0°C for 45 min, and then left at room temperature for 20 h. Aqueous NaCl is added to the solution in order to exchange TBA^+ by Na^+ ions. Finally, the polymers are purified by precipitation in 7:1 EtOH–water, washed three times, and dried under diminished pressure [31].

Most of the research on alginates consisted in the chemical modification of the free groups (-OH and -COOH) in their structure, in order to modify their properties for specific applications. Some chemically modified alginates, such as propylene glycol alginate, have been used for some time in industries beyond others that have not hit the market. Although there are many works of synthesis of modified alginate compounds, other forms of study can be explored, as well as the scope of new initiatives for the scientific, technological, and innovational future.

5.4 Biomedical Application of Alginates

Sodium alginate is a particularly attractive material to form hydrogels for biomedical applications [32, 33]. They can be classified into different categories depending on various parameters including the preparation method, the charge, and the mechanical and structural characteristics. Hydrogels are extremely suitable for a variety of applications in the pharmaceutical and medical industry. According to this definition, hydrogels are water-swollen, cross-linked polymeric structures containing covalent bonds produced by the reaction of one or more comonomers [34], physical cross-links due to chain entanglements [2], association bonds including hydrogen bonds or strong van der Waals interactions between chains [35], or crystallites bringing together two or more macromolecular chains [36]. Furthermore, drugs can be incorporated into the matrices and can be released subsequently according to various release profiles depending on the hydrogel properties.

The recent technological advancements with using alginates, issues related to alginates' suitability as a matrix for three-dimensional tissue cultures, adjuvants of antibiotics, and antiviral agents in cell transplantation in diabetes or neurodegenerative diseases treatment, and an update on the antimicrobial and antiviral therapy of the alginate-based drugs are also highlighted. Alginates have been extensively evaluated as vaccine adjuvants or coadjuvants as these polymers were displayed to enhance bioavailability and immunogenicity of antigens after nasal and oral administration.

Alginates can be easily modified through chemical or physical cross-linking in order to form alginate hydrogels and improve physicochemical properties and/or biological activity. Many methods have been described for alginates