



CHAPTER II

LITERATURE REVIEW

2.1 Gelatin

Gelatin is a multifunctional ingredient used in many food products, including jellies, ice cream, cookies and cake. Moreover, gelatin is the primary ingredient in marsh mallows and also used as a processing aid in food industry for the clarification of cider and fruit juices. The major use of gelatin in the pharmaceutical and the cosmetic industries is in the manufacture of capsules such as soft and two piece hard capsules (Cole, 2000; Zhang *et al.*, 2006).

There are two main types of gelatin. Type A, with isoionic point of 7 to 9, is derived from collagen with exclusively acid pretreatment. Type B, with isoionic point of 4.8 to 5.2, is the result of an alkaline pretreatment of the collagen. However, gelatin is sold with a wide range of special properties, such as gel strength, to suit particular applications. Gelatin forms thermally reversible gels with water, and the gel melting temperature (<35°C) is below body temperature, which gives gelatin products unique organoleptic properties and flavour release. The disadvantage of gelatin is that it is derived from animal hide and bone (not from trotters as is a common perception), hence there are problems with regard to kosher and Halal status and vegetarians also have objections to its use. Competitive gelling agents like starch, alginate, pectin, agar, carrageenan and etc. are all carbohydrates derived from vegetable sources, but their gels lack the melt in the mouth, elastic properties of gelatin gels.

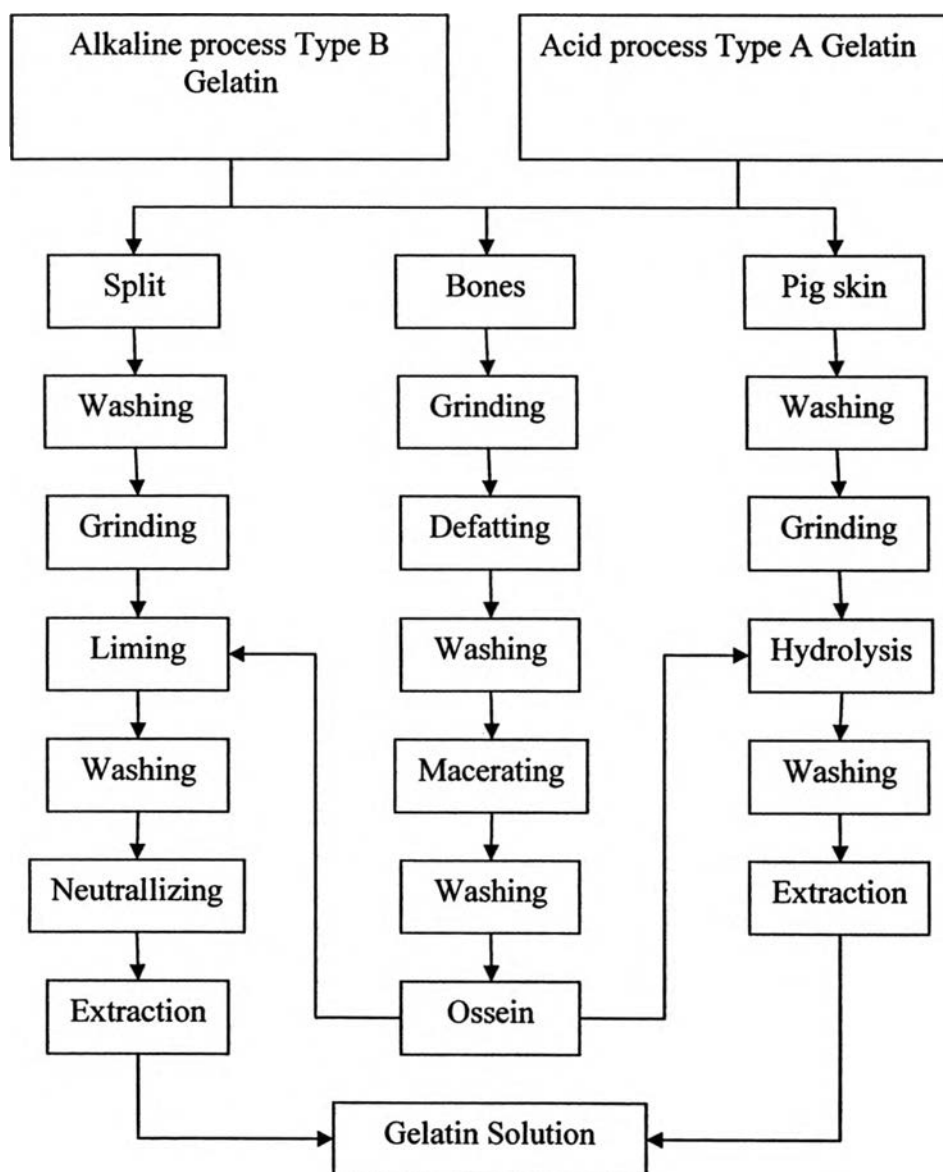


Figure 2.1 Process of Preparation Gelatin Solution.

The cross-linking of gelatin with aldehydes is being used to extend the applications of gelatin. In particular, the treatment of gelatin films with glutaraldehyde has been studied in order to improve their thermal resistance, to decrease their solubility in water, and to improve their mechanical properties. (Zhang *et al.*, 2006; Bigi *et al.*, 2001).

2.2 Solubility in water

Gelatin is only partially soluble in cold water, however dry gelatin swells or hydrates when stirred in water. Such mixtures should generally not exceed 34 % gelatin. On warming to about 40°C, gelatin which has been allowed to hydrate for about 30 minutes, dissolves to give a uniform solution (Bigi *et al.*, 2004). Alternatively, dry gelatin can be dissolved by stirring into hot water, but stirring must be continued until solution is complete. This method is normally only used for dilute solutions of gelatin.

If gelatin solutions are spray dried or drum dried from the sol state, the resulting gelatin is "cold water soluble" and such gelatins gel quickly when stirred into cold water. These gels are generally not clear, so the use of this form of gelatin is limited to milk puddings and other products where solution clarity is not required (Cole *et al.*, 2000).

2.3 Film forming properties

Gelatin's film forming properties are used in the manufacture of both hard and soft (pharmaceutical) capsules. Gelatin films shrink with great force on drying, hence such uses usually involve the addition of polyhydric alcohols to modify the adhesion and flexibility of the dry film. Also, for film forming, a gelatin with a high viscosity is preferred to one with a low viscosity, hence for hard capsules and in photography, ossein gelatin is preferred and commands a premium price (Cole *et al.*, 2000).

2.4 Gelling properties

The most common use of gelatin is for its thermally reversible gelling properties with water, or example, the production of table jellies. Gelatin is also used in aspic to add flavor to meat products while on gelling it also provides a pleasing shiny appearance to the product. In some cases, gelling is known as its "water absorbing property". For example, in canned hams, gelatin can be added to the can

before cooking. Upon cooking, the exudate from the meat is absorbed by the gelatin and appears as a gel when the can is opened.

In confectionery, gelatin is used as the gelling binder in gummy products, wine gums etc. In the manufacture of these products, gelatin is combined with sugar and glucose syrups. Incompatibility between gelatin and glucose syrup can occur (Marrs, 1982) and is a function of the concentration of glucose polymers containing more than 2 glucose units, contained in the syrup. Competition between gelatin and glucose polymers for water in low water content products can result in, at worst, precipitation of the gelatin and at best a marked loss in gelling properties or hardness of the product.

In general one can say that the lower the mean molecular weight (MW) of a gelatin the lower the gel strength and viscosity of its solution, however it has been shown that the collagen alpha-chain (MW 100 kD and gel strength = 364 g Bloom) is the main contributor of gel strength and that higher molecular weight components (beta-chain with MW 200 kD, gamma-chain with MW 300 kD and "microgel" with MW > 300 kD) make a relatively low contribution to gel strength but a high contribution to viscosity (Yakimets *et al.*, 2005).

2.5 Stability

Dry gelatin has an almost infinite shelf life as long as the moisture content is such as to ensure that the product is stored below the glass transition temperature.

The stability of gelatin in solution depends on temperature and PH. Generally, to minimize the losses of gel strength and viscosity with time, the PH of the solution should be in the range 5 to 7 and the temperature should be kept as low as possible, consistent with the avoidance of gelation and the suitability of the solution viscosity to the particular application. Often the cause of degradation or hydrolysis of gelatin in solution is microbial proliferation, so gelatin solutions should not be stored for longer than is absolutely necessary, and after addition of the acid to confectionery formulations, the solution should be used and cooled/gelled with minimal delays (Cole *et al.*, 2000).

2.6 Gelatin testing method

The best published sources of gelatin testing methods are British Standard 757 of 1975 (Methods for sampling and testing gelatine, 1975) or Standard Methods for sampling and testing gelatin, published by the GMIA (Gelatin Manufacturers of America, 1986) or the Pharmacopoeias. Many of the methods used in laboratories need to be modified to suit the peculiarities of gelatin.

2.7 Gel strength

The most important attribute of gelatin is its gel strength and when determined by the standard method (Methods for sampling and testing gelatin, 1975) is called the Bloom Strength. This is the force in grams required to press a 12.5 mm diameter plunger 4 mm into 112 g of a standard 6²/₃% w/v gelatin gel at 10°C. Several penetrometer type instruments have been adapted to determine Bloom Strength.

In 2001, Bigi *et al.* studied about mechanical and thermal properties of gelatin films at different degree of glutaraldehyde crosslinking. They found increase stabilization of gelatin at low GTA concentration. 1wt% GTA is sufficient to obtain a degree of crosslinking next to 100% and as a consequence increasing of the young's modulus, thermal stability, and swelling behavior.

In 2005, Yakimets *et al.* investigated mechanical properties with respect to water content of gelatin films in glassy state. The hydration of gelatin films proceeds through three main stages before reaching the glassy-rubbery transition at room temperature: (I) water bound by high energy sorption, (II) structural water, (III) polymolecular layer water. The mechanical properties of gelatin films in glassy state through these three stages of hydration. For the second stage of hydration, the films improved fracture behavior, This improvement of fracture behavior was related to the high renaturation level of gelatin films (triple helix structure).

In 2005, Fukae *et al.* investigated about gel spinning and drawing of gelatin. Gelatin fibers can be prepared by the gel spinning method using dimethyl sulfoxide as a solvent. Drawing of gelatin was effective for the segmental orientation of gelatin

fibers. The fibers showed high values for the mechanical properties; the tensile Young's modulus.

In 2006, Li *et al* studied the electrospinning of polyaniline-contained gelatin nanofibers for tissue engineering applications. Polyaniline, a conductive polymer was blended with a gelatin and co-electrospun to nanofibers for tissue engineering. Fibers were electrospun from pure gelatin and the other four sets of PANi-gelatin blend fibers with volume ratios of respectively, 15:85, 30:70, 45:55, and 60:40. The increasing amount of PANi reduced the average fiber size and tensile modulus increased.

In 2006, Zhang *et al.* studied the crosslinking of electrospun gelatin nanofibers. The crosslinking enhanced the thermal stability and mechanical properties, where the tensile strength and modulus were improved to nearly 10 times higher than those of electrospun membrane.

In 2006, Martucci *et al.* studied the creep of glutaraldehyde-crosslinked gelatin films. Creep behavior of glutaraldehyde gelatin films was evaluated by short time flexural tests at 30C°. Creep response decreased with increasing degree of crosslink, which indicated that crosslinking improved the film stiffness.