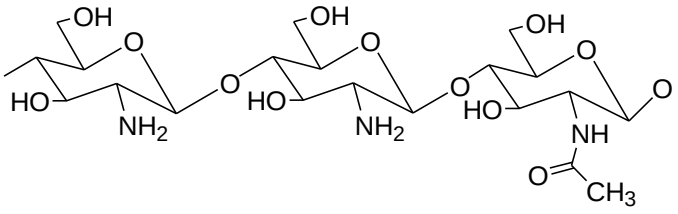
Systematic Review of Organic Nanoparticle as Antibacterial Agents

Gurmeet Kaur[1] , Ramnik[2]

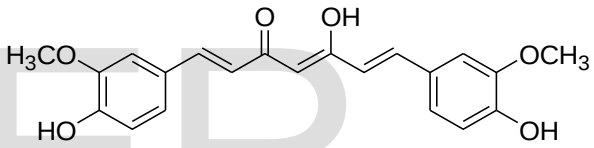
ABSTRACT: Bacterial contamination continues to draw public attention. It is estimated that approximately 48 million cases of pathogenic diseases occur in the United States (Morris 2011; Jin and He, 2011).1(a-b) Therefore, in order to solve this problem, it is highly necessary to develop effective antimicrobial agents to control the bacterial population (Kumar et al., 2008; Li et al., 2006).2 Organic Nanoparticle consists of organic compounds in solid form in nano size. It has been shown that organic nanoparticles act as effective antibacterial agent. In this review we discuss about the various functions of organic nanoparticles, their methods of formation and their antibacterial properties. *In this systematic review, data is taken from 2008 to 2018 and describes all the properties of organic nanoparticles along with their disadvantages*. In the last we describe the various application of organic nanoparticle (in the table form).

BACKGROUND: Nanoparticles is a solid colloidal particle is defined as "a discrete identity having dimension at least 100nm or less".3 Organic Nanoparticle is also a solid particle consists of organic compounds ranging diameter from 10 nm to 1μm.4 *Chitosan is one of the organic nanoparticle which is a linear polysaccharide*. Chitosan structure composed of β-1, 4 - linked D-glucosamine and N-acetyl-D-glucosamine residues.5(a-b) Chitosan molecule binds to metal ions resulting in the change in the nanoparticle properties.6 Chitosan shows excellent antimicrobial activity against typhoidal bacterial strain demonstrated by Yadav and Bhise. Takahasia et el. also described that Chitosan molecule exhibit antimicrobial activity in gram positive bacteria that is S. Aureus.7 Chitosan is a cationic polymer with high charge density, due to its cationic behaviour it must interact with negatively charged species.8 Structure of Chitosan molecule is given as:



Structure of chitosan

Another important organic nanoparticle is Curcumin. Curcumin possess various activities like Antimicrobial agents, anti-inflammatory, anti-tumor and antioxidant properties. Curcumin is extracted from turmeric.9 Chemical Structure of Curcumin is given as:



Curcumin

- *Professor Dr. Gurmeet Kaur is currently working as Professor at Chandigarh University Gharuan, India, PH-9878464360. E-mail: gurmeet.uis@cumail.in*
- *Ramnik is currently pursuing Ph. D. in Chemistry at Chandigarh University Gharuan ,India, PH-6280872003. E-mail: ramnikkaur1995@gmail.com*

KEYWORDS: Chitosan, antibacterial agents, Nanoparticles, Curcumin

ABBREVATIONS: TEM= Transmission Electron Microscope, Zn= zinc, Fe= Iron, K= Potassium, TGA= Thermo-Gravametric Analysis, SEM Scanning Electron Microscope, AFM= Atomic Force Microscopy, FACS= Fluorescence-Activated Cell Sorting, FT-IR= Fourier Transform Infrared Spectrophotometer, DTA=Differential Thermal Analysis, HMW=High Molecular Weight, LMW= Low Molecular Weight, MIC = Minimum Inhibition Concentration, ESEM=Environment Scanning Electron Microscope, MBC=Minimum Bactericidal Concentration, EDS= Energy Dispersive Spectroscopy, PAO-1= Pseudomonas aeruginosa, FE-SEM= Field Emission Scanning Electron Microscopy, DLS= Dynamic Light Scattering.

Sr.No	Year	Organic Nanoparticle	Function as antibacterial agents	Methods Used	Disadvantages	Detect	References
1	2008	Chitosan Nanoparticle	Antibacterial activity showed against S. aureus	Broth microdilution assay, Mueller-Hinton II broth	Coupling of these processes in this mechanism cannot be explained.	TEM	Raffat et el.
2	2009	Chitosan Silver Nanoparticle	Antibacterial activity showed against E. coli and Bacillus	Zone inhibition method	Depicts lesser bacterial growth	X-ray diffraction, TEM, UV – visible spectra, TGA	V. Thomas et el.
3	2010	Chitosan Nanoparticle	Chitosan shows inhibitory efficiency against fungi, gram positive and gram negative bacteria	Not given	Reduces bacterial growth rate but not kill them	TEM, SEM	M. Kong et el.
4	2011	Curcumin	Curcumin targets signalling molecules that highly expressed in cancer cells.	Ultracentrifugation , FACS Analysis	At higher concentration of drug, entrapment efficiency was reduced where the drug tends to participate.	DLS, AFM, XRD, FT-IR, DTA	A. Anitha et al.
5	2011	Silver nanoparticle-circumin composite	Antibacterial property is tested against E. coli	Diffusion mechanism	Supresses the growth of bacteria	FT-IR, UV, SEM, TEM	Varaprasad et al.
6	2012	Chitosan nanoparticle	HMW and LMW chitosan showed antimicrobial activity against all tested bacteria	MIC and MBC	Decrease efficiency in anaerobic bacteria.	MIC	E.M. Costa et al.

			with MIC varying from 1 and 7 mg/ml				
7	2013	Carbon nanoparticle	Antibacterial properties was studied against Proteus Refrigere, Staphylococcus aureus, Pseudomonas Aeruginosa, Streptococcus haemolyticus	Centrifugation	Not given	SEM, UV, XRD	Sheena Varghese et al.
8	2014	Curcumin	Inhibit in vitro growth of methicillin-resistant Staphylococcus aureus (MRSA) and Pseudomonas Aeruginosa	Sol- Gel method	Not given	SEM, TEM, DLS, UV-VIS	A.E. Krausz et al.
9	2016	Curcumin	MBC against four bacterial strains, Cytotoxic activity against eukaryotic cells	Wet milling technique	Inhibit the bacterial growth	ESEM	M. A. Adahoun et al.
10	2017	Silver nanoparticle with curcumin solid dispersion	Measures of MIC showed efficacy against gram negative(Escherichia coli and Pseudomonas aeruginosa) and gram-positive bacteria(Staphylo coccus aureus)	MIC	Not given	MIC	Alves et al.
11	2017	RuS2 and RuO2 nanoparticles loaded chitosan	Antibacterial activity showed against PAO-1 bacteria.	MIC and MBC	Not given	FE-SEM, EDS, FT-IR	Kheirandish et al.
12	2017	Curcumin loaded zein fibers	Zein-CUR fibers showed good antibacterial activity towards S. aureus and E. coli.	Electrospinnin g technique	Inhibit bacterial growth	FTIR, XRD, SEM,	H. Wang et al.
13	2018	Chitosan nanoparticle	This showed antibacterial activity against E. coli	Centrifugation	Could not completely kill all the bacteria	SEM	Sae-Yeol-Rim Paik et al.

VARIOUS APPLICATIONS-

Chitosan has many applications [23]

1) Medical industry

2) Textile industry

3) Food industry

4) Waste water treatment

5) Agriculture

6) Cosmetics

7) Paper making

8) Wound healing

9) Tissue regeneration [24]

CONCLUSION:

Organic nanoparticles act as antibacterial agents. Many synthetic methods have been used to prepare organic nanoparticles. Nanoparticles synthesised were confirmed by various analysis. In future more research should be focused on the preparation of organic nanoparticles. These particles can be applied in future studies to assess their applicability in different fields.

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