

but on the other side of the E-strip, containing EDTA with imipenem, MIC reading was less than 1 microgram/ ml. However, the shape of the zone along the E-strip was not in epsilon shape but an ellipsoid (Fig. 1).

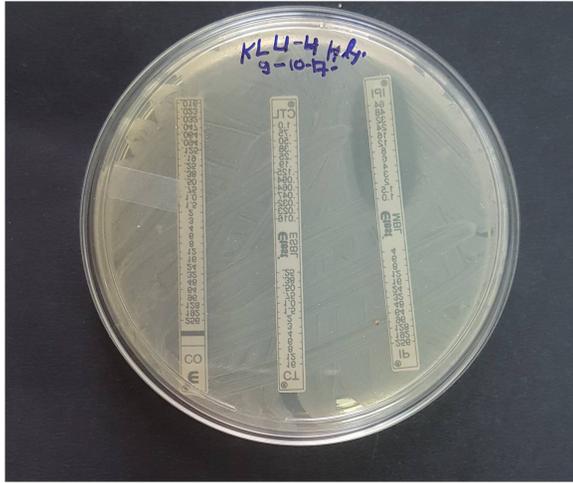


Fig. 1: E-test for determining MIC of imipenem, cefotaxime, colistin and cefotaxime+clavulanic acid and to detect MBL potential of *Streptococcus equisimilis* isolate from a lioness case of UTI

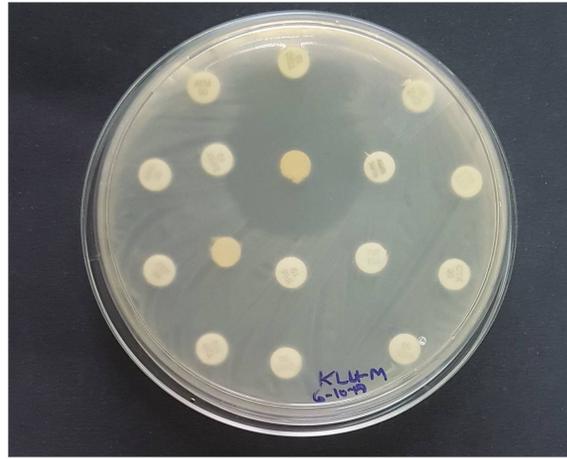


Fig. 2: Antibiotic sensitivity assay and Double disc synergy test for *Streptococcus equisimilis* isolate from a lioness case of UTI

The streptococcus equisimilis isolate appearing MBL type using E-test failed to show any synergy between imipenem/ meropenem with EDTA disc and the isolate was resistant to all the antimicrobials except showing zone of inhibition around tigeicycline (24 mm) and EDTA (28 mm) discs.

3. Herbal Antimicrobial Drug Sensitivity of the Isolates

Both *E. coli* and *S. equisimilis* isolates were tested using disc diffusion assay (Singh et al., 2013) against essential oils (1 micro l/ disc) of ajowan, betel leaves, guggul, patchouli, thyme, agarwood, sandalwood, holy basil, lemongrass, cinnamon and pure compounds of herbal origin including cinnamaldehyde, carvacrol and citral, active antimicrobial ingredients of cinnamon oil,

thyme oil (oregano and ajowan too) and lemongrass oil, respectively. Besides silver nanoparticles made using herbal acacia gum synthesis were also tested for their antimicrobial activity. The isolates of both the organisms (*E. coli* and *S. equisimilis*) were insensitive to essential oils of guggul, patchouli, agarwood, lemongrass and also to citral. However, isolates were sensitive to carvacrol, ajowan oil, thyme oil, cinnamon oil, and cinnamaldehyde. Betel leaf oil, holy basil oil and silver nanoparticle inhibited only *E. coli* isolates and sandalwood oil inhibited *S. equisimilis* isolates only.

The observations revealed that for in carbapenem-resistant but EDTA sensitive *Streptococcus equisimilis* E-test may give erroneous results and combined discs may also to be read as MBL. To determine MBL double disc synergy (DDS) is a better test in case of EDTA sensitive strains, the observations are in contradiction to observations of Picao et. al. (2008) indicating equivocality of the combined disc and DDS tests for detection of MBL. The case study also revealed that UTI infections in lions may also be associated with *S. equisimilis* infections. Further, the bacteria resistant to even most of the modern antimicrobials was sensitive to some of the herbal antimicrobials indicating the utility of herbal antimicrobials in the treatment of infections caused by MDR strains.

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