Supplementary information:

Facile fabrication of silver nanoparticle embedded $CaCO_3$ microspheres *via* microalgae-templated CO_2 biomineralization: application in antimicrobial paint development

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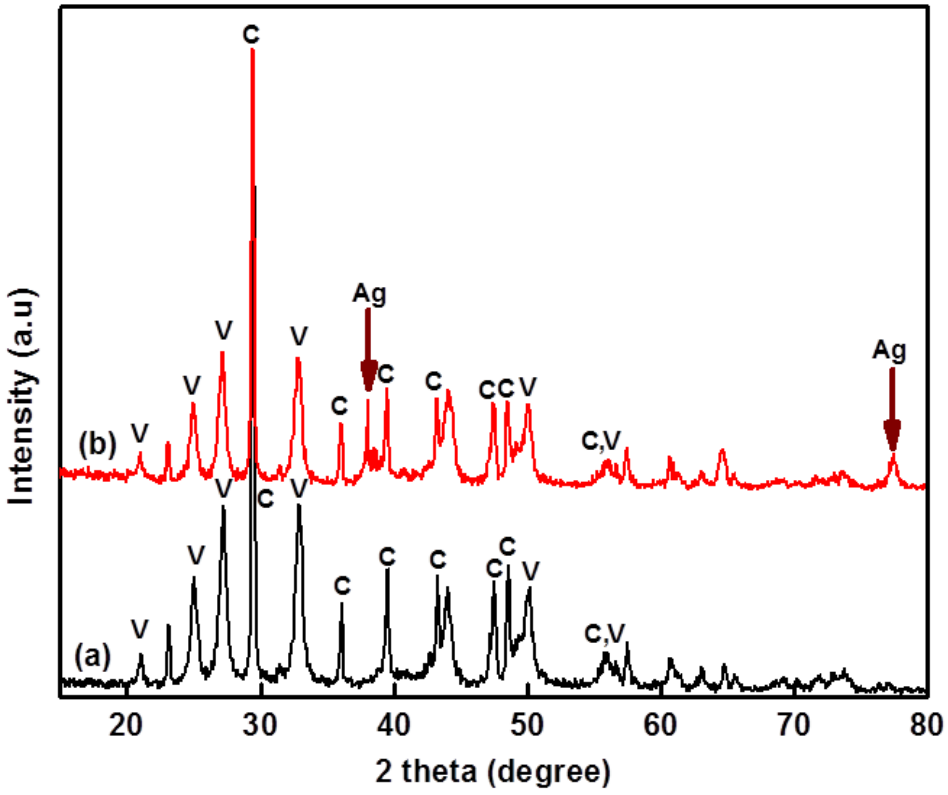


Fig. S1. XRD spectra (a) $CaCO_3$ micro spheres precipitates in the presence of microalgae at room temperature (b) nAg/ $CaCO_3$ micro spheres.

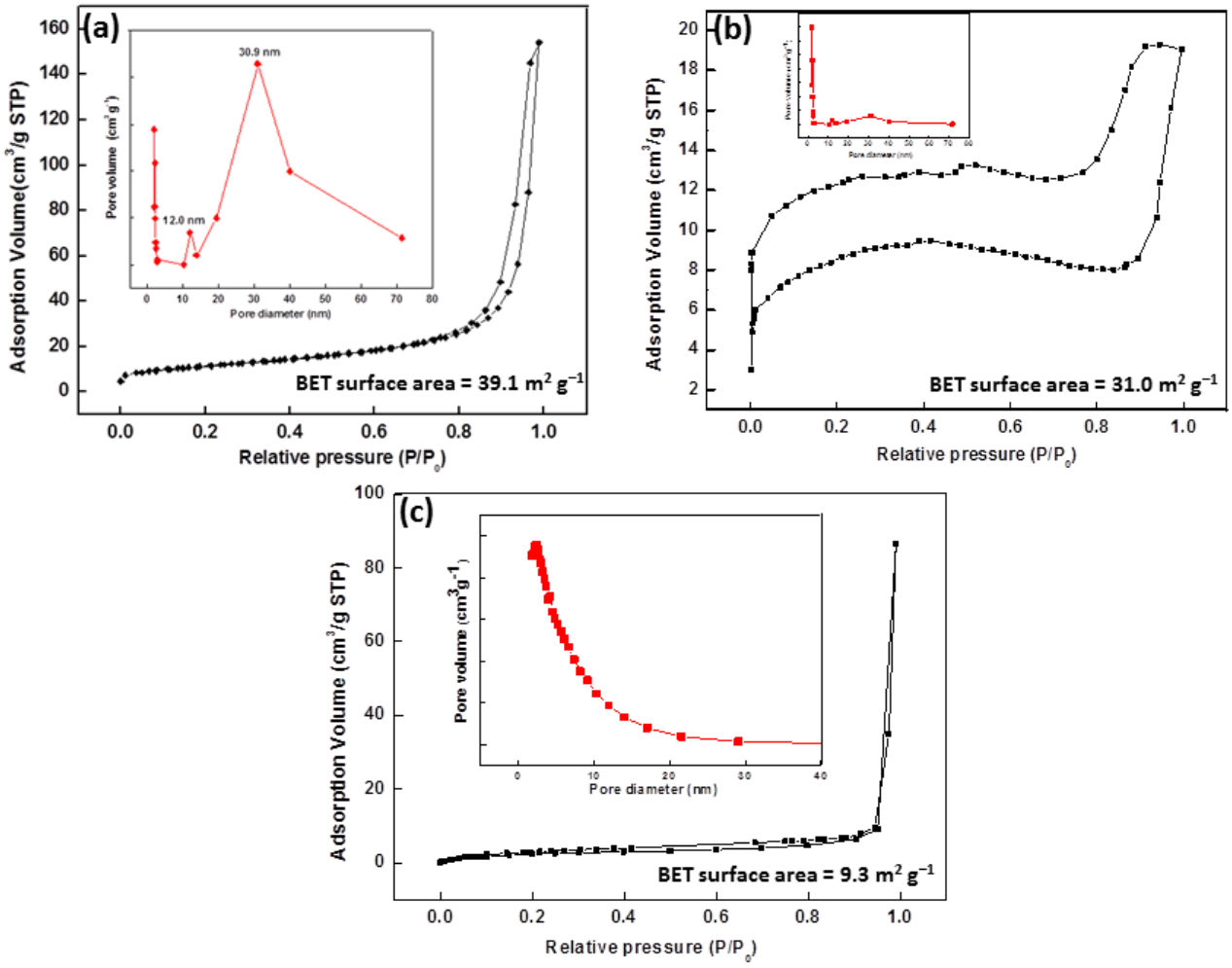


Fig. S2. Nitrogen adsorption–desorption isotherm loop of porous $CaCO_3$ microsphere. The inset is the pore size distribution curve calculated from the adsorption branch by the BJH model. (a) CaCO3 microspheres obtained with [Microalgae]: 1.2g L^{-1}, [Ca^{2+}] = 0.3 M (b) $CaCO_3$ microspheres at [Microalgae]: 2.2g L^{-1}, [Ca^{2+}] =0.3 M (c) $CaCO_3$ microspheres at [Microalgae]: 0.2g L^{-1}, [Ca^{2+}] =0.3 M. As shown in the figure the $CaCO_3$ microsphere at 0.3 M $CaCl_2$ showed different surface area and pore size at different microalgae concentration. At a microalgae concentration of 1.2 g L^{-1}, the $CaCO_3$ spheres showed comparatively higher surface area (39.1 m^2g^{-1}) and distinct porosity compared to other samples.

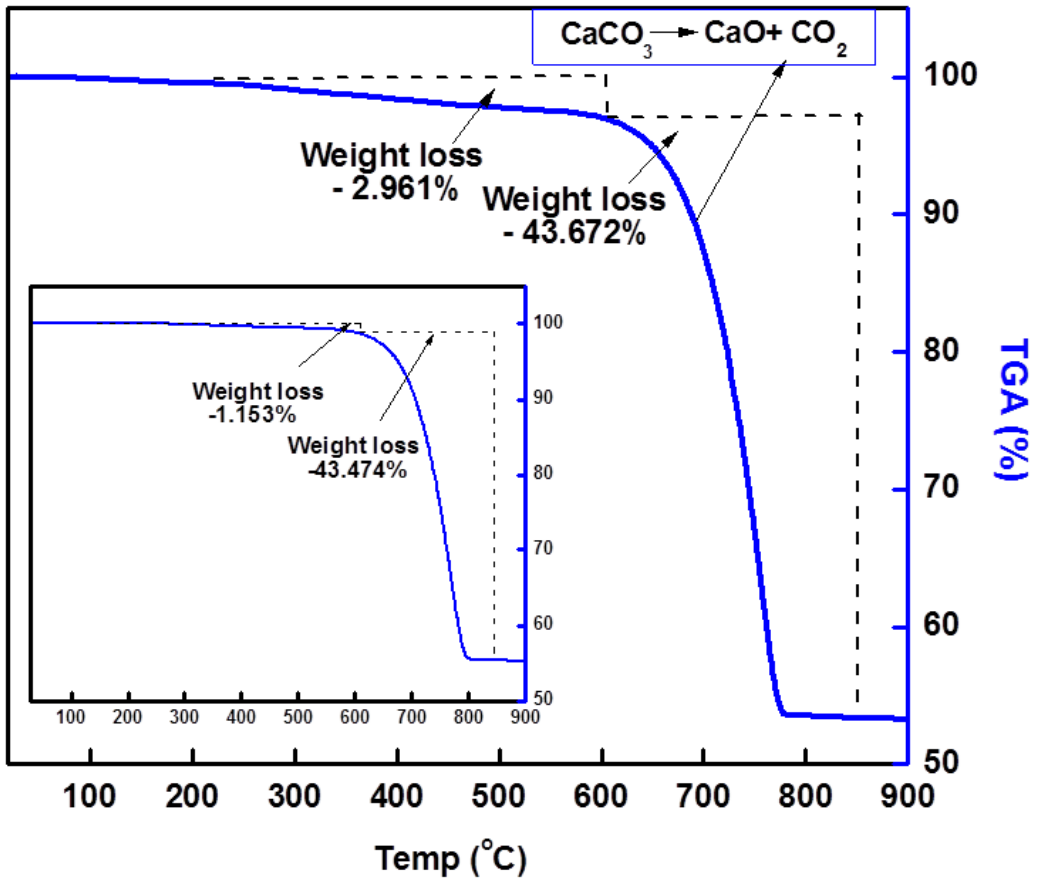


Fig. S3. **TGA curves of porous $CaCO_3$ microsphere prepared using microalgae as template. The inset represents the TGA curve for $CaCO_3$ particle without algae template.**

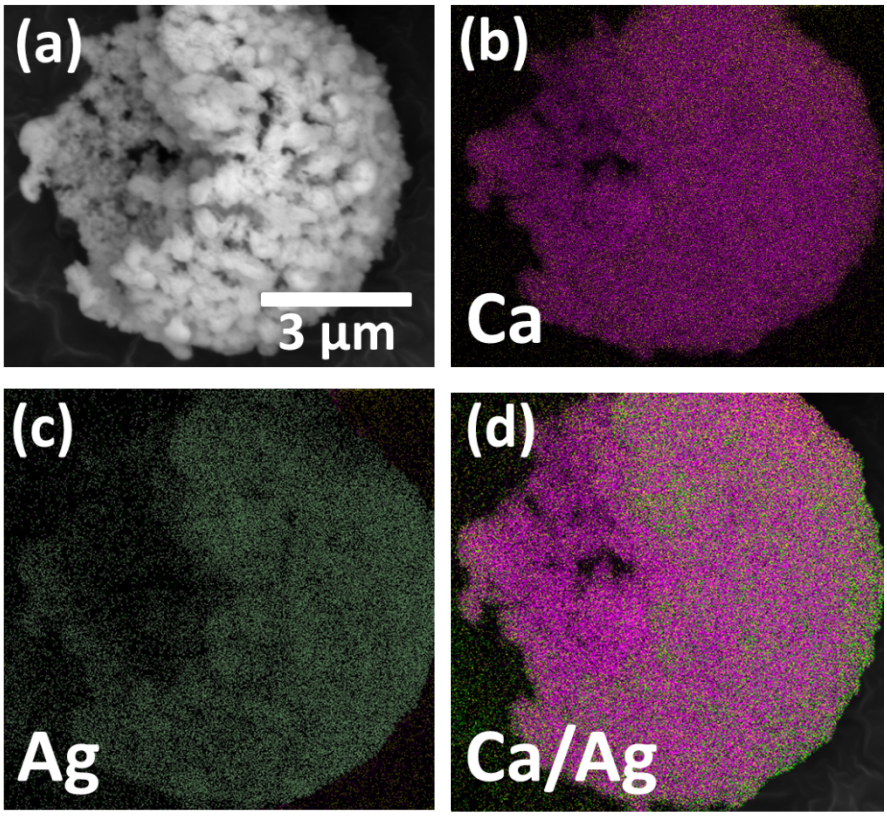
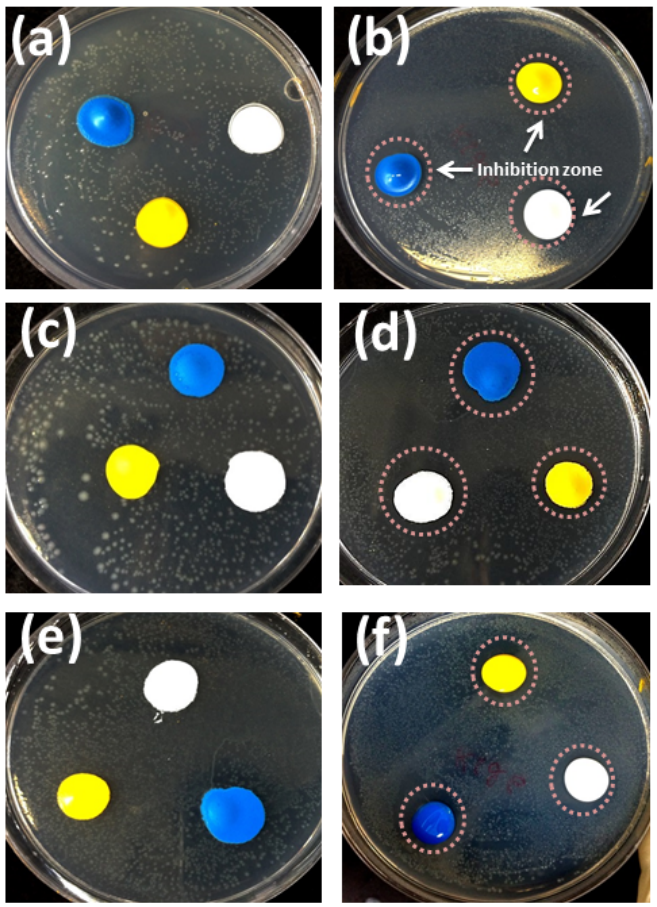


Fig. S4. SEM mapping photograph of Ca and Ag within a single particle of nAg/$CaCO_3$ microspheres (a) SEM image of the particle considered for mapping and (b) elemental mapping of Ca (c) elemental mapping of Ag (d) superimposed mapping image of both Ca and Ag together, the Ag-rich particle on the surface are clearly seen from the SEM mapping images.



	Width of Inhibition zone (millimeter, mm)		
nAg/$CaCO_3$ (mg/ml)	*E.coli*	*P. alimenterius*	*S. equorum*
0	0	0	0
0.1	0.7± 0.1	1.3 ± 0.1	1.2 ± 0.1

Fig. S5. Determination of the effect of nAg/$CaCO_3$ microsphere additive paints on *E.coli*, *P. alimenterius* and *S. equorum* by agar-diffusion assay method. In each case, 0.1 mg/ml of nAg/$CaCO_3$ microspheres was added to the commercial water soluble paint of different color and their droplets were added to the agar plate containing different bacterial strain. The zone of inhibition was highlighted with a dashed circle indicating a noticeable antibacterial effect. Here a, c and e represents the untreated commercial paint with bacteria *E.coli*, *P. alimenterius* and *S. equorum* and b, d and f represents the commercial paint emulsion with 0.1 mg/ml of nAg/$CaCO_3$ microspheres on *E.coli*, *P. alimenterius* and *S. equorum*. It clearly seen that the untreated paint did

not show any inhibition zone, whereas the treated paint showed distinguished inhibition zone after 24 h incubation at 35 °C. The table below represents the width of the inhibition zone in mm.

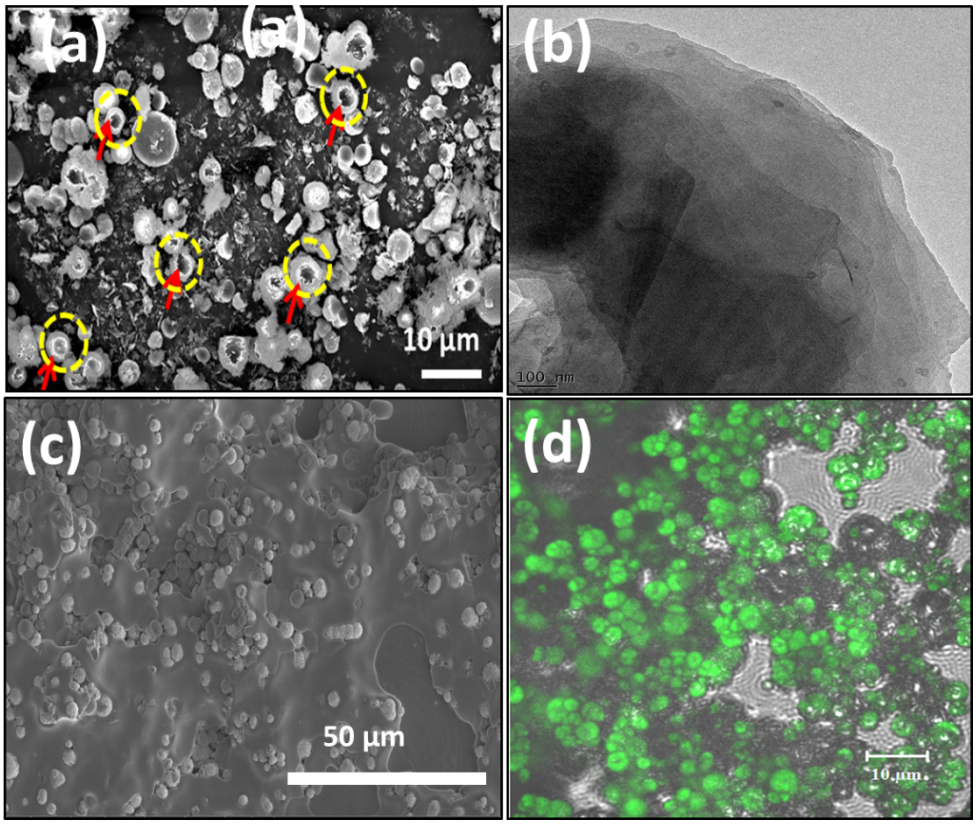


Fig.S6. (a) SEM image of $CaCO_3$ microspheres where electron beam etched their outer surface. It can be clearly seen that the particles appeared as hollow with an inner lighter layer indicated with red arrow (which might arise from the associated microalgae cells) and an outer dark core (caused likely by thick $CaCO_3$ coverings). (b) FE-TEM image of $CaCO_3$ microsphere showing the outer brighter layer and inner darker layer due to $CaCO_3$ and microalgae, respectively. (c) Low magnified image of $CaCO_3$ prepared using microalgae. It showed that most of the $CaCO_3$ exists as microsphere. (d) Confocal microscopic image of $CaCO_3$ showing that most of them exists as microsphere.

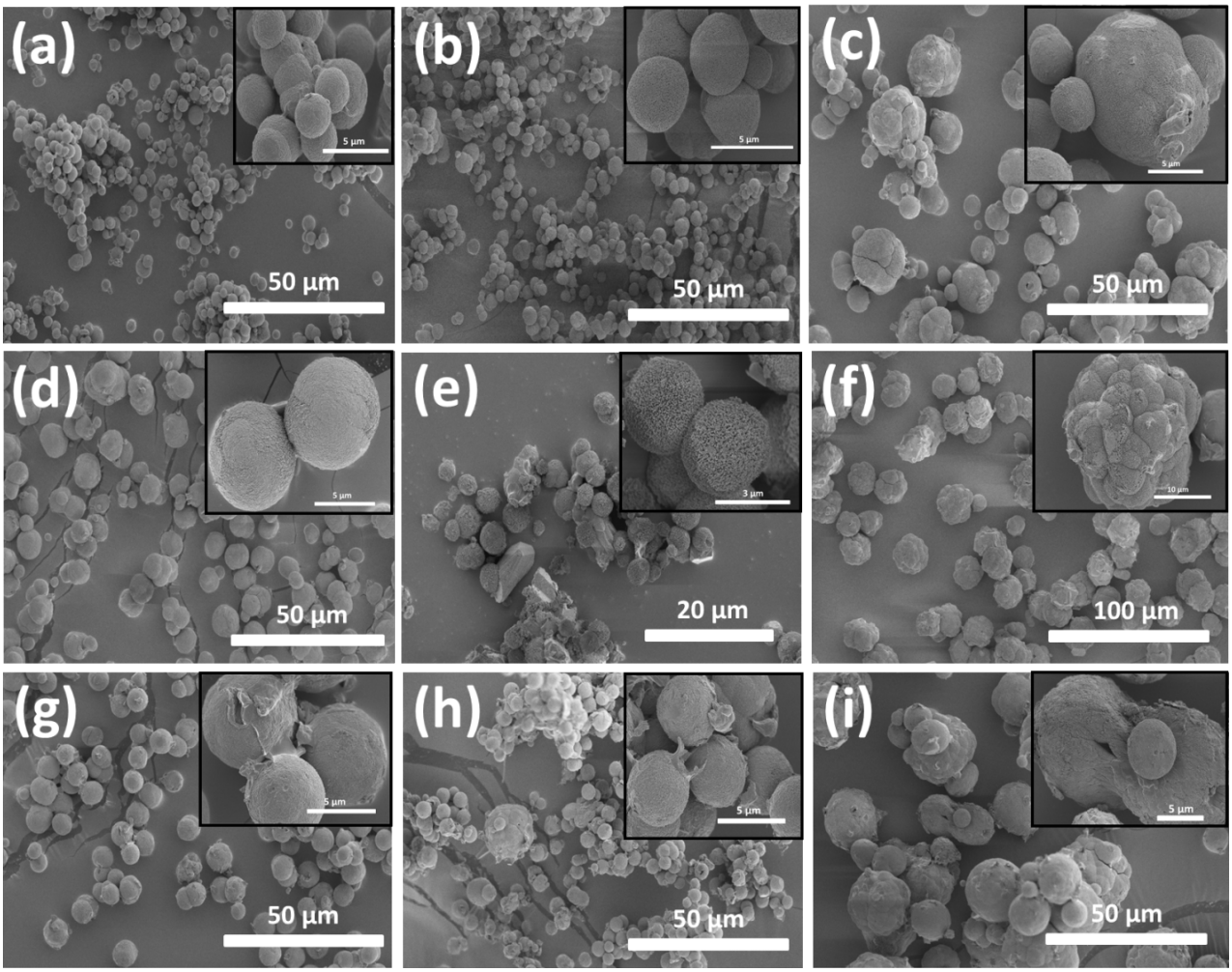


Fig. S7. SEM images of the obtained $CaCO_3$ crystals with different reactant concentrations. (a) [Microalgae]: 0.2g L^{-1}, [Ca^{2+}] =0.1 M; (b) [Microalgae]: 0.2g L^{-1}, [Ca^{2+}] =0.3 M; (c) [Microalgae]: 0.2g L^{-1}, [Ca^{2+}] =0.5 M; (d) [Microalgae]: 1.2g L^{-1}, [Ca^{2+}] =0.1 M; (e) [Microalgae]: 1.2g L^{-1}, [Ca^{2+}] =0.3 M; (f) [Microalgae]: 1.2g L^{-1}, [Ca^{2+}] =0.5 M; (g) [Microalgae]: 2.2g L^{-1}, [Ca^{2+}] =0.1 M; (h) [Microalgae]: 2.2g L^{-1}, [Ca^{2+}] =0.3 M; (i) [Microalgae]: 2.2g L^{-1}, [Ca^{2+}] =0.5 M. The crystallization conditions remain the same as mentioned in the experimental section.

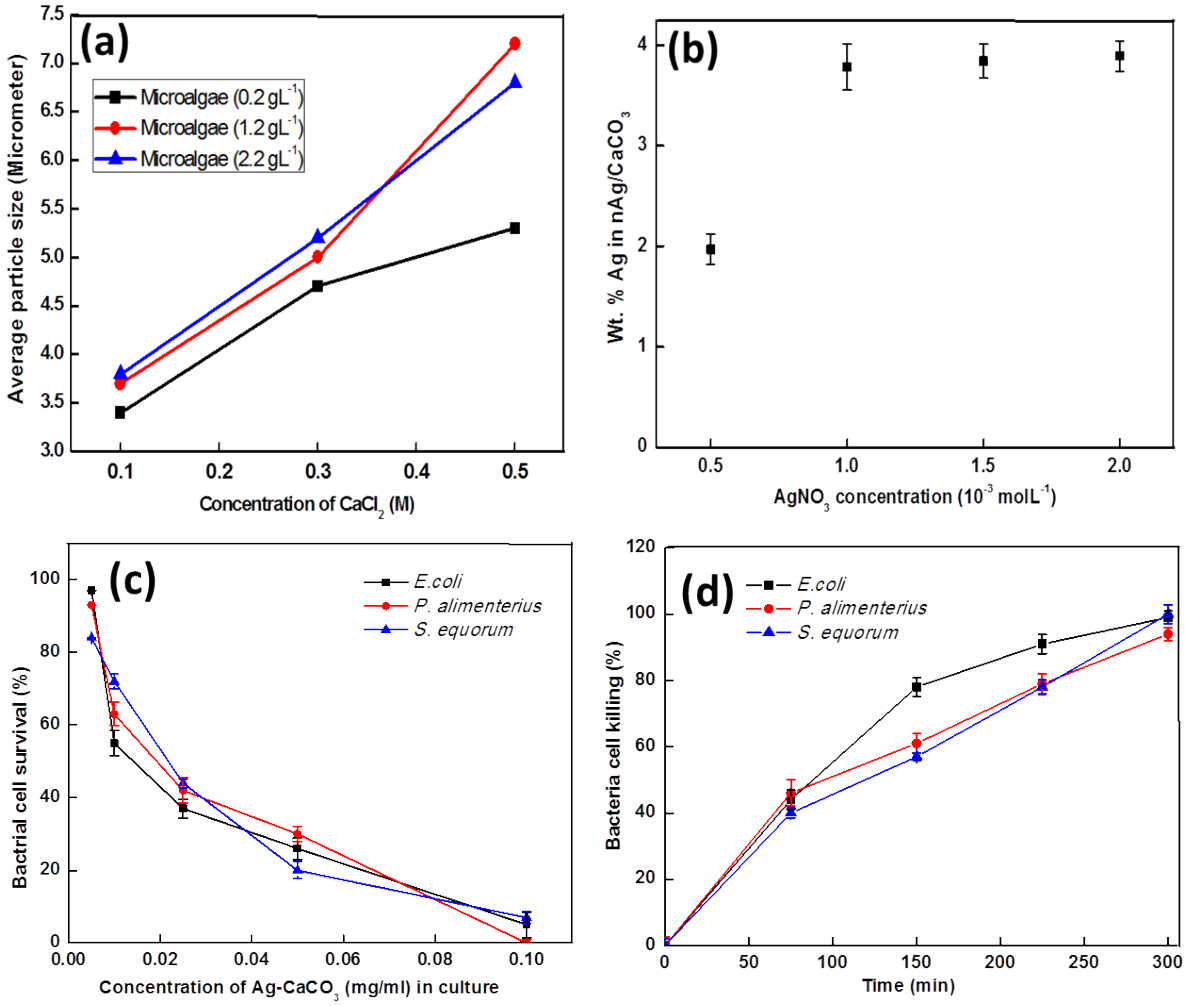


Fig.S8 (a) Average particle size variation with different $CaCl_2$ concentration. (b) Ag loading in $CaCO_3$ microsphere at different $AgNO_3$ concentration. (c) Survival percentage of *E.coli*, *P. alimenterius* and *S. equorum* after treatment with different concentrations (0–0.1%) of nAg/$CaCO_3$ along with 0.1 mg dry white paint added to the medium and (b) Killing percentage of *E. coli*, *P. alimenterius* and *S. equorum* by 0.1% nAg/$CaCO_3$ along with 0.1 mg dry white paint added to the medium.