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# Review on chitosan: its derivatives and applications

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***Abstract:*** chitosan could be a product of deacetylation of polysaccharide that is wide found in nature .Chitosan could be a perishable natural chemical compound with several blessings like nontoxicity, biocompatibility, and biodegradability. It is applied in several fields, particularly in medication. Chitosan is extraordinarily troublesome to solubilize in water, however it is solubilized in acidic resolution. Its quality in water could be a major limitation for its use in medical applications. Chitosan derivatives is obtained by chemical modification mistreatment such techniques as chemical process, alkylation, hydroxylation, quaternization, esterification, graft copolymerization, and etherification .chitosan finds application in several industries as well as the medical food cosmetics and water treatment etc.

***Key words:*** **chitosan and its derivatives, biodegradable, biocompatibility.**

## 1. Introduction:

**Chitosan** is Polycationic naturally occurring biodegradable nontoxic derived from chitin. Chitin and its acetylated derivative, chitosan, are a family of linear polysaccharides composed of varying amounts of linked residues of N - acetyl-2 amino-2- deoxy-D-glucose (N-acetyl-glucosamine) residues[1-2]

### 1.1 Structure of chitosan:

It contains quite 5000 glucosamine chemical compound. Chitosan is soluble in liquid acidic media via primary paraffin protonation. Chitosan is taken into account as materials for application on account of its biodegradability, antimicrobial activity, non-toxicity, biocompatibility and economic benefits [3-6]

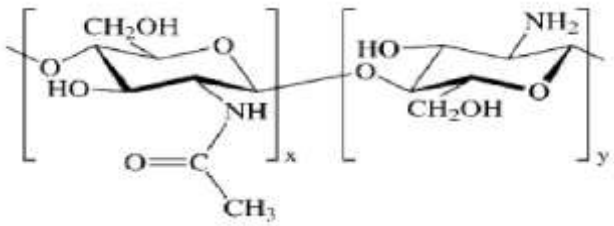



**Fig. 1 Structure of Chitosan**

Chitosan is a smaller amount frequent in nature happens in some fungi (mucoraceae). The chemical structure of polyose is formed of linear Monomeric units of two -acetamido-2-deoxy-2-glucopyranose connected through beta (1-4) linkages7

The us Food and Drug administration (FDA) has approved that chitosan is safe within the use of foods and medicines.

Functional teams gift in chitosan molecule square measure C3-OH, C6 – OH, C2-NH2 and acyl group amino and organic compound bonds. business chitosan samples were created from deacetylation of polyose from crustacean sources.

**1.2 Sources and Extraction of chitosan from raw materials:**

Chitin, the main source of chitosan is widely distributed both in animal and plant Kingdom.[8] It is found in the Iridiphores (reflective material) of both eyes and epidermis of cephalopods and arthropods of phylum Mollusca and epidermal cuticle of the vertebrates. Epidermal cuticle of paralipophrystrigloides is also Chitinous in nature[9-11]

Chitin occurs in polymorphic solid state forms designated as alpha, beta and gamma chitin which differ in their degree of hydration, size of unit cell.

Chains of chitin are arranged in tightly compacted crystalline structure of antiparallel sheets and extensive intermolecular hydrogen bonding (alpha chitin), in more mobile allomorph of parallel sheets (beta chitin) or a combination of both (gamma chitin).

Alpha chitin is most abundant and is found in selfish exoskeleton and fungal cell walls.

Beta chitin is mainly found in squid pens and diatoms while gamma chitin may be predominantly found in squid and cuttlefish stomach lining.[12-14]

## 2. EXTRACTION :

Firstly the sources like crab or shrimp cells are washed associate degreed grinded into pulverised type so deproteinized by treatment with a binary compound three to five resolution of hydroxide

After that its neutralized associate degreed demineralized at an area temperature by treating it with a binary compound 3- five you look after hydrochloric resolution to make a white or slightly pink precipitate of polysaccharide

After that polysaccharide is deacetylated by treatment with associate degree binary compound forty to forty fifth resolution of hydroxide and also the precipitate is then washed with water.

The insoluble half is removed by dissolving in associate degree binary compound a pair of ethanoic acid resolution.

The supernatant resolution is then neutralized with associate degree binary compound hydroxide resolution to get a refined chitosan[15-16]

## 3. Production of chitosan:

**Steps in production of Chitosan**

**1. Demineralization**

**2. Deproteinization**

**3. Decolorization**

**4. Deacetylation**

Chitosan created from crustacean shell like crab and shrimp. These shells contains 30-40% supermolecule, thirty to five hundredth carbonate and twenty to half-hour polysaccharide.

Generally produces a chitosan with 72-95% deacetylation[17-18]

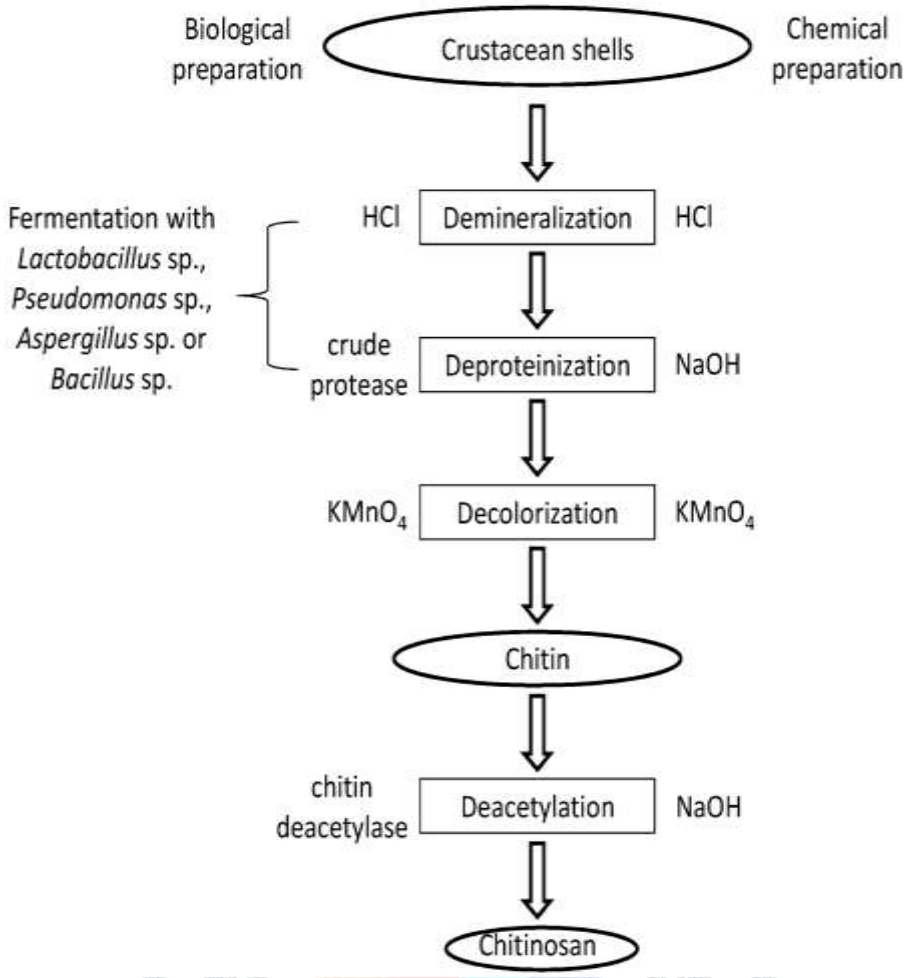



**Fig. 2 Production of Chitosan**

## 4. Properties of chitosan

### 4.1 Chemical properties

**1.** Weak base; Deprotonated amino group acts powerful nucleophile.

**2.** consisting of reactive groups for chemical activation and cross linking

**3.** Insoluble in organic solvent and water soluble in dilute hydrous acidic solution

**4.** Chelating and complexing properties

**5.** Forms salts with inorganic acids and organic acids

**6.** Entrapment and adsorption properties separation and filtration.

**7.** Film forming ability, adhesively material to isolation of biomolecules.

**8.** Flocculating agent interact with negatively charged molecules.

### 4.2 Biological properties

**1.** Safe biodegradable to normal body, non toxic

**2.** Haemostatic i. e. Stop bleeding.

**3.** Fungi- static i. e. Stops the growth of fungi

**4.** Spermicidal birth control

**5.** Anti-cancer or antitumor inhibit growth of carcinogens

**6.** Anticholesteremic - cholesterol reducing agent

**7.** CNS depressant reduces the activity of brains

**8.** Immunoadjuvant involves in the improvement of immune response.

**9.** Antibacterial

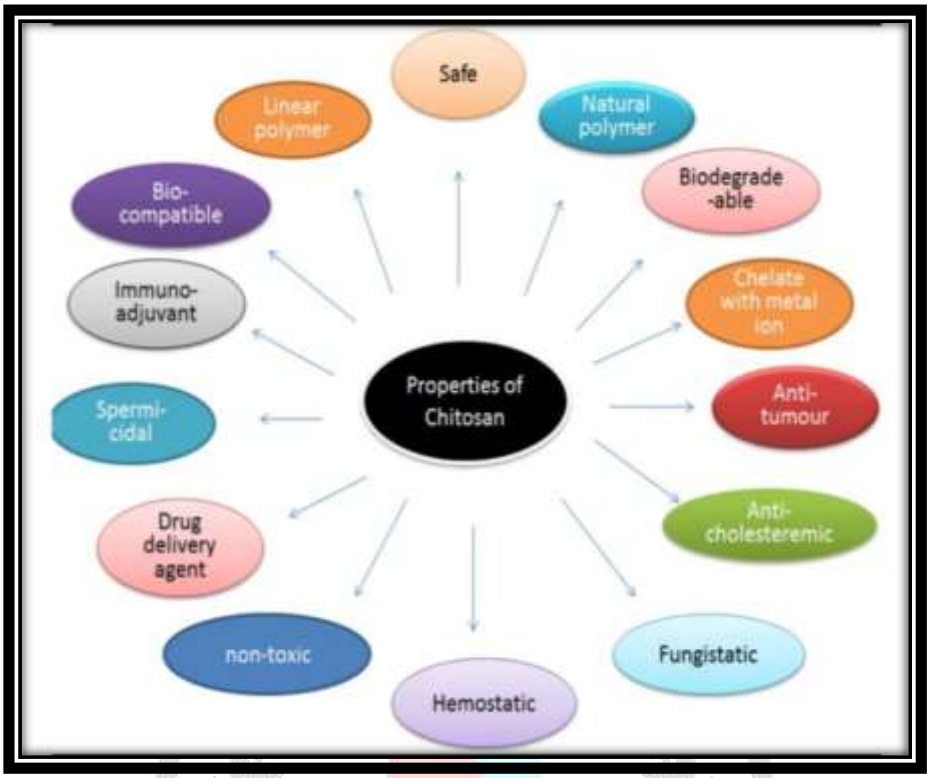



**Fig. 3 Properties of Chitosan**

### 4.3 General properties of chitosan

#### 4.3.1. Molecular weight

Chitosan is biopolymer of high molecular weight. The molecular weight of chitosan can be determined by chromatography, Light scattering and viscometry. Its molecular weight is typically between 300-1000 kDa Depending on the source of chitin.

#### 4.3.2. Viscosity

Viscosity is an important factor in determination of molecular weight of chitosan. Chitosan viscosity decreases with an increased time of demineralinization Lower viscosity chitosan facilitate easy handling.

#### 4.3.3 Bulk density

The bulk density of chitin from shrimp and crab is normally between 0.06 and 0.17 g/ml respectively indicating that shrimp chitin is more porous than crab chitin.

#### 4.3.4. Color

Chitosan powder is sort of soft in nature and its color varies from yellowness to white. The pigment within the crustacean shells forms complexes with polyose.

## 5. Derivatives of chitosan:

Chitosan derivatives were developed to improve not only biological activities but also water soluble property because water solubility is a major limiting factor for industrial use.

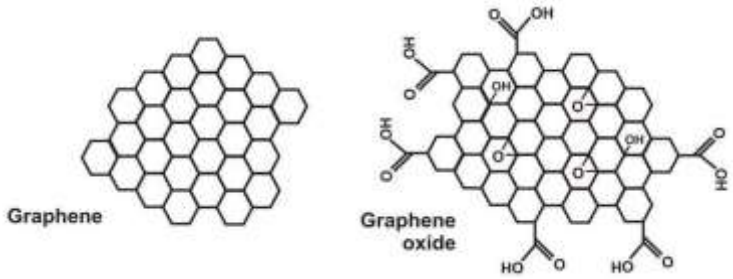
### 5.1 Chitosan chains with graphene oxide nanosheets

Graphene a member of the family of carbon nanoscaled materials arranged in a honeycomb two dimensional lattice is a single atom thick nanostructured sheet used as material in a diverse range of application due to it's intrinsic unique mechanical and electronic conductivity

high specific area, high mechanical, thermal and chemical Stabilities properties making it suitable material for electrochemical catalysis and biosensing.

To expand and optimize the use of graphene in the different application in biotechnology,

It is necessary to functionalize graphene with biomaterials such as chitosan and other polysaccharides Recently Han and Yan (2014 ) have prepared supramolecular hydrogels of chitosan and graphene oxide by the non covalent interaction between them where the nonosheets work as 2 D cross linkers[19]



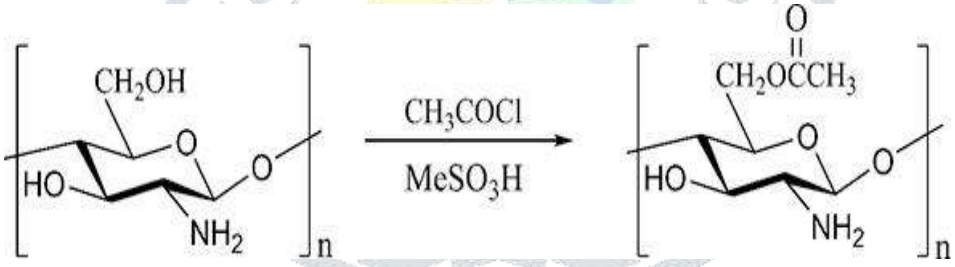

**5.2 Esterified chitosan**

This esterification reaction of chitosan is the reaction of chitosan with carboxylic acid or an oxy containing mineral acid.

Chitosan succinate and chitosan phthalate both the esters have been used as potential matrices for the colon specific oral delivery of sodium diclofenac.

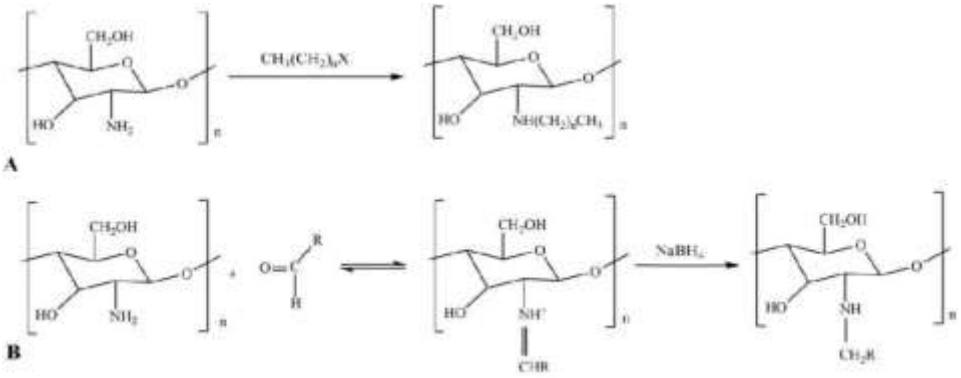
Sulphated chitosan has a significant anticoagulant activity due to its similarity in structure of

Heparin and it can be used as anticoagulant[20-22]



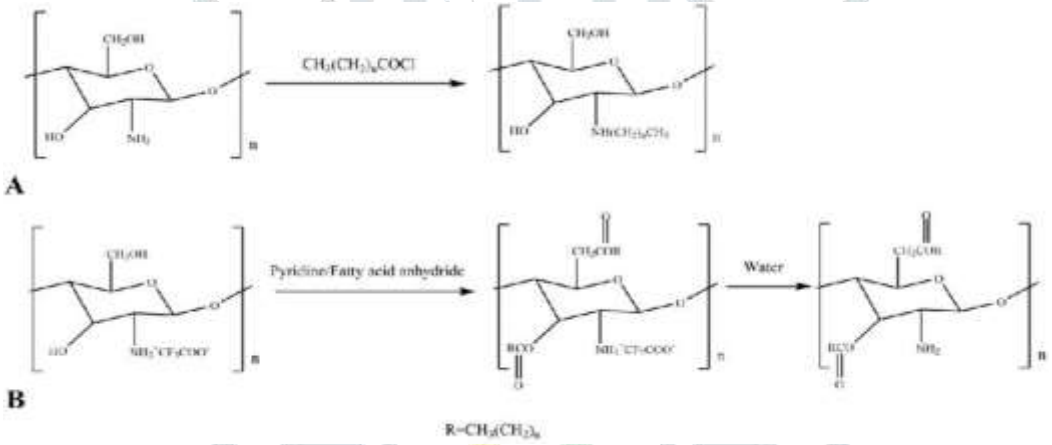

**5.3 Alkylated chitosan**

A group are often introduced into chitosan and this leads having considerably weakened unit H bonds, resulting in associate improvement in its solubility. The cluster alkyl radical group {radical chemical group} may be a hydrophobic group. Each - NH2 (amino) and C3, C6-Buckeye State (hydroxyl) are often concerned in chitosan alkylation. Alkylated chitosan are often wont to prepare medical gauze because of its natural action and medicine properties. It are often wont to absorb anionic wetter in water purification engineering because of its positive modification. N- Alkylated chitosan are often ready from Halogenated alkane series [23]



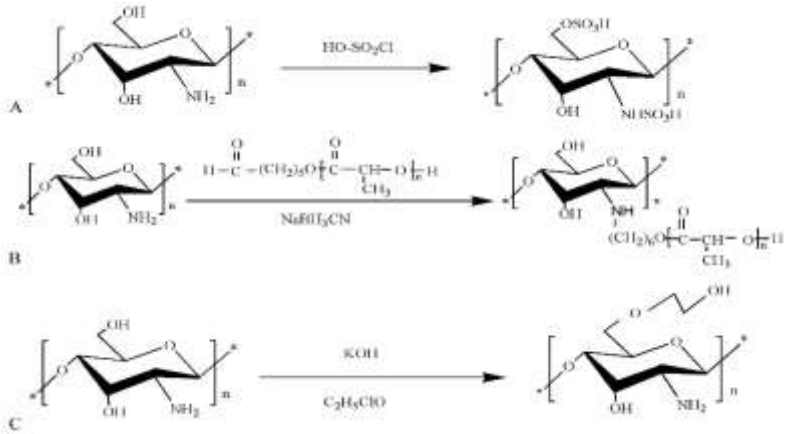
### 5.4 Acylated chitosan

Acylation modification is that the commonest modification of chitosan . The chemical process of chitosan refers to the reaction of chitosan with organic acids and derivatives of organic acids (mainly compound and acyl group chloride) ,introducing open-chain or aromatic radical to the molecular chain. The chemical process reaction destroys the unit and building block atomic number 1 bonding of chitosan that weakens its crystallinity and enhances its water solubility. N- Acylated chitosan derivatives show increased biocompatibility, anticoagulability , and blood compatibility . It will be used as a carrier or sustained unharness agent in pharmaceutical application.O – chemical process destroys the chemical bond structure of chitosan and improves it's fat solubility and property [24-26]



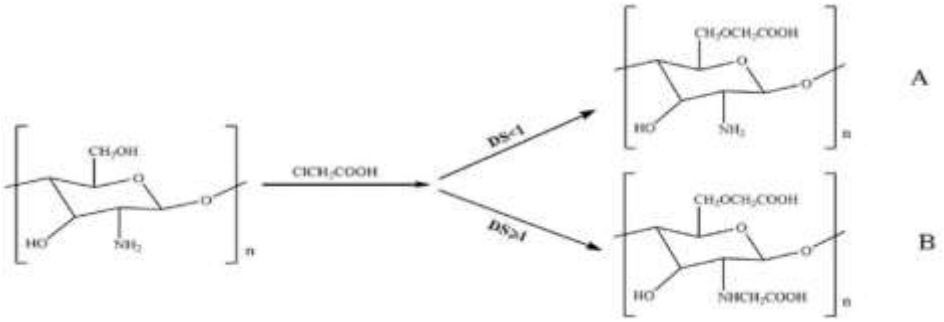
### 5.5 Etherificated chitosan

The hydroxyl group in the chitosan molecule reacts with the alkylating agent (example Dimethyl sulfate, chloroacetic acid, and ethylene oxide) to form a chitosan Etherification are Sulphuric acid phosphoric acid and Chlorosulphonic acid. Hydroxyethyl chitosan can be used as preservatives in cosmetics where they exhibit antibacterial effect on common bacteria such as e coli. The etherified product has good moisture retention, bacteriostatic and non toxicity [27-28]



### 5.6 Carboxylated chitosan

In the method of Carboxylation, there's introduction of AN acidic cluster on backbone of the base compound. Such derivatives of chitosan square measure amphiprotic in nature thanks to prevalence of amino. By mistreatment carboxyaldehyde in an exceedingly subtractive animation sequence which ends in N – carboxyalkylation. Sequent substitution giving rise to the formation of biscaroxymethyl derivatives by mistreatment glyoxalic acid. Carboxylated chitosan has sensible water solubility and will be dissolved in neutral and alkaline solutions. It's wider application than chitosan within the industrial, agricultural, medical, health and organic chemistry fields thanks to its medicine properties, that promotes wound healing, lipid lowering, antiviral, antitumor, symptom effects, medical care etc[29-30]




## 6. Applications

The poor solubility of chitin is the major limiting factor in its utilisation. Chitosan is considered as a potential polysaccharide because of its free amino groups that contribute Polycationic Chelating and dispersion forming properties. Chitosan possesses exceptional chemical and biological qualities that can be used in a wide variety of industrial and medical application

### 6.1 In the food industry

The food processing industry uses polysaccharides in food Product development and processing for the purpose of imparting desirable functional properties such as thickening, gelling, emulsifying and whipping. Recently researchers announced a chitosan based plastic wrap that doubles the shelf life of some foods. The plastic includes grapefruit seed extract which has antibacterial, antiviral, antifungal properties. The plastic can be use raw ingredients that would otherwise be discarded and biodegrades. Chitosan is also effective or dewatering activated sludge suspension resulting from Biological treatment of breathing and vegetable canning wastes [31-33]

### 6.2 In wastewater treatment

The wastewater released from processing plants typically seafood, dairy or meat processing industries contains amount of protein which can be recovered with the use of chitosan. This protein after drying and sterilisation makes a great source of feed additives for farm animals. Chitosan can be used for conditioning muncipal and industrial sludge due to mainly to effectiveness in sludge conditioning biodegradability in soil environment teen centrifugal slash dewatering[34]

### 6.3 In medical

Chitosan has interesting biopharmaceutical characteristics such as PH sensitivity, biocompatibility and low toxicity. Cheap person is metabolised by certain human enzymes, lysozyme is biodegradable. It can be used in different areas such as wound and bone healing, blood cholesterol control, contact lenses, surgical sutures, clotting agent and skin burn [35]

### 6.4 Agricultural application

The abundance, biodegradability, nontoxic and natural origin of chitosan allow it to be safely used in agricultural application. It can be used without concern of pollution, disposal or harm to consumers of ingested The use of chitosan has shown to increase the amount of crops produced by germination improvement, rooting, seed yield, and soil moisture retention, while reducing the fungal infection and diseases [36]


**Fig. 4 Application of Chitosan**

**Conclusion:**

Chitosan and its derivatives exhibit a variety of physicochemical and biological properties resulting in numerous worldwide applications in areas ranging from pharmaceutical, biomedical, dentistry, food industry, waste water treatment, agrochemical, environmental and industrial uses.

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