ISSN: 2157-7439
Journal of Nanomedicine & Nanotechnology

OPEN ACCESS Freely available online

Mini Review

Mini Review on Natural Polysaccharides Used in Vaccine by Nanoengineering

Ana Sara*

Center for Research in Molecular Medicine and Chronic Diseases, University of Santiago de Compostela, Spain

ABSTRACT

The pathogenesis of about 30 viruses and bacteria is currently prevented by more than 70 approved vaccinations. However, there are still significant obstacles in this area, such as the need for more potent, non-invasive, and temperature-resistant vaccinations. Proteins, peptides, and nucleic acids are safer subunit antigens as a result of significant biotechnological advancements. Their modest immunogenicity has, however, necessitated the use of potent adjuvants that can boost the immune response. Particulate nanocarriers have great potential as immunization adjuvants. They can improve immune responses by simulating the natural infection process because of their size and structure that resemble pathogens. They can also be adapted for non-invasive mucosal administration (needle-free vaccination), and they can control the delivery of the associated antigens to a specific area and for extended periods of time. Creating space for immunization with a single dosage. Additionally, they permit the co-association of immunostimulatory molecules, which boosts the adjuvant's total capability.

Keywords: Nanocarriers; Immunomodulation; Biocompatibility, Biodegradability

INTRODUCTION

Their interest in developing nanovaccines is justified by the natural and widespread nature of polysaccharides as well as by their inherent immunomodulation properties, biocompatibility, and biodegradability. With an emphasis on the most recent developments in the production and use of polysaccharide-based antigen nanocarriers, we seek to present a state-of-the-art overview of the application of nanotechnology in vaccine administration in this study. Vaccination has been instrumental in both preventing and, in some cases, curing serious infectious diseases throughout the past few decades. Despite the progress made to date, considerable obstacles still need to be overcome if vaccine coverage is to be gradually increased [1]. The creation of novel vaccines against specific pathogens, such as the human immunodeficiency virus (HIV), malaria, and tuberculosis, among others, as well as the creation of single-dose and needle-free vaccines with the goal of enhancing patient compliance and lowering associated costs, are among these. Last but not least, the development of formulations that can bypass the cold chain of transport constitutes a crucial step in the improvement of immunization around the globe. The importance of adjuvants and antigens has been recognised as a result of advancements in both of these fields. Using nanotechnology to address the problems mentioned above. Numerous immunomodulation biomaterials, including polysaccharides, have been proposed for the manufacture of nanovaccines. This review's primary concern and summary is this novel approach. The first commercially available vaccinations, among those against rabies, poliomyelitis, tetanus, and paediatric tuberculosis, were developed by attenuating infections and poisons. However, the hunt for optimized antigens has been prompted by the possible toxicity and difficulty of carrying out this technique with complex infections, such as HIV and hepatitis C virus (HCV). Proteins, peptides, and nucleic acids in particular have been developed as novel and safer subunit antigens as a result of biotechnology advancements and greater understanding of the features of pathogens [2].

METHOD

Using expression vectors like bacteria or yeast, recombinant DNA technology has enabled the synthesis of numerous proteins having antigenic activity. The production of the hepatitis B surface antigen (rHBsAg) in Escherichia coli is a well-known example of this application, and it has resulted in the release of the first recombinant protein-based vaccines using alum as an adjuvant [3]. Similar to this, human papillomavirus (HPV) antigens expressed in Saccharomyces cerevisae and Trichoplusia Ni are sold (a combination of alum and monophosphoryl lipid A (MPLA)) as adjuvants. Hepatitis C is one of the other infections for which recombinant protein antigens have been discovered and

***Correspondence to:** Ana Sara, Center for Research in Molecular Medicine and Chronic Diseases, University of Santiago de Compostela, Spain, E-mail: ana.sara@gmail.com

Received: 3-Aug -2022, Manuscript No: jnmnt-22-17872, **Editor assigned:** 6- Aug -2022, PreQC No: jnmnt-22-17872 (PQ), **Reviewed:** 20- Aug -2022, QC No: jnmnt-22-17872, **Revised:** 23- Aug -2022, Manuscript No: jnmnt-22-17872 (R), **Published:** 30- Aug -2022, DOI: 10.35248/2157-7439.22.13.634.

Citation: Sara A (2022) Mini Review on Natural Polysaccharides Used in Vaccine by Nanoengineering. J Nanomed Nanotech. 13: 634.

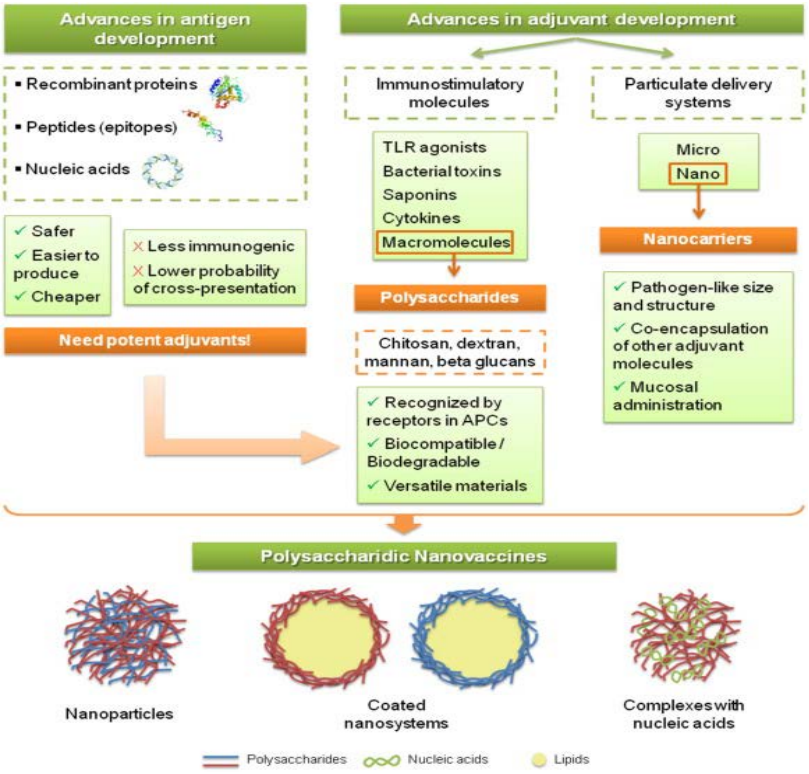

Figure1: Natural Polysaccharides Used in Vaccine by Nanoengineering.

investigated. The idea of "reverse volcanology," which concentrated on scanning the pathogen's entire genome for potential antigenic protein candidates, was a significant step forward in the creation of novel vaccines [4]. This approach resulted in the creation, for instance, of a novel meningococcal vaccination that is now being sold in Europe under the trade. This approach has also been used to investigate vaccines against diseases including Streptococcus pneumoniae and Leishmania infantum, among others. The aforementioned antigenic proteins nevertheless suffer from significant drawbacks such challenging purifying procedures, challenging production processes, and instability in liquid form [5]. More crucially, as described, for instance, in the development of a vaccine against group A Streptococcal (GAS), protein-based vaccinations have been shown to cause autoimmunity and allergic responses. These factors are what are driving current efforts to produce tiny peptides as antigens. These antigenic peptides are typically produced via easy synthesis with high purity, on a wide scale, and at a cheaper cost. They can be discovered by analysing particular antibody-inducing areas within bigger proteins (epitopes). As is the case for several preventive HIV vaccines as well as some other vaccines, a number of peptide-based vaccine formulations have already entered the clinical development phase [6].

RESULT

Overall, it can be said that proteins and peptides have a safer safety profile than live attenuated viruses, but their low immunogenicity is undoubtedly impeding their growth and success. For this reason, it is crucial to advance in the development of novel adjuvants that may aid in generating a strong immune response for these vaccines [7]. Nucleic acid-based vaccinations have attracted more interest over the past few decades. In essence, nucleic acids like plasmid DNA (pDNA) and messenger RNA (mRNA) allow the host's cellular machinery to produce the antigen in situ. This tactic, which causes the local production of the antigenic molecule, mimics the normal infection by intracellular pathogens [8].

Additionally, nucleic acids can be modified to express antigens that differ from their original forms chemically or physically in order to increase their immunogenicity. The fundamental drawback of this strategy is the low amount of gene expression that results from administration; however, this problem can be overcome by creating efficient viral and non-viral transfection vectors. Immunizations with plasmid DNA, based on the It has been used to treat cancer immunotherapy and to prevent infections like HIV and malaria by administering specific antigen-encoding DNA through a plasmid vector. According to a recent review, some of these formulations have already entered the clinical trial phase. However, more information is needed to fully understand the risk of genome integration and the long-term implications of these vaccines [9]. As a substitute, messenger RNA has drawn a lot of interest, with preclinical proofs of concept for preventative influenza vaccination and several formulations being developed for anticancer immunotherapy. The conventional adjuvant of choice for vaccinations has been alum; however its exact mode of action is still unclear. Additionally, it has particular drawbacks such the need to be stored at low temperatures, limited effectiveness for peptide antigens, and inability to elicit Th1 (cellular) immune reactions [10]. The necessity to get beyond these restrictions has sparked an interest in finding novel adjuvants. As a result, there are many different adjuvants available today. For the sake of this review, we have divided them into two groups: molecular adjuvants, also known as immunostimulatory molecules, and antigen delivery systems made by nanoengineering antigens [11].

DISCUSSION

In vaccine formulations, other compounds such as bacterial toxins, saponins, and cytokines are also utilised as immunostimulants. By directing the antigen to the M cells in the digestive tract and so generating a potent humoral response at the mucosal level, bacterial toxins in particular are known to augment the immune response. Cholera toxin (recombinant B subunit), which is used

as an adjuvant for a widely available oral cholera vaccine, is an illustration of one of these toxins [12]. Another example is a transdermal patch that contains heat-labile E. coli enterotoxin and is used to boost the immune system's defences against infections like the flu and E. coli. However, rather than the associated diseases, a key limitation of these poisons is related to the immunological reaction that can be created against themselves. In some instances, macromolecules like polymers, including polysaccharides, lipids like MPLA and squalene, as well as a number of phospholipids have been utilised to nanoengineer antigens, creating nanocarriers or antigen delivery systems.

CONCLUSION

These macromolecules occasionally naturally contain particular moieties, such as pathogen-associated molecular patterns (PAMPs) that can be detected by PRRs, or they can have these moieties added to their structures artificially to enhance their functionality. As for MPLA and squalene, their recognised immunomodulation properties have led to their inclusion in vaccines that are currently on the market or as parts of adjuvants that are currently approved, such as MF59, AS03TM for squalene and AS04TM for MPLA, as well as in other formulations that are still in development. Antigens can be linked to delivery vehicles consisting of particular biomaterials, which are often known for their adjuvant qualities, using nanoengineering techniques. These delivery vehicles have the capacity to transport antigens and regulate their release into cells, where they are supposed to exhibit biological activity. This group includes, among others, polymeric nanoparticles, ISCOMs, liposomes, and lipid nanoparticles. In general, it is acknowledged that one appealing aspect of this type of adjuvants is the depot effect produced by the majority of antigen delivery systems following subcutaneous injection, allowing their uptake by the antigen. Additionally, they can resemble the particle nature of infections, enhancing the likelihood of a successful immune response. As will be covered in the following section, nanotechnology is anticipated to have a substantial effect in this context. Since the second half of the 20th century, research into the therapeutic and diagnostic applications of nanoscale technologies and biomaterials has expanded. Over the past few decades, a wide range of nanoparticulate systems have been created to enhance the transport, targeting, and effectiveness of medicines, biomolecules, nucleic acids, and antigens. It is possible to create a variety of nanostructures depending on the materials and methodology used, such as I polymeric nanoparticles based on the matrix-type entanglement of specific polymers, (ii) oil-in-water (O/W) nanoemulsions made up of oil nanodrops stabilised by appropriate surfactants, (iii) nanocapsules, which are polymer-coated nanoemulsions forming a core-shell nanostructure.

Acknowledgement

None

Conflict of Interest

None

REFERENCES

1. Sun B, Yu S, Zhao D, Guo S, Wang X, Zhao K. Polysaccharides as vaccine adjuvants. Vaccine. 2018; 36(35): 5226-5234.
2. Zhang X, Zhang Z, Xia N, Zhao Q. Carbohydrate-containing nanoparticles as vaccine adjuvants. Expert Rev Vaccines. 2021; 20(7):797-810.
3. Zhang S, Huang S, Lu L, Song X, Li P, Wang F. Curdlan sulfate-O-linked quaternized chitosan nanoparticles: potential adjuvants to improve the immunogenicity of exogenous antigens via intranasal vaccination. Int J Nanomedicine. 2018; 13:2377-2394.
4. Sinani G, Sessevmez M, Gok MK, Ozgumus S, Alpar HO, Cevher E. Modified chitosan-based nanoadjuvants enhance immunogenicity of protein antigens after mucosal vaccination. Int J Pharm. 2019; 569:118-592.
5. Zhao Z, Leong KW. Controlled delivery of antigens and adjuvants in vaccine development. J Pharm Sci. 1996; 85(12):1261-1270.
6. Qiu A, Wang Y, Zhang G, Wang H. Natural Polysaccharide-Based Nanodrug Delivery Systems for Treatment of Diabetes. Polymers (Basel). 2022; 14(15):3217.
7. Huang J, Ding Y, Yao J, Zhang M, Zhang Y, Xie Z, et al. Nasal Nanovaccines for SARS-CoV-2 to Address COVID-19. Vaccines (Basel). 2022 Mar 8; 10(3):405.
8. Li X, Gessert T, Coutts T. The Properties of Cadmium Tin Oxide Thin-Film Compounds Prepared by Linear Combinatorial Synthesis. Appl Surf Sci. 2004; **223**: 138-143.
9. Mwathe M, Musembi M, Munji F, Nyongesa B, Odari W, Njoroge B, et al. Effect of Annealing and Surface Passivation on Doped SnO_2Thin Films Prepared by Spray Pyrolisis Technique. Adv Mater. 2015; **4** (3) 51-58
10. Gurumurugan K, Mangalaraj D, Narayandass SK, Balsubramanian C. Structural, Optical, Electrical Properties of Cadmium Oxide Films Deposited by Spray Pyrolysis. Phys Stat Sol. 1994; 143: 85-91.
11. Zafar F, Jahan N, Bhatti H. Increased Oral Bioavailability of Piperine from an Optimized Piper nigrum Nanosuspension. Planta Med 2019; 85(3):249-257.
12. Gera S, Talluri S, Rangaraj N, Sampathi S. Formulation and Evaluation of Naringenin Nanosuspensions for Bioavailability Enhancement. AAPS PharmSciTech.2017;18(8):3151-3162.