

In fact, they generally have an increased affinity of binding with ALGs as compared to divalent cations. They form a more compact gel network by binding in a 3-D structure due to their ability to bind with three carboxyl groups from different ALG biopolymers at the same time [18].

The ionic gels are widely used in various industries; like in the food industry, these are used in encapsulation of bioactives, in pharmaceuticals for making drugs, and in the biotechnology industry for cell immobilization.

1.4.1.2 *Alginic Acid Gels*

Alginic acid gels are formed when pH less than the dissociation constant (pKa) of the polymer is used for making the solution [12]. Alginate is negatively charged across a wide range of pH because M and G residues have pKa of 3.38 and 3.65, respectively [19, 20]. Alginate solution is affected in two ways by the rate of decrease in pH. A rapid decrease in pH leads to precipitation of alginic molecules into aggregates, while a low rate of decrease in pH leads to the formation of continuous alginic acid bulk gel [21]. The strength of the gel is correlated to the G block content in the polymer chain like in case of ionic gels [1], while they differ from ionic gels in that the hydrogen bonding in acid gels of ALG is known to stabilize them and M block residues have an important role in gelation. Although alginic acid gels have not got as much importance as compared to ionic gels due to their limited application [21], they are commonly used as antacid to relieve gastric reflux heartburn [22].

1.4.2 **Molecular Weight**

Alginate is a linear polymer whose viscosity is determined by molecular weight, rigidity, and extension of the chain of the polymer. Alginates may be prepared with a wide range of average molecular weights (50–100,000 residues), which depends on the application. Generally, the molecular weight of commercially available sodium ALGs ranges between 32,000 and 400,000 g/mol.

1.4.3 **Solubility and Viscosity**

Alginic acid is insoluble in water and organic solvents, whereas its monovalent salts and esters are water-soluble and form a stable, viscous solution [1–4]. Physical properties of ALG gels can be modified and further improved by increasing the molecular weight of ALG. However, it becomes highly viscous on increasing the molecular weight, which is often not desirable in further processing [23]. For example, there is a risk