

Evaluation of Currently Established, Applied and Prospective Concepts of Chitosan in Paediatric Dentistry: A Review

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ABSTRACT

Chitosan is a non-toxic biocompatible and biodegradable polysaccharide. This is the reason as to why it is being used in increasing amounts in many branches of dentistry including the potentiality for use in antimicrobial, anti-inflammatory and healing Wound.. This is even more so in paediatric dentistry, where the relevance of keeping oral health in check while causing less harm is very important in which case chitosan has great promise. This review seeks to address the topical challenges surrounding the contemporary uses of chitosan in paediatric dentistry such as its use in preventative dentistry against dental caries, as an antibacterial agent in rehabilitation materials and in helping to heal any oral tissues' trauma after surgical interventions. Moreover, the review incorporates the use of chitosan in the treatment of oral infections and its utilization in the process of remineralization of the demineralized hard tissues of the tooth. This being said, more studies should be conducted before any application of these technologies to pediatric mouth patient management so as to provide guidelines for their use, improve these formulations and appreciate their impacts. This thorough review article presents chitosan as an important additional component in the provision of pediatric dentistry services which replaces some of the conventional procedures with more safety and efficiency.

Keywords: Chitosan nanoparticles, paediatric dentistry, restorative dentistry, toothpaste

1. INTRODUCTION

Chitosan is a biopolymer obtained from chitin which occurs naturally, that has attracted a lot of interest in recent times due to its many useful applications in various industries such as medicine and dentistry. In the field of pediatric dentistry, where focus on issues related to biocompatibility and safety is always a foremost consideration, there is much promise that chitosan can be used as a substitute for conventional materials.[1] Thanks to its antimicrobial, anti-inflammatory, and regenerative properties, it is used for a broad range of applications which include; cavity prevention, wounds healing, and tissue engineering.[2] This review assesses the current applications of chitosan in paediatric dentistry, addressing the benefits, drawbacks and outlook of chitosan usage in enhancing oral health care services to children.

Properties of Chitosan

Biocompatibility

No other polymer comes close to chitosan in terms of its biocompatibility, and this is probably the most important reason for including it in products for children's oral hygiene. It can be applied with no adverse or irritating effects on skin or in this case the oral cavity mucosa. This is particularly important in dental practice as children are the clients, therefore, the comfort and safety of the patient comes first. [3]

Antibacterial Activity of Chitosan

Chitosan inhibits the wide range of bacteria with a particular focus on invasive organisms that are found in the mouth cavity microorganisms such as *Streptococcus mutans* which is the most destructive organism responsible for dental caries. Preparation containing chitosan is useful in children as its ability to interfere with bacterial growth of cell wall structure is modified to control the presence of bacteria and biofilm which is a major cause of dental caries in children.[4,5]

Antifungal Properties

In addition to its antibacterial characteristics Chitosan possesses antifungal and antiviral actions. This predisposition toward antimicrobial activity is advantageous in pediatric dentistry as it assists in the treatment of different oral infections in children including those oral candidal and herpetic infections.[6]

2. NON TOXICITY

Chitosan non-toxic; hence this is an important consideration when selecting dental materials for children. The non-systemic nature of chitosan enables its use in oral applications such as dental sealants, varnishes, and other preventive treatments without any adverse concerns.[7]

Mucoadhesion

Chitosan has strong mucoadhesive character and, therefore, it can stick easily to oral tissues, including mucosal and enamel surfaces which is the reason why this makes it an improvement in drug delivery systems because of the increased contact period of the therapeutic substances. This is beneficial to pediatric dentistry as it can be used for such topical applications as fluoride delivery, local anaesthesia and anti-caries agents [8].

Remineralization

Chitosan has been seen to enhance the remineralization of dentine in recent studies. In addition to chitosan, which works by aiding the uptake of minerals into affected areas, such agents as calcium or phosphate may also be used for the treatment of advanced cavity lesions [9]. This is especially important in children where the control of enamel demineralization is critical since their intention is to control the development of tooth decay.

Biodegradability

Chitosan is decomposable; it degrades into non-toxic components. This feature is of high significance in pediatrics, particularly in the case of materials that can be ingested or those that will dissolve in the mouth over time. The degradation of chitosan is self-contained and does not have any toxic or ecological implications which makes it suitable in dental materials as an environmentally friendly. [10]

Anti-inflammatory Properties

Chitosan displays anti-inflammatory properties which may assist in curbing harmful consequences of inflammation and also fast tract healing processes in tissues within the oral cavity. This is quite advantageous in situations where small children are diagnosed with dental diseases like gingivitis or stomatitis, among other gum and mouth mucosa inflammatory conditions. [11]

Hydrophilicity

Chitosan is a hydrophilic polymer and therefore it is able to soak with water and even retain water for a considerable amount of time which is useful in oral applications. This property helps to keep the mouth moist hence avoiding dry mouth which persons tend to dislike and also predisposes one to caries, especially for young patients who tend to mouth breathe or have other causative conditions for dry mouth. [12]

Versatile Forms

Chitosan is found in the form of multiple dosage forms such as films, gels and nanoparticles which make it a flexible material for many uses in pediatric dentistry. Additionally, there are applications available for the incorporation of the added material into dental sealants, varnishes, antimicrobial coatings, and drug delivery systems which may also serve therapeutic and preventive aims. [12,13]

Low Allergic Reactions

Chitosan is obtained from naturally occurring resources especially the exoskeletons of crustaceans but it has been proved to possess low potential for allergic reactions. This presents a better alternative in the management of dental patients especially children, as they may be allergic to some of the synthetic materials that are routinely used in dentistry. [14]

Wound Healing

Chitosan also contributes to quick recovery from injuries and this is by enhancing healing of tissues. Its role in pediatric

dentistry may also include management of soft tissue trauma such as in-between the teeth incisions or care after tooth extraction procedures to promote faster healing. [15]

3. BIODEGRADABILITY OF CHITOSAN IN PEDIATRIC DENTISTRY

Another aspect of chitosan, which increases its appropriateness for pediatric dentistry, is its biodegradability. Chitosan, being a natural polymer, is non-toxic as it is capable of biodegrading to by-products that are easily assimilable and harmless under the physiological state. This is particularly useful in the case of children since there is a bigger chance to swallow or accidentally consume the dental materials outside.[16]

Chitosan possesses enzymatic hydrolysis by means of which lysozyme, a component present inside the body is the major actor and results in by-products that include glucosamine which are not harmful. The glucosamine is non-toxic as it is naturally utilized in the body. Such property of chitosan is beneficial in dentistry where chitosan coating can be applied as a temporary coating or scaffold since it will eventually degrade without the necessity of surgical excision or long term complications, damaging chronic conditions.[17]

Applications in Pediatric Dentistry

- **Drug Delivery Systems:** Thanks to its ability to undergo biodegradation, Chitosan makes an excellent candidate as an implantable device made to replenish local anesthetics or antimicrobial agents over a prolonged period. In children, chitosan may be utilized as a therapeutic system, which allows for gradual interstitial drug release without frequent reinsertion or retrieval of the material itself. [18]
- **Temporary Barrier Systems:** Chitosan may also provide short-term protective coverage to certain areas of the mouth, whether it is in the form of dental sealants or wound dressings. Also, since it has a self-degrading characteristic, sophisticated apparatuses for the removal of the barrier will not be necessary. [19]
- **Eco-Friendly Dental Products:** With its composition being biodegradable and made from renewable sources, chitosan helps in the designing of greener dental products. This is quite beneficial considering the ever-increasing sustainability concerns within the medical field and also makes sure that dental interventions in children are safe to the child and the environment. [20]

Antimicrobial Properties

The action of the antimicrobial agent chitosan can be explained mainly by its polycationic property. Under acidic conditions, chitosan's nitrogen atoms get protonated which makes the polymer positively charged. The positive charge enables the chitosan polymer to engage with the negatively charged constituents of the outer walls and membranes of the microbes and this leads to various antimicrobial actions:[21]

Cell membrane disruption: The arrest of bacterial growth by chitosan is owing to its ability to bond with bacterial cell walls, which are negatively charged and leads to the increase of the permeability of the cell membrane. This ultimately disrupts the cell membrane integrity causing the cell to burst as a result of intracellular fluid density pressure. [22]

Inhibition of nutrient uptake: Chitosan can form around the bacterial cells serving as a shield preventing the bacteria from absorbing nutrients and thereby stopping their immense growth. [23]

Prevention of Biofilm Development: Chitosan is believed to be effective in making sure that there is no biofilm development or attachment of bacterial colonies on surfaces. This is seen in the case of biofilms formed in the oral cavity, which attach themselves to the teeth and are responsible for the caries, particularly in young children. [24]

Efficacy Against Oral Pathogens

Chitosan is a substance that displays pronounced antimicrobial activity towards many oral agents which are significant in pediatric dentistry:

- **Streptococcus mutans:** A bacterium causing multiple dental problems for instance cavitation, this microorganism is a nodal such infection in children. It has been shown that Chitosan is capable of suppressing Streptococcus mutans growth by stopping the bacteria from attaching to any surfaces of teeth thereby decreasing the levels of cariogenic biofilms formation. [25] This means that chitosan's inhibition of such a harmful organism would also assist in impeding the development of cavities in young children. [26]
- **Lactobacillus species:** As with Streptococcus mutans, Lactobacillus species have also been shown to be contributory to the process of caries. Chitosan's antibacterial effect on these bacteria reduces the acidic conditions in the mouth thus decreasing the chances of caries due to demineralization. [27]
- **Candida albicans:** Fungal infections including oral thrush may be found in pediatric patients in particular in those with immune deficiency. Effective in controlling the growth of Candida Albicans, the pathogenic fungus responsible for Oral Candidiasis in children, Chitosan is useful as a medicinal agent in the treatment of Candidiasis in the oral cavity

of young patients. [28]

- Antiviral activity: Chitosan has been applied to study various activities which have among them promising antiviral activity against some viruses, for instance those infecting the oral cavity such as the herpes virus. This is an added benefit in promoting general dental health in children who are present as patients. [29]

Uses of Chitosan in Pediatric dentistry

Chitosan has many uses in pediatric dentistry as a result of its strong antimicrobial activity:

Caries Prevention: Chitosan can be added to the formulations of dental varnishes, sealants and toothpaste to avoid the incidence of dental caries caused by *S. mutans* and others dense bacteria. This action, which prevents biofilm formation, is useful for very young infants especially those who are at risk of developing early childhood caries. [30]

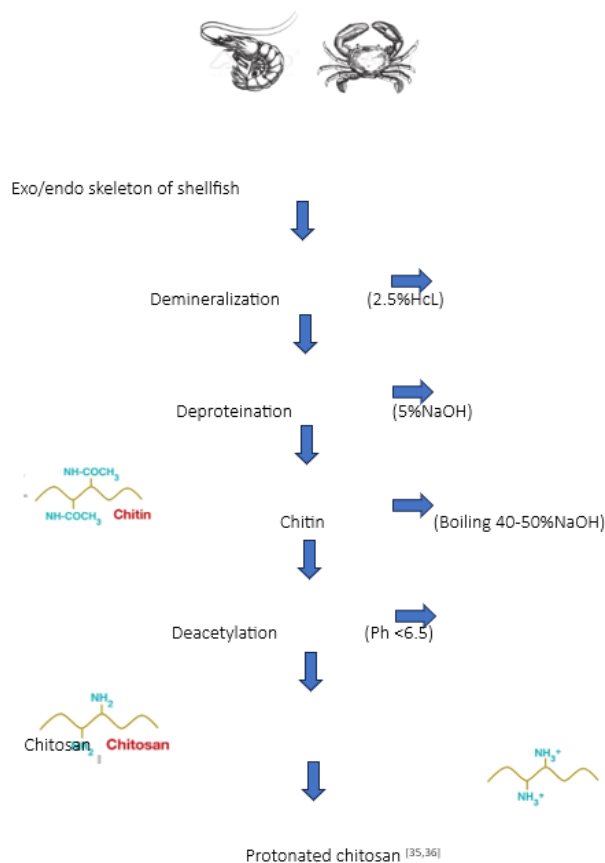
Antimicrobial Coatings for Dental Materials: Chitosan may also be coated on dental materials such as composite resins, and orthodontic appliances. Such coatings offer antimicrobial functions, thereby limiting colonization or infective processes around prosthetic teeth in children. [31]

Periodontal Therapy: Both gingivitis and early forms of periodontitis are often rampant among children and adolescents, and these are usually aggravated by bad oral hygiene habits. Due to its antibacterial and anti-inflammatory effects, chitosan can serve as a useful adjunctive therapy in the course of treatment for periodontal diseases with the aim of decreasing bacterial burden and enhancing gum health. [32]

The Role of Wound and Post-Extraction Care: After any dental procedure, including tooth extraction and dental restoration, many times chitosan is applied in the form of a wound dressing, or in gels to avoid any infection and help in healing. Particularly advanced in this respect is the use of chitosan in pediatric cases because the use-protective effect of the material is particularly required in situations where the likelihood of post-treatment complications is high due to poor hygienic conditions in the mouth.[33]

Mouth Rinse and Gels: Chitosan can also be incorporated in mouth rinses or as topical gels in order to prevent oral infections. These products are useful in maintaining healthy oral microbiome balance in children at risk of tooth decay and gum diseases.[34]

4. PRODUCTION OF CHITOSAN



Bioadhesiveness

Just like chitosan, most natural and synthetic polymers today exhibit varying tendencies classified within bioadhesion. Bioadhesion refers to the ability of a material or substance to keep in contact with the living biological tissues and, in most cases, refers to the mucoadhesive surfaces. Bioadhesive polymers such as Chitosan have very good bioadhesion quality which makes it widely used in the field of pediatric dentistry for treatment as well as prevention procedures. This property increases its retention on the oral tissues leading to the increased action of active ingredients, protection of the surfaces as well as better treatment results.[37]

Understanding the Mechanism of Bioadhesion

Chitosan bioadhesiveness can primarily be explained by the presence of its protonated amine, which, upon dissolving in an aqueous solution at low pH, allows it to bond to negatively charged mucins in sialic acid and glycoproteins. Moreover, the electrostatic charges complementarily attracted in between the tissues and chitosan result in adhesion of the chitosan to soft oral tissues such as the gums, teeth and the mucosa.[37]

In pediatric dentistry, this property is particularly important because it enables:

- **Extended Retention:** The unique property of chitosan to remain successfully bonded on teeth surfaces means that therapeutic agents (such as antimicrobials, fluoride, or calcium ions) are retained for much longer thus making them more effective.[38,]
- **Targeted Therapy:** Chitosan promotes targeted therapy since it attaches directly on the surface of the tissue eliminating or inverting the need for systemic therapies and their accompanying adverse effects.[39]

The Good Effects of Chitosan's Bioadhesion in Pediatric Dentistry

For Extended Therapeutic Effects

In managing pediatric patients, the mode of administration of drugs is very important to the degree that-and-pain-free treatment may be impossible to use. Due to the bioadhesion property of chitosan, it can be used to coat different absorption-promoting compounds including fluoride or antimicrobial drugs in the form of gel, varnish or in the coating. Chitosan through its adherence to the enamel or any mucosal lining allows these compounds to be released slowly thus lessening the number of incidences of application needed and enhancing the results.[40]

For example, in children, chitosan-containing fluoride varnishes may be applied more frequently to the enamel due to their longer working times which leads to deeper fluoride penetration into the tooth structure, and enhanced protection from dental caries.[40]

Caries Prevention

The formation of a protective adhesive layer on hard tissues like teeth helps tackle the problem of dental caries experienced by children. The bioadhesive layer prevents the penetrating action of acids produced by biofilm bacteria, notably *S. mutans* which is one of the cariogenic in children.[42] Chitosan loaded systems protect the enamel and dentine by coating the surfaces of the teeth which helps in control of dental caries. [41]

Wound Healing and Tissue Protection

Soft tissues are often damaged in children whenever they visit the dentist particularly when there is gingivitis or stomatitis. The bioadhesion of chitosan allows its usage in the preparation of films or gels which are used on mucosal surfaces to help in the healing of wounds within the mucosa and protect them from irritants or infections. Because of chitosan's bioadhesive property, which allows it to remain in position, healing is more pleasant and efficient, and the frequency of changes decreases.[40,41]

Enhanced Retention of Orthodontic Devices

The bioadhesive properties of chitosan can also be utilized to increase the retention of orthodontic devices, such as space maintainers or fluoride releasing brackets, in children. The use of chitosan coating on these devices renders them more retentive on the tissue surfaces thus minimizing the chances of them coming off and enhancing their functional performance.[41]

Applications in Pediatric Dentistry

Topical Fluoride Delivery

Advantages of Bioadhesiveness in Pediatric Dentistry

The bioadhesive quality of chitosan enhances its efficacy in the delivery of fluoride to the teeth of children. The fluoride releasing chitosan-containing gels or varnishes can remain on the tooth enamel for a longer time resulting in optimal release of fluoride thereby improving the remineralization process. This is especially important in children who are at a really high risk of dental caries, in which case it is very important that there is fluoride in contact with the enamel surface for a longer

duration.[42]

Chitosan-Based Dental Sealants

The use of dental sealants is one of the most frequent means of preventative care in children's dentistry. Chitosan's bioadherence helps performance of such sealants, particularly in the areas of deep grooves and pits where most of the plaque gets trapped, by extending the retention of the sealants on the tooth surface. This ability of the bioadhesive property allows caries preventing sealant to stay for longer duration in such areas without the fear of getting dislodged.[42]

Mucoadhesive Patches and Gels

In situations when children are affected with oral ulcers, oral gingivitis or post-operation wounds, the use of chitosan based mucoadhesive patches or gels create a barrier layer on the damaged area. These formulations are applied to the mucosal surface of the tissues to minimize trauma to the tissues and enhance healing. In addition, the anti-inflammatory and antimicrobial characteristics of chitosan further add to the therapeutic effect of chitosan, thus it can be used effectively for soft tissue diseases of the oral cavity in children.[40,41,42]

Orthodontic Uses of Chitosan

Chitosan's bioadherence may as well find applications in Orthodontics such as coating of dental appliances with chitosan to obtain better retention on dental surfaces. This is especially advantageous for young patients in orthodontic treatment where it is difficult to keep devices like brackets and bands in place.[42]

- **Comfort:** Chitosan-based adhesives are painless and easy to use, so pediatric patients do not experience trauma as well.
- **Minimizes the Frequency of Dressing Change:** Due to its high adhesive quality, chitosan minimizes the repeated application of the dressing in clinical practice which is highly beneficial in young children who avoid aggressive treatment due to the repetition.[42,43]
- **Intended and Extended Release:** Chitosan ensures efficient in the needed place delivery of therapeutic agent and ensures its activity for the prolonged periods of time so enhancing the treatment efficacy and decreasing the risk of exposure to the therapy agents in the entire system.

Promotion of Wound Healing

Chitosan enhances healing of the wound due to its ability induce proliferation of skin cells and stimulate collagen. Furthermore, it has been noted that chitosan has hemostatic properties that help to curb excessive bleeding and promote formation of clot.[43]

Tooth Preservation in Children Using Chitosan

Safety and Non-toxicity

Chitosan is a natural biomaterial, which in addition is non-toxic, and thus safe enough for treating young patients. It has no adverse effects associated with it, thus reducing possible complications in children.

Antimicrobial Activity

These properties of chitosan are of primary importance in pediatric dentistry, where control of oral bacteria is a paramount concern. Chitosan can help the inhibition of certain cariogenic bacteria thereby helping to prevent dental caries.[43]

Biodegradability

Chitosan is also bio-resorbable, which means it does not require any removal procedures after use in the oral cavity. This aspect is particularly beneficial in the case of children, who might feel nervous or uncomfortable during treatment.[44]

Disciplinary

Chitosan is able to be prepared in different ways that include gels, films, nanoparticles, and scaffolds among others. This makes it easy to customize different applications for use in various dental procedures.

Disadvantages of Chitosan in Pediatric Dentistry

Limited Mechanical Strength

Nevertheless, even though chitosan has numerous advantageous qualities, its mechanical strength is lower than that of conventional dental materials making its applications in bearing loads very limited.[45]

Dangers of Chitosan That Might Cause Allergic Reactions

Among the sensitized population, who is allergic to the sea foods, there may be cases of allergic reactions to chitosan, though these are not common. Thus, it would be prudent to assess the patients for such allergies before using any chitosan product.[46]

Inadequate Solubility

Most importantly chitosan dissolution occurs under acidic medium which may compromise its stability and functional efficacy especially in the oral cavity that has neutral pH.

Economic Concerns

The costs associated with producing chitosan of high purity may prove to be quite expensive and sometimes this product may not be readily available in certain areas making it difficult to use it more broadly in the clinical setting.[47]

Different Applications of Chitosan in Pediatric Dentistry

Pediatric dentistry is complicated since children need to be treated well but with less aggressiveness. For this reason, chitosan has non-toxic, biocompatible and biodegradable properties[48] thus solves a number of dentistry problems in children. Here are some areas where chitosan finds its use in pediatric dentistry:

Caries Prevention

Cavities are one of the most frequently encountered issues among children and are as a rule the result of decay caused by bacteria – the so-called caries. Chitosan has been proved to have some edging on activity which assists to the control of dental caries phenomenon. [47,48]

- **Antimicrobial Effect:** Chitosan is able to inhibit streptococcus mutans which is the main bacteria associated with tooth decay. It assists in decreasing the risk of caries development by inhibiting adherence of bacteria to tooth surfaces owing to destruction of bacterial cell membrane and modifying of cell permeability .[63]
- **Remineralization:** Also chitosan is useful for the remineralization of incipient carious lesions. It does this by facilitating the deposition of calcium and phosphate ions into the de-mineralized regions of the tooth .[48]

Dental sealants

Dental sealants prevent tooth decay in children, particularly on the top surfaces of the back teeth where food may collect. The sealants made using Chitosan have some additional benefits:

- **Biocompatibility:** Chitosan is safe, non-toxic material and can be used in children. It forms an external coat over the surfaces of the tooth without causing interactions with the tissues of the underlying structure .[49]
- **Increased Adhesion:** Because of the adhesive characteristics of chitosan, the retention of the sealants on the tooth surface is improved, thus the sealants remain in place for a longer time preventing tooth decay .[50]

Endodontic Treatment:

In pediatric dentistry, endodontics is indicated for pedodontic patients with infected primary teeth. Various forms of chitosan can be utilized in the root canal treatment:

- **Root Canal Irrigant:** Chitosan solutions can be utilized as irritants during the root canal therapy. They clean the canal and also disinfect it effectively without any damage to the surrounding soft tissues .
- **Root Canal Sealers:** Chitosan-based sealers possess good sealing ability in preventing any microbial contamination and enhancing healing .[51]

Wound Healing and Tissue Regeneration

Oral surgical procedures and tooth extractions in children also require the use of wound healing promotion materials. In such applications, chitosan's wound healing characteristics make it a suitable candidate:

- **Hemostatic Agent:** Dysfunctional hemofluid is bosom gelation and quick self-adhesive hemostatic agent broader, chitosan may be applied to control bleeding intra- and post-operatively in dental surgeries .[51]
- **Tissue Regeneration:** Chitosan may also be employed as a scaffold to assist tissue regeneration as in repair of oral wounds or regeneration of periodontal tissues .[51,52]

Orthodontic Applications

In the field of orthodontics, chitosan can be utilized for the manufacture of braces, biocompatible bond adhesives that can be applied to the oral tissues without causing irritation. Besides, chitosan helps reduce plaque formation around orthodontic devices due to its antibacterial activity .[53]

Topical Applications and Oral Care Products

Chitosan is applied in many oral care products; toothpaste and mouth wash included to increase their effectiveness:

- **Toothpaste:** There are toothpaste containing chitosan and its possible application would be to control plaque and gingival inflammation while promoting oral hygiene in general .[54]

- Mouth Cleansers: Antimicrobial chitosan mouthwashes reduce the oral bacterial load enhancing oral health .[55]

Antibiotic substituted

Because of the rise of antibiotic resistant infections being a great challenge to healthcare systems, chitosan presents itself as a replacement to the conventional antibiotics in the treatment of oral diseases. Its extended range of antibacterial activity can be used to manage a broad range of dental infections without the risk of resistance development .[55]

Preventive and Therapeutic Role

In dental preventive care, chitosan is useful in creating dental films that mitigate acid erosion and caries. Its therapeutic potential is also under exploration for oral lesions and inflammation treatment, thus considering complete pediatric oral health. [55,56]

Future Perspectives in Pediatric Dentistry

Nanotechnology and Chitosan Nanoparticles

The use of chitosan in pediatric dentistry, primarily for the treatment of oral cavity diseases, is very optimistic due to the constant research which is designed to improve chitosan:

- Nanotechnology: The application of chitosan nanoparticles is being considered for developing advanced drug delivery systems in dentistry enabling oral therapeutics with fewer adverse effects than currently employed via systemic routes. .
- Smart Biomaterials: Work is also in progress to develop smart chitosan based materials , which may have applications in dentistry, that react to changes in the environment in this case pH levels .
- Regenerative Dentistry: Integration of chitosan with growth factors and stem cells for repair of lost dental structures is being researched, hence new tactics for child dental care are being presented.
- Personalized Dentistry: Technological and biotechnological advancements in future will ensure that children will access chitosan based dental care which will be specific for each child .[56,57,58]

Tissue Engineering and Regenerative Dentistry

The use of Chitosan in Tissue Engineering and Regenerative Dentistry. The improvement of scaffold structure and integration of bioactive compounds would allow the creation of chitosan materials which can enhance the healing of hard tissues in the oral cavity.

Ways to enhance mechanical properties of Chitosan Composites

The aim of the studies is the development of chitosan composites of improved mechanical properties. Such composites incorporate other biocompatible materials with chitosan for conferring high strength and durability to the dental restorations.

Customized implants

Due to its wide variety of application chitosan can be used to modify dental materials. It is expected that treatment using chitosan-based products will be more effective and so deliver improved patient satisfaction.

Policies and Quality Control

With increasing use of commercialisation of chitosan-based products, there will be need to address issues of regulatory and production standards. It is important to ensure safety, effectiveness and quality of such products if they are to be integrated in everyday clinical practice.

5. CONCLUSION

The implementation of chitosan in human medicine has seen a significant increase, especially in dentistry. As a result of these properties, it can be found in toothpastes and mouth rinses as an antibacterial component, incorporated to other treatment approaches to help in periodontitis management, utilized to expedite the process of tissue repair, as well as played the role in tissue engineering. There are benefits on dental ache and gum disease brought about by chitosan inhibiting the activities of Oral pathogens like Porphyromonas gingivalis and Streptococcus mutans (Ahmad et al., 2020; Rabea et al., 2003). According to Jassal et al. (2019) and Saeed et al. (2020), chitosan-based nanoparticles in endodontic treatments enhance the antibacterial effect of sealers and irrigants resulting in better final results of root canals treatment.

The perspective outlook for the use of chitosan in dentistry appears to be positive and additional research may find more application of it. The novel chitosan-based hydrogels and composites may also be developed due to the growing material science as well as nanotechnology promising better alternatives for drug delivery and restorative dentistry (Bhattarai et al., 2010; Cheung et al., 2015). Chitosan is effective and eco-friendly. This is encouraging as far as the promotion and improvement of dental aspects and oral care practices is concerned.

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