

enzymatic process; the gum both encapsulates the bacterial cell and is secreted into the surrounding medium. The composition and structure of the xanthan gum produced by commercial fermentation is identical to the polysaccharide formed by *xanthomonas campestris* on plants belonging to the cabbage family, where it occurs naturally.

Each xanthan gum repeat unit contains five sugar residues: two glucose, two mannose, and one glucuronic acid. The polymer backbone consists of 1,4 linked  $\beta$ -D-glucose and is therefore identical in structure to cellulose. Trisaccharide side chains on alternating anhydroglucose units distinguish xanthan gum from cellulose. Each side chain comprises a glucuronic acid residue between two mannose units.

Numerous studies have indicated a molecular weight for xanthan gum of approximately two million, which corresponds to approximately two thousand repeat units per polymer molecule.

Xanthan gum solutions are highly pseudoplastic. When shear stress is increased, viscosity is progressively reduced. Upon the reduction of shear, total viscosity is recovered almost instantaneously. This behavior results from the high-molecular-weight, rod-like molecule, which forms complex molecular aggregates through hydrogen bonds and polymer entanglement.

At low concentrations xanthan gum displays the unusually high viscosities important to its suspension-stabilizing properties.

Solutions of xanthan gum at 1% or higher concentration appear almost gel-like at rest, yet these same solutions pour readily and have a very low resistance to mixing and pumping. These same qualities are observed at typical use levels of about 0.1% to 0.3%.

At or below about 0.25% gum concentration, monovalent salts such as sodium chloride cause a slight decrease in viscosity. At higher gum concentrations, viscosity increases with added salt. At a monovalent salt level of 0.1%, the viscosity plateau is reached, and further addition of salt has no effect on viscosity. Many divalent metal salts, including those of calcium and magnesium, have a similar impact on viscosity.

A synergistic interaction occurs between xanthan gum and galactomannans such as guar gum, locust bean gum, and cassia gum. This interaction results in enhanced viscosity or gelation.

Among these materials, it is preferable to use water soluble polymers which have not been covalently cross-linked to form insoluble materials. It has been found advantageous to use those polymers which either can be used underivatized as visco-elastic materials or which can form substances which will begin to degrade in a period of about 2-5 days up to about 1 year. In order to vary the degradation time, the viscosity of the gel can

be varied by varying the concentration of the xanthan gum. The more viscous the gel, the longer the degradation time.

It is possible to prevent adhesions by injecting a visco-elastic material such as a gel of xanthan gum, which is more viscous and elastic than blood, so that it prevents blood from clotting at the interface of two vital tissues, thus preventing an adhesion from forming.

The invention will now be described in further detail with reference being made to the following examples. It should, however, be recognized that the examples are given as being illustrative of the present invention and are not intended to define the spirit and scope thereof.

#### EXAMPLE 1

Xanthan gum gels were formed by mixing between 1.0 and 3.0 grams of Kelco xanthan gum with 100 grams of Tyrode's solution using a high speed mixer. The resultant solutions were a thick viscoelastic fluid which could be heat sterilized and placed in a syringe for easy application during surgery.

#### EXAMPLE 2

Xanthan gum gels were formed by mixing between 1.0 and 3.0 grams of Kelco xanthan gum with 100 grams of 0.9% saline solution (pH 7) using a high speed mixer. When 1.0 to 3.0 grams of Kelco xanthan gum was mixed with 100 grams of 0.9% saline solution (pH 7) using a high speed mixer, as above, a viscoelastic material resulted. Again, this material could easily be injected between tissues to prevent adhesions.

While several examples of the present invention have been described, it is obvious that many changes and modifications may be made thereunto, without departing from the spirit and scope of the invention.

We claim:

1. A method of preventing adhesions between vital tissues comprising the step of placing a viscoelastic gel comprising 1-3 weight percent biodegradable xanthan gum in an aqueous solution, between the tissues.

2. The method as set forth in claim 1 further comprising the step of mixing an anti-thrombogenic agent with the biodegradable xanthan gum solution prior to placing the material between the tissues.

3. The method as set forth in claim 1 wherein the viscoelastic gel comprises between 1 and 3 grams of xanthan gum dissolved in a 0.9% saline solution at a pH of 7.

4. The method as set forth in claim 1 wherein the viscoelastic gel comprises between 1 and 3 grams of xanthan gum mixed with 100 grams of Tyrode's solution.

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