



# GELATIN INFORMATION

**G**elatin is a highly purified protein derived from collagen which is the major structural component in skin, bone, tendon and other fibrous tissues. The refined extract of collagen forms clear, viscous solutions in water. Gelatin minus the moisture and a small amount of ash is “100% pure soluble protein.”

The most important property of gelatin is its function as a hydrocolloid. Gelatin is a superior protective colloid because of its unique physical and chemical structure. Its solutions form heat-reversible gels. It is amphoteric. It forms a fluid colloidal solution in water. It remains soluble throughout the entire pH range.

The gelatin manufacturing process makes the collagen soluble in hot water where, as a thermally reversible gel, it becomes useful in countless applications. For applications needing cold-water solubility or where its gelling ability is not desired, the gelatin is enzymatically treated to produce Gelatin Hydrolysate.

Gelatin, one of the most versatile hydrocolloids, enjoys wide-spread use in industry. It is used in the food industry for making desserts, marshmallows, jellies, aspics, canned meats, jellied meats, bakery products and dairy products. It is also used by the pharmaceutical industry in the manufacture of capsules, tablets, and bandages. Gelatin is also an important raw material in the photographic industry.

Gelatin Hydrolysates have numerous applications in many different industries. Some applications in the pharmaceutical field are microencapsulation, tableting, and as a film forming agent. In the food industry it is found in instant drinks and flavorings, in the microencapsulation of flavors and food colors and as a substitute for carbohydrates in sweets and other fat-containing foods. For nutraceuticals it is used in protein drinks, protein bars, and supplements for anti-inflammation and joint health. For cosmetics it is used in shampoos and conditioners (hydrolyzed animal protein), as well as in lipsticks and fingernail formulas. For technical uses it is sought out for its film-forming characteristics and as a protein source for biotechnology media.

The object of this bulletin is to give a general description of gelatin together with information on those of its properties which are of direct concern to the gelatin user. With this in mind we have prepared this brochure covering raw material, manufacture, physical and chemical properties, and preparation of gelatin for use. We have also included a section describing many of the uses of gelatin.

## RAW MATERIALS

Gelatin is extracted from animal tissues which contain high proportions of collagen (the white connective tissue). The tissues used commercially are skins, sinews and bones. While it is possible to extract gelatin from these tissues with boiling water, the rate of extraction and quality of gelatin are greatly improved by pretreating the collagenous raw material.

## MANUFACTURE

There are a large number of unit processes used in the manufacture of gelatin, the raw materials used include demineralized bone (called ossein), pig skins, cow hides and fish skins. These are the current commercially available raw material sources. Perhaps in the future it will be feasible to use other sources to obtain the unprocessed collagen.

The production process is illustrated in Figure 1 on the following page. The incoming raw material is first washed with water and pretreated with acid or alkali. The pretreatment, or cure, may be a short-time soak in a dilute acid solution or a prolonged soak in a saturated lime solution. Pig skins respond well to acid cure, while trimmings (calf skins, beef skins, and fish skins), and demineralized bones (ossein) respond better to lime conditioning. The pretreatment is used as a basis for classifying gelatin. Gelatin derived from acid-cured tissue is known as Type A Gelatin. Gelatin derived from alkali-cured tissue is known as Type B Gelatin.

Upon completion of pretreatment, the raw material is once more washed with water and the pH adjusted to the desired value, followed by washing again.

The gelatin is then extracted from the raw material with either a continuous process or with a series of applications of warm water at progressively higher temperatures. Each successive extraction (cook) yields gelatin of lower gel strength and viscosity. The gelatin solutions (liquors) are filtered, deionized (optional), pre-concentrated under heat and reduced pressure (vacuum) or by ultrafiltration, polish-filtered, concentrated, and sterilized. The concentrated liquor is cooled to a gel and dried to the desired moisture content.

After having been physically, chemically, and microbiologically, analyzed, the gelatin is ready for grinding, screening, and blending to customer requirements. The finished gelatin is sampled for quality control analysis and packaged.

The gelatin is packaged in plastic-lined paper bags, heavy gauge polyethylene bags or fiber drums with an inner plastic bag to prevent moisture pick-up. Gelatin should be stored at ambient temperatures. Opened packages must be carefully reclosed. If properly stored, gelatin has an indefinite shelf life.

## PHYSICAL AND CHEMICAL PROPERTIES

The gelatin molecule is made up of amino acids joined together by amide linkages in a long molecular chain. There are 18 different amino acids in gelatin, each occurring in its own level and sequence in the molecule. Of the nine essential amino acids, gelatin is lacking in tryptophane and, therefore, is not considered a complete protein. The amino acid analysis of gelatin is variable, particularly for the minor constituents, depending on raw material and process used, but approximate values by weight are: glycine 21%, proline 12%, hydroxyproline 12%, glutamic acid 10%, alanine 9%, arginine 8%, aspartic acid 6%, lysine 4%, serine 4%, leucine 3%, valine 2%, phenylalanine 2%, threonine 2%, isoleucine 1%, hydroxylysine 1%, methionine and histidine <1% with tyrosine < 0.5%.

Estimates of the molecular weight of gelatin range from 15,000 to 250,000 depending on the method used. The size of gelatin molecules is hard to determine since they are randomly coiled.

# HOW GELATIN IS MADE

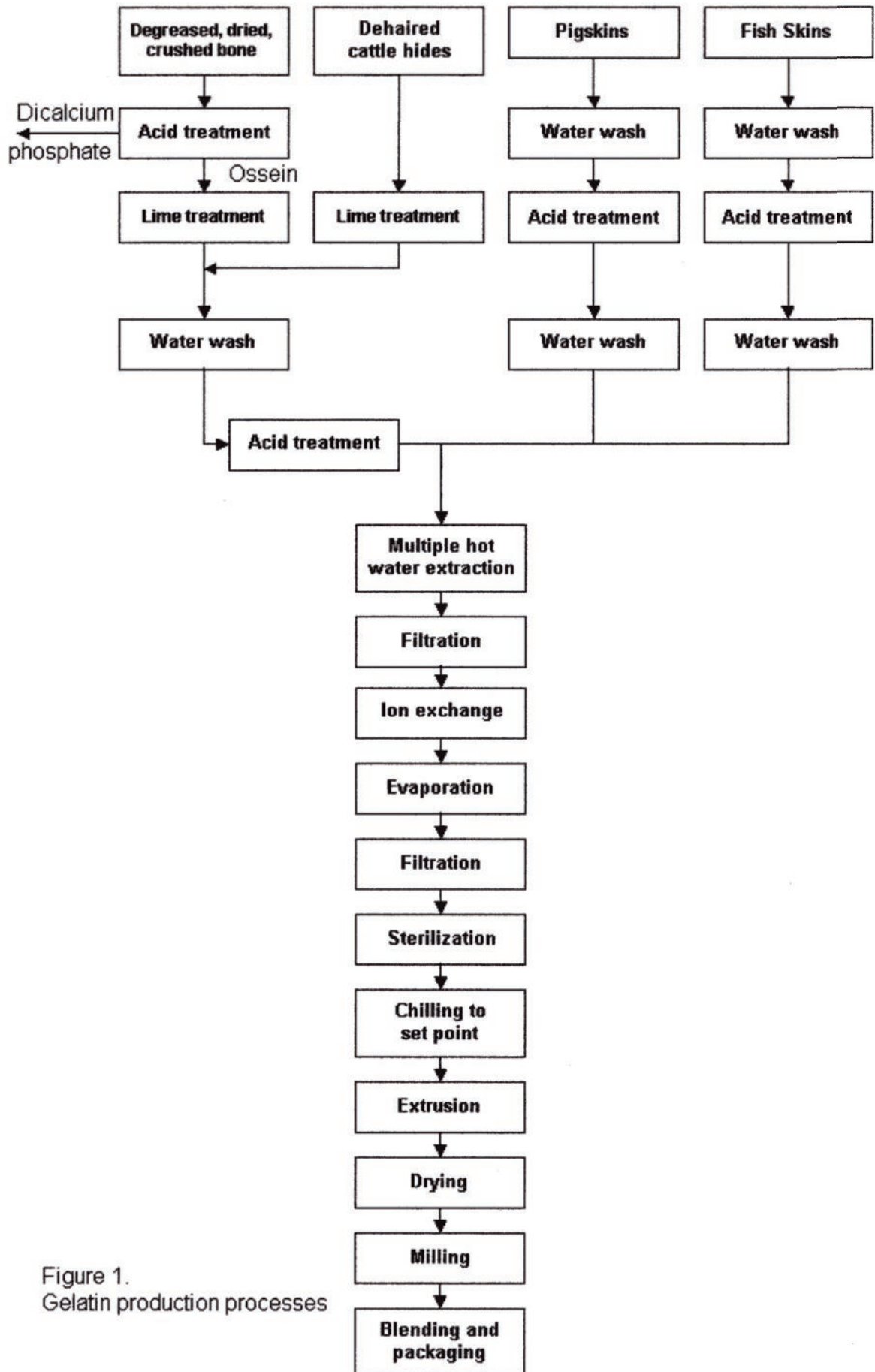
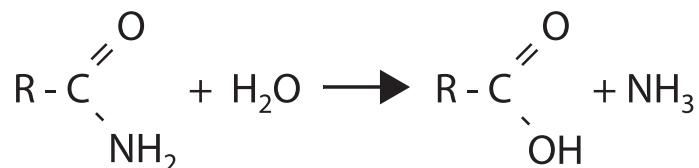


Figure 1.  
Gelatin production processes

Certain properties of gelatin such as solubility, melting point, setting time, and viscosity are associated with the molecular weight of a given type of gelatin.

The charge on the gelatin molecule and its iso-electric point (IEP) are due largely to the carboxyl, amino, and guanidine groups in the side chains.

In collagen, many of the carboxyl groups on the side chains are present as amides:



During alkali cure, this group is hydrolyzed to form free carboxyl groups and ammonia. Very little of this hydrolysis occurs in acid cure.

The increased number of free carboxyl groups in alkali-cured gelatin gives Type B Gelatin a greater negative charge and lower IEP as shown below in Table 1 and in Chart A on the next page.

**TABLE 1**

Gelatin	Free Carboxyl Group	IEP
Type A	78 to 80 mmol per 100 grams	7 to 9.5
Type B	100 to 115 mmol per 100 grams	4.7 to 5.3

Gelatin contains about 88% protein, 10% moisture and 2% ash. The greatest amount of ash comes from the acid or lime used in curing and the resulting salt when the pH is adjusted. The moisture content may vary from 5-14%. Gelatin is hygroscopic and tends to hold water depending on the relative humidity at which it is dried and stored.

Gelatin is amphoteric having both acidic (carboxyl) groups and basic (amino and guanidine) groups. The isoionic point is between 4.7 and 9.5 depending on the raw material used and the method of manufacture. The charge of the gelatin molecule will depend on the pH of the solution and the presence of other ions. The pH at which ionization of both groups is equal is called the isoionic point (pI). If salts or other electrolytes are present, there may be a shift in this point and the pH of the resulting neutral-charged solution is called the isoelectric (IEP). The isoelectric point is the pH at which gelatin molecules do not migrate in an electrical field. At a pH value below the isoelectric point, the gelatin molecule has a positive charge. Above the isoelectric point the gelatin molecule has a negative charge.

## PHYSICAL PROPERTIES OF GELATIN SOLUTIONS

The most important characteristic of gelatin is its ability to form a thermally-reversible semisolid gel in water solution. Gel strength is determined by a standardized G.M.I.A. (Gelatin Manufacturers Institute of America) test in which a 6 2/3% solution of gelatin and water is prepared and placed in a 10°C water bath for 16 to 18 hours. The strength of the gel formed is then determined by the amount of force or weight required in grams to depress a 1/2 inch plunger 4 millimeters into the surface of the gel. If it takes 250 grams of weight (force) to depress the plunger the required 4 millimeters the gelatin would be rated as a 250 bloom

gelatin. Why bloom? So that people will always remember the name of the man who developed this test.

The viscosity of a gelatin is a measure of the molecular weight. Viscosity is determined by measuring the time for 100 ml of a 6<sup>2</sup>/<sub>3</sub>% solution at 60°C to flow through a special viscosity pipette. Viscosity is also an indication of the water-binding ability of a gelatin.

Setting point and melting point are sometimes useful in determining the suitability of a gelatin for certain applications. The setting point of a gelatin solution is the temperature at which it gels. The melting point is the temperature at which a gel becomes liquid.

These qualities are affected by bloom strength and concentration. To raise the setting point and melting point, increase the bloom strength of the gelatin and/or the concentration.

Gelatin solutions tend to lose strength when held under relatively high temperatures. The degradation rate increases rapidly as the temperature goes up-particularly over 60°C. (See Chart B)

The pH of a gelatin solution is also a factor in the degradation of gelatin.

Degradation is at a minimum between pH 5 and pH 9. On either side of these values, the degradation rate increases rapidly in an exponential fashion. (See Chart C on next page)

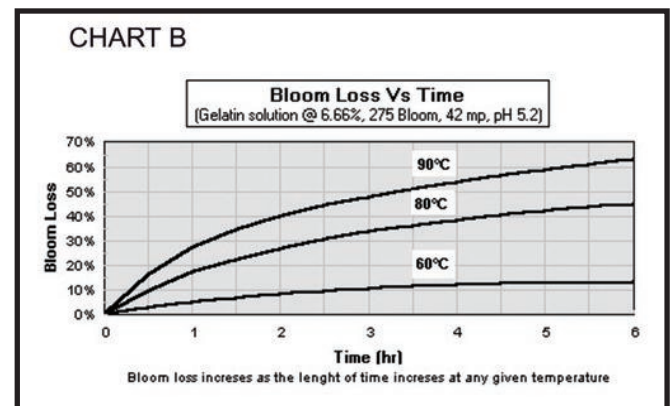
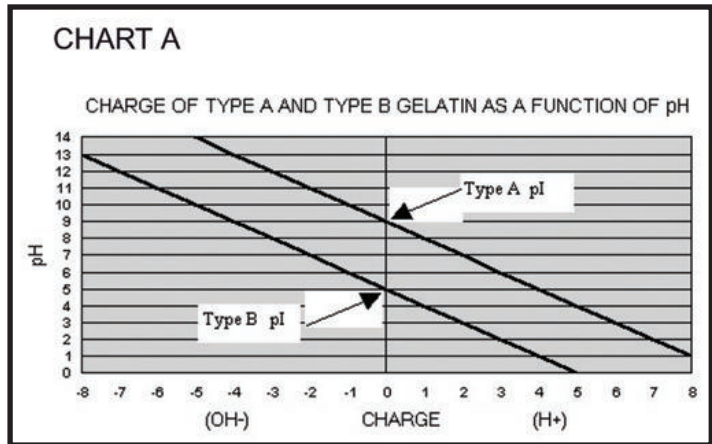


The effect of the pH of the gelatin solution has been studied. In an isoionic solution (a solution containing only hydrogen or hydroxyl ions), gel strength is at a maximum and viscosity at a minimum. However, salts such as sodium chloride reduce this effect greatly. The ability of gelatin to imbibe water at all pH levels and to form gels that do not synerize is unique. This permits use in many applications where other gelling and stabilizing agents fail.

Gelatin forms continuous films at most moisture levels and is a good agent to use where clear films ranging from rigid to very flexible are desired. Humectants, such as glycerin, can be added to gelatin solutions to maintain moisture content and permit flexibility. Gelatin films have been found to be impermeable to many gases including oxygen.

Gelatin has the ability to form strong ionic bonds with other compounds. Should the other compound be oppositely charged, a coacervate is formed which leads to insolubility and poor water-holding properties. Gelatin will form coacervates with most negatively-charged hydrocolloids, such as gum Arabic, carrageenans, alginates, pectins, and agar.

Gelatin tends to form insoluble gels with tanning agents such as formaldehyde. The resulting gels or films tend to



hold water and the melting point is increased. Polyvalent metals such as chromium and aluminum salts may also be used to form insoluble gels with gelatin.

Gelatin is an excellent growth medium for most bacteria, hence considerable care needs to be taken during manufacture to avoid contamination. This care is evidenced by the use of documented cGMP and HACCP programs by the manufacturers.

## PREPARATION OF GELATIN SOLUTIONS

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 this rule does not always apply. It will also depend on the size, distribution and frequency of the molecules' chains.

Gelatin is only partially soluble in cold water, however dry gelatin swells or hydrates when stirred into water. Such mixtures should generally not exceed 34% gelatin. Upon warming to approximately 37°C, gelatin that has been allowed to hydrate for about 30 minutes dissolves to give a uniform solution. Alternatively, dry gelatin can be dissolved by stirring into hot water, but stirring must be continued until dissolution is complete. This method is normally only used for dilute solutions of gelatin.

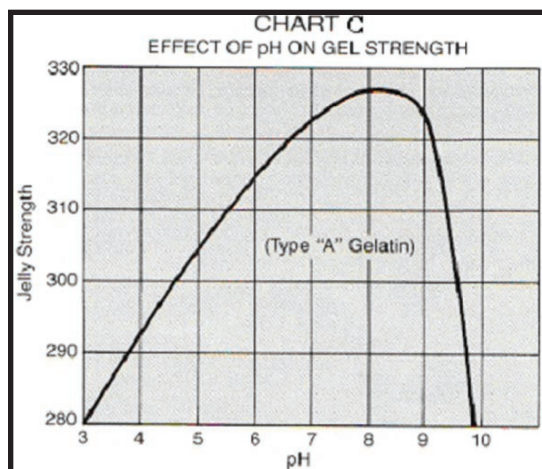
Only extensively hydrolyzed gelatins dissolve in cold water to give a stable solution. Gelatin is freely soluble in hot water over the entire pH range.

The compatibility of gelatin in aqueous solution with polyhydric alcohols like glycerol, propylene glycol, sorbitol etc. is virtually unlimited and they are used to modify the hardness of gelatin films.

In products with limited moisture availability as in confections where there is another polymer competing for the water such as in glucose syrup, gelatin may precipitate resulting in loss of gelation and cloudiness. In these cases the gelatin solubility is very dependent on the charge of the protein molecule of the gelatin and the pH of the rest of the combined product. Hence, the further the product pH is from the isoionic pH of the gelatin, the better the solubility and performance of the gelatin.

Particular care should be exercised in dissolving gelatin. It is important that the gelatin be completely dissolved so as to get the maximum benefit. Gelatin, being hygroscopic, absorbs water readily. The finer the gelatin is ground, the faster it absorbs water. It is therefore important to choose the right grind of gelatin to suit the method of dissolving. In principle, there are three different groupings of product form.

1. Coarse ground gelatin (5-20 mesh) is used when air should not be incorporated into the solution. The gelatin is mixed gently into cold water in a jacketed kettle, and then allowed to hydrate for at least one hour. Next, the gelatin is melted and dissolved by the application of moderate heat.



2. Medium ground gelatin (30-40 mesh) can be dissolved as described above. Another method is to dissolve the gelatin instantly by adding it directly to warm water (140°F). The gelatin must be added at a slow enough rate with vigorous stirring, so that each particle is wetted and the formation of lumps is avoided.

3. Finely ground gelatin is dissolved with warm water (130°-160°F) using vigorous stirring and well-adjusted dosage to avoid lumps. It may be desirable to dry blend the gelatin with other powders such as sugar or dextrose to help disperse the gelatin more completely in the water. This is absolutely necessary when extremely fine mesh (80-100 mesh) is to be dissolved.

Some raw fruits like pineapple and papaya contain proteolytic enzymes like bromelain and papain which hydrolyze gelatin and destroy its gelling ability. In such cases it is essential that the fruit is raised to a high enough temperature to destroy the protease before the fruit is added to the gelatin solution.

## REMEMBER TO USE CARE IN HANDLING GELATIN

- Equipment should be of stainless steel or other corrosion-resistant material for easy cleaning, and to minimize particulate accumulation and growth of microorganisms.
- Water must be of good bacteriological quality.
- The pH of the gelatin solution should be between 4 and 6. Bacterial growth is usually greatest at neutral pH.
- Always weigh the gelatin and carefully measure the water and other ingredients.

## USES OF GELATIN

### Gelatin Desserts

Few desserts are so well-liked as gelatin desserts. They are prepared by the addition of water to dry-blended powders consisting of a sweetener, gelatin, food acid, buffer salt, flavor and food color. Gelatin forms a sparkling clear jelly that does not synerize and has a crisp, clean, refreshing mouth-feel. Gelatin is used at a level of about 1 1/2% to 3% basis the finished dessert. A high bloom gelatin of excellent clarity is preferred.

### Nutritional Products

As stated before, gelatin is not a complete protein source because it is deficient in tryptophan, however the digestibility is excellent. Studies have shown that the consumption of 7 to 10 g/day can significantly improve nail growth rate and strength and it also promotes hair growth. Gelatin has also been shown to benefit arthritis sufferers in a large proportion of cases.

### Dairy Products

Gelatin is compatible with milk proteins and makes an excellent stabilizer for dairy products because of its gelling, water binding and protective colloid actions. Many contend that gelatin is without an equal for use in cultured dairy products. In sour cream and yogurt, it helps provide a firm yet tender body. In addition, the protective colloid action of gelatin gives a smooth texture and is most effective in preventing syneresis or separation. Gelatin is often added to buttermilk in small amounts to prevent separation and give a smooth body.

## Pharmaceutical Uses

The pharmaceutical industry uses very large quantities of gelatin primarily for making hard and soft gelatin capsules. Hard capsules are made by dipping stainless steel pins into a gelatin solution which is distributed uniformly around the pin. The gelatin is set with a blast of chilled air, then the moisture is removed very uniformly. The dry capsules are trimmed, removed from the pin, and cap and body put together to make the closed empty capsules.

Soft capsules are made from a solution of gelatin, plasticizer (such as glycerin), and water. Two gelatin ribbons are formed and go between dies. As they meet, capsules are formed by injecting with fill material as the paired halves are sealed. The filled capsules are washed, dried, inspected, and packed.



A popular method of protecting pharmaceuticals from environmental effects is accomplished through microencapsulation. Here the drug is encased in micro sized. capsules that can be handled as a powder.

In wound and burn healing, the various amino acids found in gelatin make it a well-suited raw material for pharmaceutical use. Other pharmaceutical applications for gelatin include its use in tablets, emulsions, surgical sponges, ointments, salves, jellies, and suppositories

## Marshmallow

Marshmallow is an aerated confection containing sugars, water, gelatin, and flavor. Depending on the type of marshmallow desired, the syrup is generally whipped to a weight of between 35 to 60 ounces per gallon. A good marshmallow gelatin should be high in bloom and viscosity. In addition, it should have good whipping qualities.

## Jellied Meats

Gelatin is used to gel the fluids in jellied meats and to bind the pieces of meat to form a mold. Gelatin is used in other jellied foods such as jellied consommé and aspic. Gelatin of high bloom strength and good clarity is indicated for these products.

## Canned Hams

Gelatin acts to gel the juices exuded when canned hams are processed. It also assists in binding and shaping the meat in the can. The grade of gelatin used in canned hams shows some degree of variation among canners. Generally a medium strength gelatin is used.

## Bakery Products

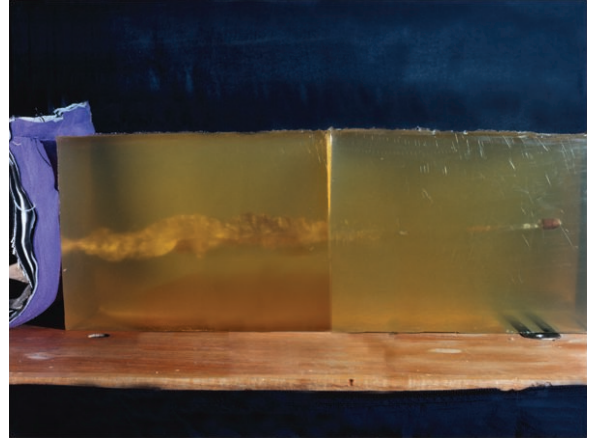
Gelatin has many uses in bakery products because of its unique function. It is particularly useful in marshmallow, icings, glazes, and creme fillings. It stabilizes the aqueous phase of such systems and helps to maintain a fine sugar crystal structure. Gelatin is also used in mousses, chiffons, cream fillings, and whipped toppings because of its whipping and stabilizing properties.

## Clarification of Wines and Juices

Gelatin has the tendency to form coacervates with other proteins and hydrocolloids. This property makes gelatin useful for precipitating materials that cause haze or cloudiness. Gelatin is used to clarify wines, beer, apple juice and vinegar.

### Ordnance Gelatin

Gelatin is used extensively for the testing of ammunition to determine its effectiveness for hunting as well as for military and crime stopping applications. When gelatin is made into blocks according to established law enforcement procedures, it provides valuable information due to its ability to mimic flesh. High clarity gelatin is used so that the projectiles' trajectory, penetration, fragmentation, etc. may be observed and photographed. On a lighter note, gelatin is also used to make paintballs for the growing paintball gun warriors.



### Industrial Applications

There are many non-food applications where gelatin has been found to have particular advantages. The microencapsulating process, described in the "Pharmaceutical Uses" section, has been used in specific applications such as the production of carbonless copy paper. Here, the ability of gelatin to form a coacervate that can be hardened with an aldehyde is used. The encapsulated material is kept encased until the capsule is ruptured or dissolved and the internal phase released.

The same property of coacervate formation with other macromolecular compounds has made gelatin useful in the processing of synthetic polymers and latexes. In the manufacture of these materials, the reaction could continue until the whole mass has polymerized. Gelatin functions as a protective colloid to prevent the coagulation of the suspension and to control the size of the polymer particle.

The photographic industry uses large quantities of gelatin in several applications. The gelatin used is primarily derived from crushed beef bone because of the inherent photographic properties of the raw material. Photographic grade gelatin is used in all of the layers of a photographic product including the silver halide crystal-containing emulsion layer, top coating layer, sub-coating layer, anti-halogen layers, and non-curl layer.

Some other applications of gelatin include hair care products, cosmetics, electroplating, and paper and textile sizing.

**Kosher and Halal certification is available.**

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*In this pamphlet, we have attempted to highlight the many facets of gelatin. Perhaps the broad versatility of gelatin can best be illustrated by pointing out its primary functions, as a gel forming agent and as a protective colloid. In addition, it can act as a film former, stabilizer, binder, thickener, texturizer, emulsifier, dispersing agent, softener, tenderizer, foaming or whipping agent, tableting agent, water imbibitor, flocculator, clarifier, and protein source.*

*The foregoing information on gelatin, its properties, handling and use is based on our own experience and that of others. It is intended for general guidance and implies no guarantee on the part of the manufacturer.*

*As a company dedicated to customer satisfaction, the experience and resources of Vyse Gelatin Company are at your disposal for development of new products and optimization of current production. Please call on us if we can be of service.*

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# P R O T E I N

BARS DRINKS SUPPLEMENTS CANDIES DESSERTS



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