collected from Vadapalani

was observed in the food samples taken for analysis. These results are high compared to that documented by other researchers (Genigeorgis 1989; Sokari 1991; Wieneke et al., 1993; Haeghebaert et al., 2002; Aycicek et al., 2005; Chomvarin et al., 2006). Similar to the previous studies, all *S. aureus* isolates were methicillin resistant (MRSA) (Kluytmans et al., 1995; Leonard and Markey 2007). Prevalence of vancomycin resistant *S. aureus* (VRSA) was also observed in the food samples. Most of the isolates were resistant to ampicillin and novobiocin and all the isolates were sensitive to gentamicin and norfloxacin. The multiple antibiotic resistance (MAR) index value observed in this study was high.

In the present study, the wide spread contamination of MRSA in food samples was observed. All the isolates were sensitive to gentamicin and norfloxacin. This is because of the less (or) nil exposure of food samples to these antibiotics, whereas, some clinical isolates have shown

resistance to gentamicin and norfloxacin (Daxboeck et al., 2004; Harbarth et al., 2005; Farzana and Hameed 2006). Notably, vancomycin resistance was observed in some of the fishes and fruits only. The use of antibiotics against pests and microbes is the main reason for increased resistance to antibiotics. Some have reported the plasmid borne resistance of *S. aureus* against antibiotics (Best et al., 1977; Amyes et al., 1987; Bhakta et al., 2004). Thus spreading of the strains harboring resistance plasmids and natural transformation of these plasmids to non-resistant strains would pose a threat during treatment of diseases.

The incidence of *S. aureus* and their antibiotic resistance in different food samples have been documented (Barreto and Vieira 2003; Ekici et al., 2004; Normanno et al., 2007).

There have been reports on food initiated disease outbreak of *S. aureus* (Kluytmans et al., 1995; Jones et al., 2002; Jadhav et al., 2007). Some researchers have reported that food handlers act as carriers of antibiotic resistant *S. aureus* (Wei and Chiou 2002; Vieira et al., 2007; Ingham et al., 2007).

A novel approach of typing *S. aureus* based on similarity index calculated upon antibiotic resistance pattern was described in the present study. The similarity index between the isolates was in the range of 0.22 to 1.0. The antibiotic resistance pattern observed in the homologous resistance groups are HRG 1 (M A K Nv Am), HRG 2 (M B A Nv Am), HRG 3 (M B A K Nv Am), HRG 4 (M B A Nv Nf Am) and HRG 5 (Va M B A K Nv Am). About 4 HRG groups, 2 each in MAR index value of 0.42 and 0.5 respectively was observed. The other HRG was observed in the MAR index value of 0.58. It was observed that, as the MAR index increases, the occurrence of HRG decreased. The source of the *S. aureus* isolates in 4/5 HRG was similar: HRG 1 & HRG 5 (fruits), HRG 2 (juices) and HRG 4 (milk), except that of HRG 3 which contained unrelated sources. This method of typing is useful in describing the effective chemotherapeutic treatments in case of disease outbreaks with multiple antibiotic resistant *Staphylococcus aureus*.

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