1
Introduction

1.1
Gelatine – Yesterday, Today, and Tomorrow

1.1.1
The Future of Gelatine Has Just Begun – Its Multi-faceted History Is Proof

The foodstuff gelatine has had a long and successful history. In ancient times it was used as a ''biological adhesive'', and in the course of time it progressed to industrial manufacture and diverse applications. Some 8000 years ago, cave dwellers in what is now the Middle East were able to produce glue from animal tissues. Some 3000 years later, the Ancient Egyptians were well aware of its functionality and used a type of wood glue produced from collagen as an adhesive to glue their items of furniture together. And, at the court of Henry VIII of England (1491–1547), pickled dishes with ''glittering calves'-foot jelly'' were on the menu at every banquet. It was in the Napoleonic era, however, that gelatine experienced its first real boom: it was used as a source of protein to feed the French when meat became scarce during the blockade of their ports by the British navy. And, of course, modern pharmaceuticals and photography would be unthinkable today without gelatine.

The use of gelatine for health purposes has been documented since as early as the Middle Ages. For example, Hildegard von Bingen, Benedictine Abbess and universal scholar, recommended in her ''Physica'' around 1150 that ''frequent and adequate'' portions of a broth made from calves' feet was good for joint pain. Today, science has proven just how right she was.

1.1.2
It All Began with Glue

However, archeologists have established that certain forms of crude gelatine were used much earlier. Chemical and microbiological analyses carried out at the Weizmann Institute in Israel on samples taken from a cave near the Dead Sea clearly show that its inhabitants in the New Stone Age knew much about the adhesive strength of collagen glue and used it for numerous purposes. Discoveries

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Fig. 1.1 Gelatine has had a long and successful history. The granulated types are today's most common grades for industrial use.

in both Deir el Bahari (in the funerary temple of Queen Hatshepsut) and in Thebes [1] (today's Luxor) also unambiguously prove that animal glue was used in Egypt at the time (see Fig. 1.2). This form of glue, so-called glutin glue, is still produced today from the collagen of animal hides. In addition, some pyramid texts indicate that the Egyptians also used bones in the preparation of various broths and soups [2].

Thus, the use of gelatine for the preparation of food during the first few centuries AD can be clearly established. During this period, the bone and hide of animals was boiled to obtain glue. However, a different kind of product was also obtained – a raw extract that, when cooled, solidified to produce what in fact was the ''original form'' of edible gelatine.

Fig. 1.2 The Ancient Egyptians used glutin glues for furniture production. This glue is still produced today from the collagen of animal hides and bones in some countries, including Egypt.

1.1.3
Pure Luxury for Kings and Aristocrats

For centuries, gelatine was a luxury item; it was used to prepare an extravagant jelly for dishes presented at court and in aristocratic villas. It was only in the late 17th century that scientists started propagating its nutritional and physiological qualities.

In 1682 the French mathematician Denis, Papin invented a pressure cooking pot [3] called a "digester" that made it possible to cook bones until soft. Papin recommended using the stock produced for preparing soups; he even suggested to King Charles II of England in 1681 that "the jelly produced from bone be used as a general foodstuff for the people."

1.1.4
During the Napoleonic Wars, Gelatine Was Systematically Researched as a Source of Protein

Gelatine's popularity as a foodstuff came about during the Napoleonic Wars. The blockade of the French ports by the British navy during the wars meant a shortage of meat protein for the population. Politicians and scientists initiated a search for possible alternatives and in fact found one – gelatine. In 1803 and 1818, the administrator of the Military Hospital in Paris, Anton Alexis Cadet de Vaux, published reports on "gelatine produced from bones and on the resulting bouillon". A commission headed by the chemist d'Arcel used these to compile methods for manufacturing gelatine. Gelatine as a source of protein for nutritional purposes was then systematically researched and its manufacture and application improved. The obvious consequence was the industrial production of gelatine.

The first company to manufacture gelatine on an industrial scale was Coignet & Cie., founded in 1818 in Lyons, France. The company improved production in two areas: it was the first company to use "hide split" (so-called "glue leather") as a raw material (see Section 2.2.2), and it introduced a process for the industrial drying of thick gelatine leaves. This remained the method of choice until

Fig. 1.3 Manufacture of gelatine was extremely work-intensive until the middle of the 20th century. Here, packing of the dried gelatine sheets.

the middle of the 20th century. The first products to be sold under the label "powder gelatine" were no more than ground thick leaves or bars of gelatine.

1.1.5 Suddenly, Medicines No Longer Had a Bitter Taste

Almost at the same time, the first new applications for gelatine were developed. The first breakthrough came about in 1833 when French pharmacist Mothes was granted a patent for the manufacture of gelatine capsules (French Patent No. 9690). These "original capsules" were produced by immersing a small leather sack filled with mercury into a concentrated solution of gelatine. The chilled and dried gelatine film which looked like a capsule was then stripped from the leather bag. These capsules enabled drugs to be dosed more easily and, for the first time, to be better protected from the effects of heat, cold, and humidity. More importantly, however, the medicines they contained no longer tasted bitter.

Later, American companies became technology leaders in the manufacture of capsules. In 1897 [4], the company Eli Lilly, based in Indianapolis, IN USA, started filling powders and granulates into very thin, two-part hard gelatine capsules. By 1913, the company had also developed and globally introduced the first automatic method for the production of hard gelatine capsules. The process for the simultaneous production of "bodies" and "caps" was introduced in 1931 by Parke, Davis & Company in Detroit, MI USA.

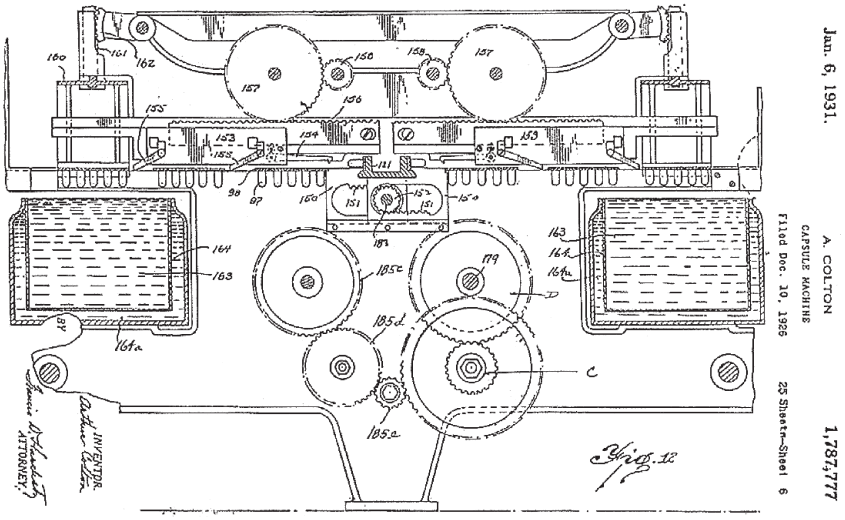

Fig. 1.4 Construction plan of a hard shell capsule machine from the patent application of Parke, Davis & Company, 1931.

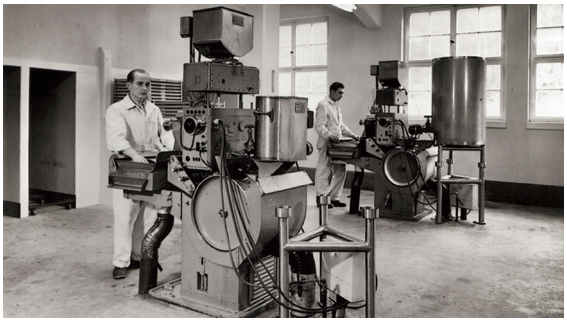

Fig. 1.5 Two of the first soft shell capsule machines of Robert P. Scherer, who revolutionized the manufacture of soft gelatine capsules with his development.

Around 1930, a further pioneering invention revolutionized the manufacture of soft capsules: Robert P. Scherer invented a machine for the automatic and continuous manufacture and filling of soft gelatine capsules, a process that very soon spread throughout the world (see Fig. 1.5). Gelatine, however, was also used in other pharmaceutical applications: it was used, for example, for coating tablets and microcapsules, thus reliably protecting the active substances contained in them from the effects of light and atmospheric oxygen.

It is not only this effective barrier function that makes gelatine so valuable in pharmaceutical production; its high degree of compatibility and extremely low allergenicity make it an ideal component of drug systems. These particular properties have also been utilized in applications in medicine: since the 1940s, for example, gelatine sponges have become indispensable as hemostats against surgical bleeding (see Fig. 1.6). Interestingly, this has a connection with the early history of gelatine: during the 3rd century, the Chinese and Japanese used gelatine for this specific purpose [5]. A further example is in the area of emergency medicine, where gelatine-based substances are used as blood replacement agents or plasma expanders (see Fig. 1.7). These were intensively researched during the First World War [6] and successfully used on a large scale during the Second World War.

1.1.6
Gelatine Helped to Popularize Photography

The history of photography would also have been quite different without gelatine. The decisive breakthrough was made by Frenchman Louis Jacques Mandé Daguerre (1787–1851), who developed the "Daguerreotype" process of photographic printing. The process, however, was somewhat complex and difficult to handle. In addition, it was only possible to prepare unique original positives. These were expensive, and hence the hobby of photography was restricted to those who could afford it.

Fig. 1.6 Gelatine sponges are available in a variety of shapes to stanch surgical bleeding in different areas of the human and animal bodies.

Making photography uncomplicated, important for its widespread popularity, was made possible half a century later with the help of gelatine. From 1880 onwards, ready-to-use dry photographic plates coated with gelatine emulsion became available. With these, it was possible to produce negatives and therefore many positives. However, photography was only finally popularized by George Eastman who, in 1888, introduced his famous "Kodak Number 1" camera (see Fig. 1.8).

This made it possible for the amateur photographer to produce photos at reasonable cost as the easy-to-use camera worked with rolls of film instead of plates. An indispensable aspect of the exposure and development of the films was the coating of the photographic paper with high-quality gelatine. The gelatine used had to be chemically pure and particularly uniform in terms of its viscosity and texture. The companies involved in the photographic business, although many, like Kodak, had their own gelatine manufacturing plants, soon started to cooperate with specialists in photographic gelatine.

At the end of the 19th and beginning of the 20th centuries, such specialists were to be found particularly in Germany and France. The close cooperation that followed soon led to both industrial areas becoming closely knit, at least in part. In 1921, for example, George Eastman and Heinrich Stoess, after a long and successful transatlantic cooperation, founded together the first German-American joint venture after the First World War – the Odin Factory in Eberbach, Germany, the plant supplying Kodak with its photographic gelatine (see Fig. 1.9).

Also, Agfa AG, at the time one of the largest of Kodak's competitors in Europe, concluded a contract with DGF (Deutsche Gelatine Fabriken AG) in Göppingen

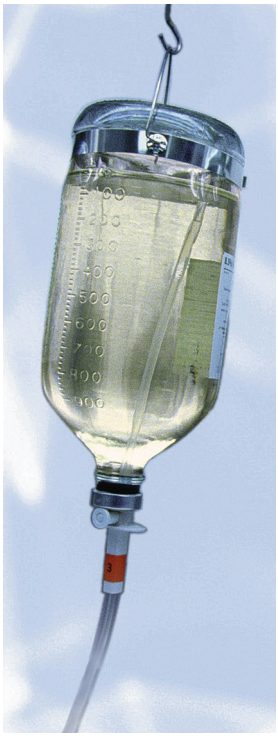

Fig. 1.7 Blood plasma substitutes based on gelatine are widely used for the temporary replacement of blood in the circulatory system after surgery or accidents.

and Schweinfurt in Germany whereby DGF AG agreed to supply all of Agfa's requirements for photographic gelatine. In 1964, in fact, Agfa AG itself started producing gelatine: it acquired completely the company Koepf & Söhne and from then until the year 2000 produced part of its total requirement of gelatine at its own plant in Heilbronn, Germany.

1.1.7 Magically Appearing Text

The contracts between Kodak and Stoess on the one hand and Agfa and DGF on the other were quite different in nature. However, they had one thing in common: as with all documents at the time, they were duplicated using carbon paper. This changed dramatically in the 1960s: Barrett Green and Lowell Schleicher of the company NCR invented the microcapsule for carbonless paper that was based on the reaction between gelatine and gum arabic (US Patent No. 72 800 457). This enabled special dyes to be embedded in microscopically small capsules that were

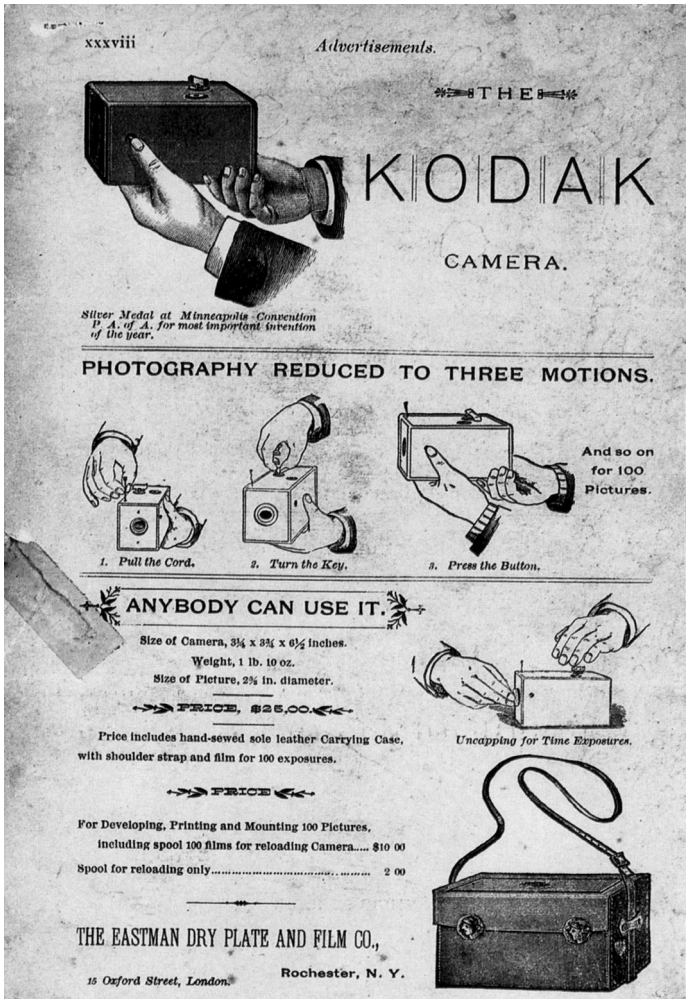

Fig. 1.8 Advertisement for the "Kodak Nr. 1" camera which worked with rolls of film instead of plates. This made it possible to produce photos in an easy way and at reasonable cost.

coated onto the reverse side of the paper to be written on (see Fig. 1.10). The pressure exerted by either the pen or the typewriter keys caused the capsules to rupture, hence releasing an initially colorless amount of ink. A special coating on the upper side of the copy then rendered the ink visible, and the text appeared as if by magic! This ended the period of black "carbon fingers" in many a typing pool.

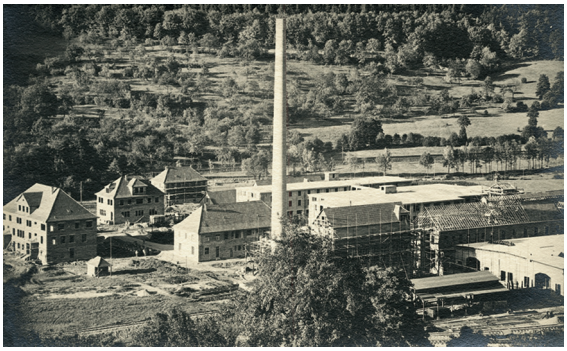

Fig. 1.9 In 1921, George Eastman and Heinrich Stoess established a joint venture – the Odin Factory in Germany. The plant supplied Kodak's factories world-wide with its photographic gelatine for close to 20 years.

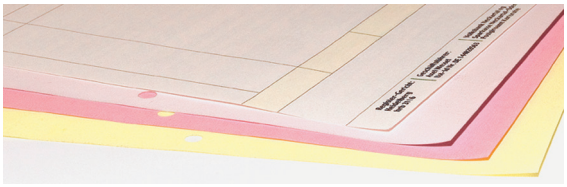

Fig. 1.10 Carbonless paper forms are covered on the back with gelatine microcapsules filled with ink. The capsules collapse and release the incorporated dye as a result of the pressure of the pen when writing.

1.1.8
Gelatine Literally on Everyone's Lips

A further important step that made gelatine ubiquitous in its use was the introduction of household packs of granulated gelatine in the United States in 1890 through the efforts of Charles Knox (see Fig. 1.11) and in Germany, during the period of worldwide economic recession, through DGF AG. This single event made gelatine into a basic and very popular ingredient for numerous foodstuffs and brought about its use on a worldwide basis.

Another major move to make gelatine more widely known was made by Peter Cooper in the United States when, in 1845, he obtained the first patent for a gelatine dessert. In 1897, the product was improved by adding fruit flavors and was named JELL-O®. The first recipe book was published in 1904. Sales of JELL-O® are currently about 300 million boxes per year in the United States. A different way of offering gelatine desserts to the public was developed in Great Britain by

Fig. 1.11 Household packs of granulated gelatine were introduced in 1890 by C. Knox and soon became very popular in the United States.

the company Rowntree. Starting with a similar product to JELL-O® in 1923, they started marketing concentrated cubes called Jelly Tablets in 1932. These also contained different fruit flavors (see Fig. 1.12). Although the product was very successful in Great Britain, it never managed to be marketed on a broader scale abroad.

Ever since, not only the food industry but also gelatine manufacturers have been continuously developing new applications for gelatine. Further aspects of its multifunctional properties were discovered and made available via new products to consumers. Many of these products were literally on everyone's lips:

Fig. 1.12 Jelly Tablets are concentrated gelatine cubes containing sugar and different fruit flavors. After mixing with hot water and then chilling, the dessert is ready to eat.

Fig. 1.13 Today, gelatine is a very popular ingredient in numerous foodstuffs. Confectionery products are by far the largest application area for gelatine around the world.

marshmallows were introduced into the United States in the early 1900s and became extremely popular by the 1950s, in 1930 the now-famous gummy bears were introduced, and by the 1970s gelatine enabled fruit yogurts without the filmy layer of whey on the surface to be developed (Fig. 1.13).

At the end of the 1970s, hydrolyzed gelatine became one of the top topics on the talk shows on American TV. The result: the calorie-reducing "liquid protein" created a record-breaking demand. Gelatine was also significantly involved in the worldwide success of the low-fat margarines and sandwich spreads invented by Lage Sundstroem in Sweden that, by 1984, were being produced on an industrial scale (US Patent No. 4071634). Gelatine was the emulsifier and stabilizer used to ensure the consistency and spreadability demanded by consumers.

1.1.9
An Essential Element of Our Daily Lives

Today, gelatine is a modern product with a very wide range of uses. It is an essential element of our daily lives, even if this is not obvious at a first glance. Match heads contain gelatine and digital holiday snapshots can be printed on top-quality, gelatine-coated ink-jet photographic paper or, traditionally, on classical photographic paper in the photo laboratory. Gelatine has also been proven to be effective as a cleansing agent and is used in the clean-up and refurbishment of buildings contaminated with asbestos. It is also used for the restoration of historical documents. Furthermore, it helps to support healthy joints and bones, and has many other uses. However, in spite of these numerous applications, not all of the many and various functional properties of gelatine have been exhaustively researched. The highly versatile history of gelatine has shown that its future has in fact just begun.

1.2
The Development of the Gelatine Industry

This chapter will give an overview of the development of the industry over more than 200 years from small local manufacturing through growth periods to global players. Because of the limited space available in this book, very small operations and companies of little importance or significance for the general development of the industry or which disappeared rapidly have been ignored. Company names have been abbreviated.

1.2.1
Period 1800–1865

In this early period, gelatine was produced for edible purposes solely on a private level or by small businesses on a semi-commercial scale. But some small glue manufacturers already existed and saw the possibility of changing their production to the manufacture of gelatine.

France

The first production of gelatine on an industrial scale by the company *Coignet* was reported in 1818 for their plant in Barabon-sur-Rhône (see Section 1.1). Soon after, they acquired further small glue and gelatine plants in France and Belgium and also started exporting. In 1839, the business of *Weishardt* started what was most likely the first glue manufacturing facility in the south of France.

Belgium/England

In the following years, small companies started in Belgium and most likely also in Great Britain. However, no details are known.

Germany

In 1840, the first German gelatine plant of O. Lindenbauer was established, but during the next 25 years only three more were built, including the company *Creutz*, which subsequently existed for more than 100 years as an independent small gelatine company.

There is no information about the size of production available from those times, but it is very likely that even the best and largest plants did not produce more than 10 000 kg per month.

The raw materials used in those times were hide pieces, but also bones collected from butchers and residues from those businesses making combs and buttons from bone were used. Most of the process development was transferred from France to other countries. The product made had the form of thick gelatine plates, like those of chocolate.

After the invention of the use of gelatine for the photographic process in several steps between 1839 and 1856, the best qualities of edible gelatine were chosen for this application. The general interest in gelatine production also became

obvious, and it must have been profitable because soon more and more gelatine companies were founded.

1.2.2 Period 1866–1900

France

The existence of four more glue and gelatine plants in France in 1875 is reported. These also supplied products to Germany. In 1891, E. Rousselot founded the company *Rousselot* which manufactured glue, and he acquired two additional glue plants in France in 1894 and 1900. His gelatine production is confirmed for 1909 but may have started earlier. These were the roots for today's second largest gelatine manufacturer in the world.

Belgium

Efficient, well-known manufacturers must have existed, because purchases from this region are reported by German companies. In 1895, a plant processing Indian bone was built (*Société Anonyme de Vilvorde*) next to an existing plant (*Société Anonyme de Grimbergen*). Both establishments merged in 1911 and are the roots of today's company *PB Gelatines*.

Great Britain

The company *W. Oldroyd* started gelatine production in Widnes – which was later an important gelatine site, and *B. Young* changed his production in London from glue to gelatine. About 1900, C. Simeons, the son of a German gelatine manufacturer, came to England and founded the companies *C. Simeons* and the *British Gelatine Works* in Luton to manufacture photographic gelatine. The Luton plant later (1920) became part of *British Glues & Chemicals* and afterwards part of the *Croda* company.

United States

Several gelatine plants were established during this time. In 1890, C. Knox founded *Knox Gelatine*, but no details are available about production. In 1888, some 92 glue plants existed in the United States, but it is not known to what extent they also produced gelatine.

One of those glue plants was owned by *Peter Cooper*, who had purchased a glue plant in 1820 in New York City. He invented several pieces of labor-saving equipment for manufacturing gelatine, and in 1845 he obtained the first American patent for his process.

Germany

Gelatine manufacturing became very popular during this time, and a total of 16 plants are reported by 1900. Some were based on modified glue plants, and others started when tanneries decided to upgrade the value of their by-product hide splits and pieces instead of selling or dumping them.

The following were the roots of today's *GELITA AG*, the world's largest manufacturer of gelatine. In 1867, A. Schmitt started his gelatine production in Schweinfurt, and in 1872 C. Heinrichs founded a gelatine plant in Höchst, which was then merged in 1889 with the Schmitt company to form the first *DGF*. In 1880, the brothers Paul and Heinrich Koepff, who ran a tannery, founded a gelatine and glue plant in Göppingen. Their relative, Jacob Koepff, founded a gelatine plant in Süssen in 1889. In 1888 H. Stoess established the *Heidelberger Gelatine-Fabrik Stoess* in Ziegelhausen (close to some large tanneries) and soon specialized in the production of photographic gelatine.

The glue plant of *Caesar & Ewald* was founded in 1886 because several tanneries were in the neighborhood. Mr. Ewald was a businessman and Mr. Caesar had experience in tanning. In 1906 they changed from glue to gelatine plates. Today they are still a major manufacturer of edible leaf gelatine.

The other plants founded during this period had disappeared by this time.

The production of photographic gelatine increased rapidly after 1880, and included exported material. During this period, about 100 tons/annum of photographic gelatine was exported from Germany to the United States, mainly to Eastman Kodak.

Only for Germany are best-estimated production figures (all kinds) available:

1880	approx. 200 tons
1890	approx. 400 tons
1900	approx. 1200 tons.

During this period, the gelatine plates produced became thinner, and the description "leaf gelatine" was created. The thinnest leaves have proven to be of the best quality – a rule which is still valid today. In this period the milling of plates and leaves was also started for the manufacture of powder gelatine.

Local fresh bones, partly degreased with solvents, and hide splits and pieces were the raw materials used during this period. However, calf heads and legs were also common. The manufacture of ossein started in Germany after the first attempts in France.

Regarding the location for a gelatine plant, some basic requirements had to be fulfilled:

1. Nearby raw material supply, at that time mainly tanneries. Long transport routes for material comprising 80% water was expensive, as it is today, especially as the raw material degraded rapidly during long periods of transport.
2. Adequate availability of fresh water wells for groundwater, springs, or good quality river water.
3. Location away from housing areas because of the odor of the raw materials and from the plant.
4. Close to a river or the sea shore, primarily for disposal of the effluent, but also to transport raw materials and final products.
5. For fuel for firing the boilers, the availability of wood and coal.

6. A location close to forests was also an advantage because of the requirements for the drying of the gelatine. A forest cleans the air of dust and also has a moderating effect on the climate. This was important because at that time no air conditioning for drying the air was available. Because of this, it is reported that the gelatine quality in winter months was superior of that of summer months. Some companies even manufactured only during winter.

1.2.3 Period 1901–1914

France

This was a period of rapid growth for the gelatine industry. In France, both *Coignet* and *Rousselot* developed their businesses very successfully. In 1901 *Rousselot* acquired the plant in Camp-Major near Marseille; after this they built the plant in Angoulême near Bordeaux, and in 1913 the construction of the plant in Isle-sur-Sorgue near Avignon was commissioned. And they also acquired an ossein plant and a glue and gelatine plant in Belgium. Angoulême and Isle-sur-Sorgue are still major manufacturing plants of *Rousselot* today.

In 1908, *La Société des Colles et Gélatines Francaises* was founded to manufacture hide gelatine and glue in two plants. One was destroyed during the war and was rebuilt in 1922 in Attichy to manufacture bone gelatine; it also specialized in the manufacture of hard shell capsule gelatine. The *Compagnie des Gélatines Francaises* (CGF) also became an important supplier of photographic gelatine. In 1971, the Attichy plant was purchased by *Rousselot*. It was shut down in 1981 after complete know-how transfer because of over-capacity within the *Rousselot* group.

Belgium

It is also surprising to see the development of the glue and gelatine industry in a small country like Belgium during this period. Eleven manufacturing companies existed at places around Vilvorde and Ghent, which are still the locations for large gelatine plants. So they must have been successful in their export business.

Germany

Four new companies went into operation. The Koepff brothers split their business into the *Göppinger Gelatine-Fabrik Paul Koepff* and the company *Koepff & Söhne* in Heilbronn, which in 1964 became part of Agfa AG. Also of importance was the foundation of the *Chem. Fabrik Calbe* which, after World War 2, became the major manufacturer of gelatine in East Germany until its liquidation in 1991. In 1911 the Göppingen company of Paul Koepff and the *DGF* company in Höchst merged, *DGF* thus becoming the largest manufacturer in Germany.

Because of the technology transfer, the production methods of the gelatine plants became more and more similar. The French companies had by this time lost their leading position. The business in gelatine and glue was quite profitable, and a lot of money was invested in expansion and modernization of the plants. In 1912/13, *DGF* built the most modern and largest gelatine plant in Europe and most likely in the world. In 1914/15, they produced 614 tons of leaf gelatine, of which 258 were for photographic purposes.

Great Britain

In England, a new company, *Cleveland Products*, was established in 1907 to manufacture gelatine from ossein. This company was also merged in 1920 into *British Glues and Chemicals* along with four other companies.

The Netherlands

The Dutch company *Lijm and Gelatine Fabrik Delft*, which was established in 1885 and started the production of bone glue in 1887, partly moved into gelatine production in 1911.

Australia/New Zealand

Until 1913, there was no gelatine production in the Pacific area. In that year, C. Davis, who had formed the *New Zealand Glue Company* in Auckland in 1889, changed another hide glue plant, which he had bought in Christchurch in 1909, into gelatine manufacturing, and *Davis Gelatin* was founded. The technology used was imported from England. The business progressed rapidly, and sales were soon extended to both Canada and Australia, so that it became necessary to import large quantities of raw materials from Australia.

United States

At the same time, the granulated gelatine of *Kind Gelatine* in Camden NJ, a company founded in 1908 by M. Kind, became very popular in the United States. Most of it was sold to the ice cream industry. Kind had learned how to make gelatine in his family business in Czechoslovakia.

In the same year the first gelatine was manufactured by the *American Glue Company* in their plant in Peabody MA. The Boston area was at that time very popular for its tanning industry, and Peabody was called ''Leather City''. Eastman Kodak soon became the principal customer for this plant. Some technical exchange was initiated to produce high-quality photographic gelatine. Some time before this, George Eastman almost went bankrupt when batch after batch of his photographic glass plates produced poor results because of inferior gelatine from one of his suppliers. In 1930 the Peabody plant was purchased by Eastman Kodak and renamed *Eastman Gelatine* to ensure access to the high quality gelatine from this plant. At this time, close cooperation between the photographic companies and their gelatine suppliers started. The emulsion recipes and the gelatine used fitted like a key in a lock. For this reason *Eastman Kodak* and *Stoess* also intensified their business relationship.

During this period, the use of imported bone from overseas started in Europe because the local raw material supply of bone and hides was not sufficient and quality problems were experienced.

In 1910/11 more than 23 000 tons of bone were exported from India to Belgium, and in 1913/14 this increased to 34 000 tons. In the same year 16 000 tons were exported from India to France and 10 000 tons to the United States. However, Brazil and Argentina also started to export bone to France, Germany and the United States.

The best estimates for the total production of edible and photographic gelatine in 1910 are approx. 2000 tons each in France and Belgium. In 1913, production in Germany was most likely about 3500 tons.

In 1913, the total gelatine production in the US is reported to have been approx. 5000 tons.

1.2.4 Period 1915–1918

The First World War had a very negative impact on overall gelatine production.

Europe

Raw material imports decreased, utilities were scarce, and production decreased in Germany in 1918 to about 1/3 of normal. The plants in Belgium also stopped production during the war. But in France, the *Coignet* plant in Isle-sur-Sorgue expanded, and very soon (in 1918) took advantage of the market demand. Mainly, the market for photographic gelatine was growing, which was related to the importance of the military use of the photography. However, quite apart from the war, there was still export business during this period.

United States

In the United States, *Knox* acquired an interest in the *Kind* gelatine plant in Camden NJ, because he saw his business mainly in marketing and less in production. Because of the cutting off of imports of ossein from Europe during the war, an ossein plant was built in Everett MA, which was in operation until the late 1940s.

Australia/New Zealand

In 1917, the first gelatine plant in Australia was established in a suburb of Sydney by the New Zealand-based *Davis Gelatine*. M. Davis wrote in his book on company history that the presence of many tanneries in this area and the plentiful supply of pure, fresh water in the sand beds beneath the property were the most important factors involved in selecting the location.

1.2.5 Period 1919–1939

Shortly after the end of the war, the gelatine industry recovered rapidly and expanded worldwide.

France

In France, *Rousselot* in 1920 acquired a further gelatine plant in Strasbourg and in 1931 the plants in Angoulème and Isle-sur-Sorgue; at the same time the business became a public company. Also in 1931, *Rousselot* started the production of photographic gelatine. A further step in their expansion was the foundation of a gelatine plant in 1936 in Clifford, England. However, during this period, France lost its leading position in the market, with a production of only approx. 4000–5000 tons in 1938.

Belgium

Substantial changes took place here. All companies expanded and, following a fusion, the company *Gélatines Hasselt & Vilvorde* was established, which had had a production of approx. 4000 tons before the war. At that time, Belgium was most probably the largest gelatine manufacturing country in Europe, with more than 6000 tons/annum.

In 1919, a bone-degreasing operation based on petroleum was established in Vilvorde, and in 1932 the name of *Pont Brûlé Etablissements Duché* was changed to *Pont Brûlé*.

Germany

Of course, Germany suffered most from the war. However, good personal contacts helped to regain and even increase some export business afterwards. The war had created severe supply problems for the *Eastman Kodak Corp*., which had been supplied by *Stoess* and *DGF*. To develop this business further because of the good quality of the Stoess gelatine, the two companies founded a joint venture in 1921. This resulted in the *Odin* gelatine plant being built in Eberbach for the exclusive delivery of products for 20 years to the various plants of Eastman Kodak. In 1939, however, the plant was closed down because of the war.

DGF on the other hand had made a contract with Agfa to supply them with gelatine. In the same period, two new gelatine plants were built in Germany, but many others disappeared. From a total of 26 plants built since 1840, only 11 remained in 1934 because of the worldwide economic crisis in 1929/33. But the industry recovered again from approx. 1000 tons in 1919 and reached a peak in production in 1938 with approx. 5000 tons. However, margins were extremely low.

In 1929/31, the production of *Stoess* was moved from the Heidelberg plant to a new plant in Eberbach approx. 30 km away because of the need to expand.

Because of the growing demand for bone gelatine, *Ewald*, in 1928, built a plant for the manufacture of ossein and also started the production of photographic gelatine, which ceased in 1960.

Great Britain

The foundation of *British Glues and Chemicals* in 1920 was an important step, which consolidated the business of five gelatine companies.

Beside this, five more gelatine plants were established, of which that built in 1937/38 by *Leiner* in Treforest, Wales later became a very important factory. The

total production increased from 2400 tons in 1930 to 7000 tons in 1935, but the use of gelatine in England exceeded domestic production by approx. 3000 tons/annum.

United States

Production showed rapid growth during this period. Thirteen plants manufactured more than 10 000 tons of edible gelatine in 1937, and a further approx. 3000 tons of edible gelatine was imported. For 1930, imports of approx. 600 tons of photographic gelatine from Germany were documented.

During this period, the use of pigskin as a raw material was started by the company *Swift* in Chicago, a meat packing company, as was the gelatine plant of *United Chemical and Organic Products* (*UCOPCO*) in Calumet City/Chicago, part of Wilson & Co., another meat packer. This plant later became *Dynagel* and part of *DGF Stoess*. Also *Grayslake Gelatin*, which was founded in 1919, used pigskin as the sole raw material. This company ceased its production in 1982 because of the energy crisis. Eastman Kodak had had its own gelatine plant in Peabody since 1930 and built a further one in Rochester NY because of growing demand and quality problems with some purchased gelatines. The plant in Peabody still exists; the one in Rochester was closed in 1984.

AGFA in Germany later produced also its own gelatine, in common with *Konica* and *Fuji* in Japan.

In 1919 a gelatine plant was founded in Woburn, by five tanneries in that area. The first major customer was the owner of the *Jell-O* table jelly business. Production in 1920 was approx. 100 tons, and in 1921 it was approx. 300 tons. In 1922, a five-year contract was signed to supply 500 tons per year. The total production of that plant in 1924 was up to 1000 tons. In 1925, the *Postum Cereal Company*, later to be known as *General Foods*, purchased the *Jell-O* brand. Because of the high demand for gelatine for table jellies and to ensure a steady supply, *General Foods* acquired *Atlantic Gelatin* in Woburn in 1930, which then became the largest gelatine plant in the world after the war with about 10 000 tons/annum.

Kind Gelatine, Camden was also of great importance, as was the gelatine plant *Keystone* in *Dubuque IA*, founded by *American Agricultural Chemical*, which owned two more small plants.

Peter Cooper owned a gelatine plant (*US Gelatin*) in Oak Creek, using pigskin raw material. This was acquired in the mid 1970s by *Rousselot*. The raw material at that time was imported ossein.

Japan

The production trials for gelatine in Japan were started in 1926 by the company *Nitta Belt*. Local hide glue production had become important for the *Nitta* company after world war one because of import restrictions for many goods. As in many other countries, the production of glue started to be shifted into higher quality gelatine because, after the war, western products like ice cream, marshmallows, and jellies increased in popularity also in Japan. In 1930, a gold embargo was imposed, and the price of imported gelatine increased rapidly. *Nitta*

therefore started to produce gelatine on a regular basis in their Yao factory. Soon, several other companies followed suit. In 1932, *Nihon-Hikaku (Nippi)* evaluated the gelatine production based on hide splits in their Tokyo plant. In 1940 they built a new gelatine factory in Fujinomiya for photographic bone gelatine in close technical cooperation with Fuji. Because of growing demand, the Ministry of Commerce and Industry had, in 1933, decided to offer cash incentives for the domestic production of photographic film, which supported the foundation of Japanese photo manufacturers. These companies also started to search for close cooperation with domestic gelatine manufacturers. In 1934, *Rokuo-sya (Konica)* manufactured about 1000 kg per day together with *Yasu Photo Chem*. In 1937 a public grant was given to the Sanshine Chemical Institute because of the work of a researcher, G. Kobayashi, who had been working on photographic gelatine since 1920, to build a plant for photographic gelatine in *Takarazuka*, which, after the war, became part of the *Konica* company. The plant went into operation in 1939. Also, Fuji was involved during this period in investments in the *Japan Chemical Industries* to make gelatine in the factory, which became known, after 1941, as *Fuji Film Kawakami* when they acquired ownership. But this plant was closed in the 1950s. One of the reasons for the increasing photographic gelatine production was also the war between Japan and China in 1937, which made imports very difficult.

Australia/New Zealand

The *Davis* plants in New Zealand and Australia were also expanded during this period, and many overseas sales offices were established. During the 1930s, *Davis* supplied about 40% of the Canadian edible gelatine requirements and 55% of South Africa's.

South America

In the early 1920s, the first gelatine plant in South America was established in Brazil north of Sao Paulo by a British meat packer called *Angelo*. But the business went bankrupt after a few years. Until the 1970s, slaughter was predominantly done in the south of Brazil, which was therefore also the location of the tanneries. But it took another 20 years before a second and very successful round of gelatine production started in South America.

All the plants in the industry modernized on a step-by-step basis. Stainless steel started to play an important role in the equipment. Also, new equipment for jellifying the gelatine solution was invented to replace manual work in the production of gelatine leaves, which were still very common in Europe.

More and more plants changed from expensive hide raw material, which was in short supply after the war, to bones, which were imported at very low cost from India, Brazil, and Argentina.

In 1929/30, France imported approx. 11 000 tons from India, Belgium more than 50 000, Germany approx. 8000, the United States 11 000, and Japan 4000. In addition to this, the United States imported on average approx. 40 000 tons/annum from Argentina in the period 1924/29.

1.2.6 Period 1940–1948

The Second World War affected the whole European gelatine industry tremendously. Several plants were more or less completely destroyed and were not rebuilt. Others, which were less damaged, re-started with different products and reduced production. During the war, what production there was concentrated on photographic gelatine because of its military importance, most of the other plants in Continental Europe having closed down.

France

In 1947, *Rousselot* started to export gelatine again, and in 1948 *DGF* in Germany followed with photographic gelatine and in 1950 with edible gelatine.

Germany

In 1939 the cooperation between Eastman Kodak and Stoess was discontinued and the *Odin* plant stopped production. Very little production remained.

Great Britain

In Treforest (Wales), a new plant in was built by *Leiner* to manufacture hide gelatine. In 1943 they expanded the plant to produce bone gelatine based on imported bone from India and Pakistan, where they later installed their own bone mills.

United States

Production in the gelatine industry expanded strongly during this period because of the missing imports from Europe. In 1948/49, over-capacity was first reported, and in 1948 *Atlantic Gelatine* exported approx. 500 tons of photographic gelatine to Russia. In 1945, *Hormel*, a large meat packing company, established a gelatine plant in Austin MN based on pigskin from their own slaughtering plant. The gelatine plant was located in the same building. At that time, *Hormel* was the third meat packer to enter the gelatine business.

Japan

In Japan, the government reorganized the location of gelatine and glue plants to spread them over different regions and to ensure a reasonable size of the businesses (130 companies were merged into 9). In 1941, *Miyagi Chemical Industries* started to make gelatine from whale bones, and Fuji Film acquired the gelatine plant of *Japan Chemical Industries*. In 1944, *Konishiroku* (*Konica*) bought the Sanshine Chemical Research Institute and changed its name to *Sanyo Military Use Photographic Gelatine Co*., changing it again in 1948 to *Takarazuka Gelatine*. In 1945 *Nitta Belt* segregated its activities and established *Nitta Glue & Gelatin*.

Spain

In 1947 in Spain, a company named *Junca* started to manufacture hide glue in a little town close to Girona where many tanneries were located, because of a sur-

plus of water supply. Because Spain was relatively isolated at that time, it took about 20 years to develop into a regular daily gelatine production based on hides. Not far away, in Girona, another glue manufacturer, *Pagans*, founded in 1942, had a business based on bone. In 1948 their daily production of gelatine based on imported ossein was about 200 kg per day.

South America

The companies *Sairsa*, *Rodrigues Pinto*, and *Rebiere* were founded in the early 1940s in Brazil to manufacture glue and some gelatine. *Sairsa* and *Rebiere* had already been part of a tannery businesses and *Rodrigues Pinto* was also built close to a tanning facility. All were located within a radius of about 100–300 km north west of Sao Paulo. But as the companies grew in production they were forced to source their raw material hundreds of kilometers away because the tanneries had moved with the cattle herds further north. *Rebiere* is still an independent family business, *Sairsa* became a part of *DGF Stoess* and *Rodrigues Pinto* was acquired by General Brands, then Nabisco and today Kraft General Foods.

Just after the war, the American *Stauffer Chemicals* completed a new gelatine plant in Buenos Aires to serve the local market. In 1965 *Rousselot* became a shareholder in this company.

1.2.7 Period 1949–1972

France

After the war, *Coignet* and *Rousselot* were dominant in the French gelatine industry. The *Weishardt* company was of less importance until the 1960s. But then they expanded and started to export larger quantities of pigskin gelatine, mainly to Germany. Nevertheless, by the end of the war, *Weishardt* had serious cash flow problems and *Rousselot* acquired 30% of the shares in the company.

One of the shareholders in the *Coignet* business, which had six plants for glue, gelatine, and bone degreasing, was at this time the large industrial company *Ugine Kuhlmann*, and this company acquired the business completely in 1965.

Rousselot developed its business further with its four French plants for ossein and gelatine. In 1962, the gelatine plant in Ghent was acquired from *Union Chimique Belgium*. In 1964, the ownership in Rousselot was 75% the Rousselot family and 25% the large French St. Gobain corporation, a leader in the chemical industry. In 1965, *Rousselot* acquired a shareholding in the Argentinian *Stauffer* company to have better access to the South American markets. In 1968 the glue, gelatine, and raw material businesses of *Rousselot* and *Ugine Kuhlman* merged, *Rousselot* retaining a 66% majority.

Belgium

After the war, six plants remained in Belgium. The two largest in Ghent and Vilvorde are still important manufacturing sites.

In 1958, the ownership of the Vilvorde plant changed to *Pont Brûlé*, the majority share of that company being acquired in 1964 by *Produits Chimiques de Tessenderlo*, a large chemical group which was itself mainly in the ownership of a French government-controlled company. In 1972, the gelatine-related activities were split off and became *PB Gelatines*. In 1972, the Vilvorde plant made its first attempt to move from bone and cow hides to pigskin.

The plant of *Hasselt & Vilvorde*, also a major producer of leaf gelatine for household purposes, was closed in 1971 after acquisition by *Rousselot*, and the plant of *TMB* (*Tannerie & Maroquinnerie Belges*) in Zaventem was closed in 1978. Another plant in Zaventem (*Colles et Gélatines Zaventem*) was acquired by *Pont Brûlé* in 1970 and closed after a short time.

Germany

The partition of Germany after the war placed three of its 11 companies in East Germany. Two of these plants did not start up again, and only the *Chemische Fabrik Calbe* became a state-owned company to supply the German Democratic Republic (DDR), other East European countries, and to some extent also Russia, mainly with photographic gelatine based on hides and bone. In addition, some pigskin use followed in the 1980s. After Germany's reunification, the company went bankrupt in 1992 because *DGF Stoess* were not able to acquire the plant under acceptable terms.

DGF repaired the Göppingen plant and started to expand soon afterwards. In 1973, a brand new plant had double the capacity of the previous one. The Eberbach plant of *Stoess* was also modernized and expanded in the years 1966/67. In 1965, *Stoess* acquired the *DGF* shares, combined the activities in the market, and merged the two companies in 1972. By this time the *DGF Stoess* group was again a worldwide player in photographic, pharmaceutical, and edible gelatine.

In the Eberbach plant, a large, modern semi-automatic drier for leaf gelatine was installed in 1967 after several less successful trials in the Göppingen plant several years before.

The *Koepff* plant in Heilbronn (result of the business split of the Koepff brothers in 1904) was also repaired and expanded, but on a step-by-step basis mainly with money from their main customer Agfa, who bought shares in the company. It is reported that in 1964 the shareholding of Agfa reached 75%. Thus, the company was renamed, and the name *Agfa* appeared for the first time in the new name.

After 1965, the *Chemische Werke Pfeffer* in Memmingen changed their production from glue to gelatine. But in 1974 the plant was closed by the regulatory bodies because of environmental problems.

In 1969 the *Reinert* family, a large trader of edible gelatine, acquired the small gelatine plant *Herold* (a DGF plant before the war) and built a new pigskin gelatine plant there in the 1970s.

In 1951, the glue plant of *Ratjen* in Nienburg also started a gelatine production, which was soon expanded, and the plant was modernized. In 1965, the glue and gelatine businesses were separated, and a new company *Nienburger Gelatine* was

formed. Both businesses were acquired by the pharmaceutical company Schering in 1969, which was mainly interested in the glue business and had no expertise in the gelatine field. Thus, in the early 1970s, they started to look for a potential buyer.

The *Ewald* company ceased the production of photographic gelatine around 1960 and concentrated more on leaf gelatine for households, bakeries, and catering. In 1971 the conversion of the raw material from hide splits and bone to pigskin started.

Great Britain

British Glues developed very successfully and in 1964 was the largest gelatine manufacturer in Europe. Part of their success was the establishment of modern bone degreasing plants in England, Austria, and the Netherlands for domestic bone. This gave them some quality advantages in photographic gelatine compared with the imported Indian bone. From 1949 through 1958, all plants were completely modernized. In 1968 *Croda* acquired *British Glues*, and the latter name disappeared. *Croda* was founded in 1925 as a chemical company to manufacture raw materials for the cosmetic and chemical industries. General chemicals and dyes, emulsifiers, and fat derivatives followed. The gelatine acquisition was carried out to add a further important pillar to the portfolio shortly after the company went public and had sufficient funds available.

Leiner also expanded the plant in Treforest, mainly based on imported bone. In 1956, a new plant in Canada was built, but this shut down again after a short period because of a lack of raw material. Most of the equipment was shipped to Brazil (Cotia/Sao Paulo), where a new *Leiner* company, *Cobrage-Compania Brasileira de Gelatinas*, started production in 1959. Also in this period, *Leiner* founded a gelatine production enterprise in India (today *Shaw Wallace/Narmada*). In 1961, Leiner became the largest bone gelatine manufacturer in the world. After 1959, *Leiner* tried to manufacture pigskin gelatine; this proved to be a fiasco and forced the company into bankruptcy in 1980.

The small *Rousselot* plant in Clifford was not of importance at that time, and the same was true of *Gelatine Products* in Runcorn, the former Cheshire Glue Co., which was acquired in 1991 by *DGF Stoess*.

The war had changed the position of Great Britain in the world market completely. In the 1930s, imports had been approx. 2500 tons/annum and exports approx. 250 tons/annum. In the 1960s, imports dropped to approx. 600 tons/annum and exports increased to approx. 2500 tons/annum.

The Netherlands/Switzerland

The *Delft* company in the Netherlands changed from glue to gelatine, and production increased slowly to about 1000 tons/annum.

In Switzerland, the company *Geistlich* started to producce a small amount of gelatine after being a traditional glue manufacturer since 1909.

The *Winterthur* plant in Switzerland was liquidated in 1971.

Sweden

In 1967, the KemaNord Group, a large chemical manufacturer, acquired the *Stidsvigs & Hälsingborgs Limfabriker*, a company which had been producing about 1000 tons/annum of edible gelatine from hides and bone since 1957. A new plant (*Extraco*) was built in 1971 with the target of producing 3000 tons/annum, mainly based on pigskin. In 1976 the target was exceeded, but the distance to the raw material sources, and hence the transportation costs for frozen pigskin, created financial problems.

Italy

In this period, a small plant, *Barbero* in Sta. Vittoria d'Alba, was founded, but it went bankrupt in 1968 and was acquired by F. Vezza. It then became *Italgelatine* with about 1000 tons/annum production after some investment.

In Torino the company *Fermonte* produced approx. 700 tons/annum of photographic gelatine. *Fermonte* was owned by the photographic company Ferrania Spa, which itself was owned by 3M. The *Fermonte* plant was sold in 1973 to the third Italian gelatine manufacturer during this period, *Lapi*, with its plant in Empoli, near Pisa, which had a production of approx. 700 tons/annum at that time.

Spain

In 1960, the owners of *Pagans* decided to focus completely on gelatine and divested themselves of their other businesses. In 1967, they expanded their degreasing and demineralization capacity and brought up their production to 1200 tons/annum, but they ran into severe financial problems in paying for this investment.

The other manufacturer, *Junca*, erected a new plant in the outskirts of the town in 1953/54. At the end of the 1960s the production of leaf gelatine was also started for the domestic market only. The first gelatine exports of this company were made in the early 1970s to Egypt and to the USA.

Eastern Europe

There are some indications that in those years very small technical gelatine production facilities existed in Yugoslavia, Czechoslovakia, Poland, and Romania. Most of these disappeared in the years following because of inferior technology and their small size.

Russia

No details about the foundation of the Russian gelatine industry are known. However, it can be assumed that some plants did exist during this period, founded before the war. Total production of about 5000 tons/annum was reported for the end of the 1960s.

United States

Because of the lack of imports during the war and the growing use in all applications, the gelatine industry expanded rapidly. In 1949, *Atlantic Gelatin* manufactured approx. 10 000 tons/annum. The fairly unrestricted access to fresh pigskin

impelled the industry to make their plants much larger. However, only one new plant was built in this period, the new pigskin gelatine plant of *Kind & Knox* in Sioux City IA in 1966. In 1937, a total of 13 plants produced approx. 10 000 tons/annum; in 1953 it was approx. 25 000 tons, but in 1974 only approx. 19 000 tons/annum were produced by 11 plants because imports had resumed. From 1971 to 1974 production had to be reduced because of an oversupply situation.

In 1972 *Lipton*, a *Unilever* company, acquired *Kind & Knox*, with their plants in Sioux City and Camden, from the Knox family. Their main business target was the retail market, in which the "Knox Sparkling Gelatin" packs for households played a dominant role. Therefore they sold the Camden plant in the middle of the 70s to Peter Cooper.

In the same period the gelatine plant in Dubuque became *Keystone Gelatin* and the gelatine plant in Calumet City became the *Gelatin Division of Wilson*, a large meat packer. In 1978 the *Rousselot* company bought *US Gelatin* with its plants in Oak Creek WI and Camden NY from Peter Cooper and continued international expansion.

Canada

A large Canadian integrated meat products company, *Canada Packers*, built a gelatine plant in Toronto in the 1950s mainly based on their own pigskin. In 1970 it was expanded to make 1500 tons. For a brief period it also manufactured some hide gelatine.

Australia/New Zealand/South Africa

The plants in Australia and New Zealand were further modernized and expanded, and in 1970 the first semi-automatic continuous extraction process was constructed in Botany, Sydney.

Because of the limited raw material sources in Australia and New Zealand, all kinds of raw materials besides pigskin were used – sheep legs, dried hide splits and pieces, wet hides, hairy material, but no ossein.

In 1951, *Davis* acquired 70% of the shares of the small gelatine company *Gelatex* in South Africa, which then became *Davis Gelatine Industries*. In 1971, the remaining 30% were purchased and the plant modernized and expanded.

Japan

In 1954, *Fuji Film* decided to curbail their own gelatine production, close their Kawakami gelatine plant, and concentrate on the purchase of gelatine from outside but in close technical cooperation with their Japanese suppliers.

In 1955, *Nippi* doubled their production by means of a large modernization and expansion program.

In 1957, *Tadera Glue* changed its name and *Asahi Gelatine* was founded to produce high-grade glue. In 1960 it became a cooperative factory of *Nippi* and entered a technical and sales agreement. In 1971 the factory was rebuilt and expanded and the production of acid gelatine started.

In 1960, *Nitta Glue and Gelatin* changed its name to *Nitta Gelatine*.

In 1968, *Yamaguchi Trading* and *Nitta* established a JV company, *Hikone Gelatin*. Their gelatine was exclusively marketed by *Nitta*.

Because of its dependence on imported raw material, *Nitta* started, in 1970, to make ossein with a partner in Thailand, and *Takarazuka Gelatin* did the same in 1973 with a partner in India.

Gelatine production of all types in Japan was reported in 1966 to be 3600 tons; in 1974 the confirmed figure was 6,600 tons.

But Japan was still dependent on gelatine imports for the photographic industry. So was it not surprising to see an import duty of 20% for edible and pharmaceutical gelatine but only 3.5% for photographic gelatine.

Mexico

In 1959, Mexican investors, under the leadership of A. Olazábal, founded *Industrias Coloidales* approx. 2700 m above sea level in Toluca, close to Mexico City. This was later modernized with the assistance of *PB Gelatines*. The production was based on pigskin. Some time later Olazábal left the company. Since 1990, the company has been known as *Coloidales Duché* and is controlled by a group of French investors. This is a result of certain banking turbulences.

In 1968, A. Olazábal founded a further gelatine plant, *Panamericana de Grenatina*, also in the Toluca area and approx. 8 km from his old plant. The reasons were the weather conditions and the water availability. At the beginning, the plant processed 100% pigskin; however, during the 1970s and 1980s, hide and bone processes were developed for cost reasons.

Also in the 1960s, *Grenatina Diamante* was founded in Leon in the North of Mexico in the predominantly tanning area. The plant was and still is of little importance outside Mexico. The same is true for *Grenatina Regia*.

However, probably the first gelatine plant in Mexico was *Progresa*, founded in the 1950s in Leon. This small plant still exists. Because of the importance of the table jelly market, Mexico has developed a relatively large gelatine production.

Brazil

In 1965, *Leiner* continued their world-wide expansion and founded a gelatine plant in Cotia, a suburb of Sao Paulo, a location which was also close to slaughterhouses and tanneries.

At this time, another gelatine plant was built in the South of Brazil in Estancia Velha by *Inbragel*. This was later taken over by *Leiner do Brazil*.

Colombia

In 1930, E. Minski and I. Gilinski founded a tannery in Colombia. In the late 1960s and early 1970s, two gelatine plants were built, one in Baranquilla (*Gelatinas de Colombia-Gelco*) by Minski and Gilinski and the other in Manizales (*Progel*) by Nabisco. For the latter plant, *Davis* provided the production know-how and owned a 30% stake in the company.

India

In 1948, the company *Rallis* was founded to make chemicals. Most probably late in the 1960s, their affiliated company *PPI* (*Protein Products of India* – at first a large ossein manufacturer) started to become a gelatine manufacturer based on *Rousselot* technology after *Rousselot* acquired a 14% share holding in 1969. In 1983, when the use of Indian bone became more and more questionable, *Rousselot* sold its share, and *PPI* was renamed *Rallis*.

Since 1961, *Leiner* has had a small production plant in India, the company *Leiner-Knit Gelatine* in Jabalpur. The partners previously owned tanneries in that area. Some years later, the large industrial group *Shaw Wallace* became a partner, and the plant was modernized and expanded and became *Shaw Leiner*. After several financial irregularities in that operation, all the English employees, including Mr. Leiner, had to leave the company in 1970. Leiner lost his shareholding completely in 1978 and the company became *Shaw Wallace Gelatines*.

Further, *Raymond Glues & Chemicals* in Baroda was founded in 1964. An ossein plant was built, followed by a gelatine plant.

But besides this relatively small production in gelatine itself, the Indian companies became more and more important as suppliers of crushed bone or ossein for the world's gelatine industry. However, in the 1950s, the import of crushed bone was restricted because, when unloading a vessel in France (Dunkirk), several dock workers were infected with anthrax and died. The same happened a few years later in Hamburg. This created an increased preference for the more sanitized ossein. The accidents also created a public discussion about the source of such bone material (animals that had not been slaughtered but simply died), and as a result it was used more for photographic gelatine – at least until the industry realized that Indian bones are not the best source for high-quality inert photographic gelatine.

Korea

In 1963, *Sammi* was established for the purpose of producing and distributing edible and pharmaceutical gelatine. The raw material at that time was most likely hide split, because many tanneries were located in Korea. This privately owned plant still exists today.

The most important events in this period were the following:

1. *Rousselot* and *Leiner* started to become real international companies with production sites overseas.
2. Large industrial groups entered the gelatine business for different reasons, so several private ownerships disappeared.
3. The importance of safe and secure raw material supplies was recognized because of the growing output of the industry. Local sourcing became more and more difficult. Several companies invested in affiliated businesses domestically and abroad to collect raw materials and also to install the first pre-treatments like degreasing and demineralization of the bone material.

4. Pigskin was used in Europe by many companies as an additional or alternative raw material, mainly for edible gelatine.
5. The demand for photographic gelatine showed a constant growth potential, but the main driving force in the markets in the years after 1960 was the sharply rising demand for pharmaceutical capsule gelatine, including microcapsules. In Europe, fruit gummies became very popular, and with the dairy industry a new market was created.

1.2.8 Period 1973–1993

France

In 1973, the name *Rousselot-Kuhlmann* changed again and the company became *Rousselot* by merging with its raw-material-collecting company *Soporga* and the acquired *Compagnie des Gélatines Francaises*. In 1977, the owner family of *Rousselot* had tremendous fears about the intention of the Socialist Party to nationalize important French businesses. As a result, they decided to sell the business. Because of the first oil crisis, the petroleum industry was looking into alternative businesses, and one of the major projects was to make protein from crude oil by bio-fermentation. Thus, there was general interest in proteins at that time. A potential buyer was found quickly – *British Petroleum*. However, the French government intervened and presented an alternative buyer, *ATO-Chemie*, a subsidiary company of *ELF-Aquitaine* and *TOTAL*. In 1985, the name changed again because of a restructuring of the businesses of *ELF* and the newly founded state-owned *Sanofi* company. *Rousselot* became a part of *Mero-Rousselot-Satia* (*MRS*), with a large portfolio of other products including other hydrocolloids. The next name change happened in 1988, and *MRS* became *Sanofi-Bio-Industries* (*SBI*) in the sole ownership of *Sanofi*. In a restructuring program, *Rousselot* closed the plants in Attichy (France) in 1981 and Clifford (England) in 1980, because they decided to concentrate all investment in their Camp-Major and Isle-sur-Sorgue plants. In 1975 the total production of *Rousselot* in France and Belgium was approx. 20 000 tons/annum, but further expansion was undertaken and in 1985 the total production was approx. 25 000 tons. In 1989, the Dubuque plant of *Keystone Gelatin* was acquired, and in 1990 the Argentinian plant of *Stauffer* was completely taken over. This expansion program was completed with the acquisition of the *Pagans* plant in Spain in 1991.

During this period, *Weishardt* expanded further and was reported to produce approx. 3500 tons in 1982. Export businesses were developed, and since 1981 the company has been trying, unsuccessfully, to produce photographic gelatine.

Belgium

In 1981, the last production of limed bone gelatine was made in the Vilvorde plant of *PB Gelatines*. All this production was moved to the acquired plant in

Nienburg, Germany. The plant became mainly a pigskin gelatine plant apart from some remaining acid bovine bone production. Between 1987 and 1993, substantial investment was made in Vilvorde in the bone-degreasing unit and the gelatine plant, and the capacity now exceeds 9000 tons/annum. Also, the Ghent plant of *Rousselot* (manufacturing mainly pigskin gelatine) was further modernized and expanded to produce 10 000 tons/annum.

Germany

In 1973, *DGF Stoess* acquired more than 25% of the shares of the largest bone collector in Germany, *Scheidemandel*, to safeguard the raw material supply for future expansion. At the same time, the site of the *Pfeffer* plant in Memmingen was acquired, which had previously been shut down by the authorities. On this site, the most modern bone degreasing plant in the industry was established, followed, in 1977, by an acidulation plant. After further purchases of *Scheidemandel* shares, their gelatine plant in Minden was integrated by *DGF Stoess* in 1981 and completely modernized, and the production portfolio changed from hide to pigskin gelatine. Together with *Scheidemandel*, a new raw material collection company, *Rohage*, was founded, because, after several shortages in supply, it had become more and more obvious that a secure raw material supply at reasonable prices was the most important key to the success of gelatine companies. In 1990, *DGF Stoess* tried to acquire the *Gelatinefabrik Calbe* in the former East Germany, but, because of previous environmental problems with the soil, the negotiations failed and the plant went into receivership. In 1978, *DGF Stoess* decided to expand outside of Germany. It acquired a minority shareholding in the Australian *Davis* group and started a 50/50 joint venture with *Davis* in the USA by acquiring the old gelatine plant from *Wilson* in Calumet City and building a brand new pigskin gelatine plant (*Dynagel*). Soon, further acquisitions followed – in 1983 in Brazil (*Sairsa*), in 1991 in Great Britain (*Gelatine Products*) and Sweden (*Extraco*), and in 1992 again in the United States (*Kind & Knox*). With a worldwide production of approx. 36 000 tons/annum in 1993, the difference to the Rousselot group had become insignificant. In 1979, the production of hydrolyzed gelatine in a separate plant in Eberbach was started. To expand these activities, a smaller operation for hydrolyzed gelatine was acquired in Finland (*Lappro*) in 1989, but the growing lack of hide splits in that area during this time forced its closure in 1998.

After the Schering group had realized that gelatine production did not fit into their business interests, they sold the plant to *PB Gelatines* in 1975, and over time the production portfolio moved more and more from hide gelatine to bone gelatine.

Great Britain

The *Leiner* production was continuously increased from approx. 6000 tons/annum in 1973. In 1979 it was in the region of 8000 tons/annum. *Leiner* had tried to make pigskin gelatine for many years because of the high cost of the imported bone and the growing demand for high grade gelatine of this type.

However, because of poor technical investments, lack of know-how and the need to import the pigskin, the company encountered financial difficulties and went into receivership in 1980 despite the fact that the Welsh Development Agency had earlier invested 2 million pounds in subsidies. The whole international *Leiner* group was split into separate pieces and put up for sale. A management buy-out by five managers followed, *Leiner Gelatin* was founded, and a further 1 million pounds in subsidies were provided. These, however, disappeared somehow and were subject to a parliamentary investigation. The whole site was reduced, with some bone gelatine production remaining, but the next bankruptcy took place in 1985. At this point, the plant was acquired, and the company became *PB Gelatines UK*.

Croda upgraded their plants in Widnes and Luton and implemented a new process to use chrome shavings from the leather industry to make low-grade gelatine. With more than 5000 tons/annum being produced, *Croda* became an important manufacturer of mainly photographic and pharmaceutical gelatine.

As mentioned before, *Rousselot* closed their plant in Clifford in 1980 because of lack of size and some environmental problems.

Gelatine Products had gone through a costly modernization program in the late 1980s and had established itself successfully on the market for edible hide gelatine in Great Britain. It had previously been in the ownership of a large British food company which had run into financial problems and was forced to sell off several of its companies. *DGF Stoess* took this opportunity to buy the company and to become, together with the imports of pigskin gelatine from Germany and Sweden, the leading food gelatine supplier in Great Britain.

Sweden

After the first difficult years, *Extraco* became a successful manufacturer of high quality pigskin gelatine and expanded its capacity continuously (in 1987 a quantity of 5000 tons/annum was reached, in 1989 7000 tons, and in 2001 12 000 tons), but it always had problems getting enough raw material from within short distances because it did not have its own raw-material-collecting company. After German reunification, it went into a contract manufacturing agreement with *DGF Stoess* under which they got German pigskin and sold the manufactured gelatine back. This way, a close cooperation started, and when their parent company (*Nobel Industries*) was forced for financial reasons to sell *Extraco* together with 15 other businesses, *DGF Stoess* acquired them in 1991. The combination with the raw material organization of *DGF Stoess* secured their raw material supply for future expansion.

Italy

At this time, *Italgelatine* expanded their plant to approx. 3000 tons/annum capacity and started to use pigskin, as many of the Italian tanneries had been closed by the authorities because of pollution by their waste water. As a result, hide splits became in short supply.

Spain

In 1975, *Pagans* was acquired by the Belgian DeSmeet group, one of their equipment suppliers, as they could not pay their bills. DeSmeet decided to start the production of pigskin gelatine and to move the plant out of town. In 1986 the new plant was inaugurated, and in 1991 the business was sold to *Rousselot*. Also, *Junca* started to change away from hide splits to pigskin because the breeding of pigs increased constantly in Spain and generated additional raw material for the gelatine industry. Besides this change, *Junca* also started to make hydrolyzed gelatine in liquid and spray-dried form.

Eastern Europe

At this time, there were three small plants in Czechoslovakia, of which one, founded in 1982, was acquired in 1995 by *Weishardt* and became *Gelima*. There were three plants in Poland and one in Romania. In Poland, several attempts had been made to increase gelatine production by building new plants with state subsidies, but most of the money mysteriously disappeared, and, after a large corruption scandal (in the press at least), one of the persons responsible was sent to prison. *Lapi*, an Italian manufacturer, invested in the Romanian plant unsuccessfully and the plant was closed.

Russia

In the 1980s, five plants existed, with a total production of approx. 6000 tons/annum. However, they never showed up on international markets. The main site was *Kazan*, which accounted for 50% and was the center for photographic gelatine next door to the largest Russian plant for the manufacturing of photographic films and paper.

United States

In the United States, the business of *US Gelatin* was bought by *Rousselot* with the two production sites in Oak Creek WI and Camden NJ. In 1980, the Camden plant was closed and the production transferred to Oak Creek, which was also closed in 1985. Thus, the name *US Gelatine* disappeared from the market. Further restructuring took place in the United States. In 1979, *Hormel* started up a new gelatine plant in Davenport IA and the Austin MN plant was closed. As well as standard gelatine, they also started to make hydrolyzed gelatine.

At the same time, Lipton decided to build a new bone gelatine plant, which started up in 1978, and was directly connected to their pigskin plant in Sioux City IA. During the 1980s *DGF Stoess* had tried a few times to convince Lipton about a joint venture or to sell their business, but without success. However, suddenly, in 1991, Unilever decided to concentrate on their consumer business and to sell *Kind & Knox*, which made mainly gelatine for ''industrial use''. After an auction process, which lasted many months, the business was sold to *DGF Stoess*, not so much because of the highest offer, but because of the best business concept. After this acquisition, *DGF Stoess* became equal in size to *Rousselot*, with about an 18% share of the world market.

Canada

In 1990, *Canada Packers* sold their gelatine plant in Toronto to *Nitta*, and it was named *Cangel*.

Australia/New Zealand/South Africa

In 1983, the *Davis* holding company was acquired by the food company *Fielder Gillespie* and lost its independence. A few years later, the new company was again taken over by *Goodman*, and in 1987 *Goodman Fielder* acquired a 60% stake in *Leiner do Brazil* and the company *Leiner Davis* was formed. The remaining part of this business was then bought in 1992, including the new Argentinian plant. In 1991, the Australian plant in the Sydney area had to be closed because of environmental problems, and a new plant for hide gelatine was built in Queensland by transferring much of the dismantled equipment. Because of many technical problems, it took until 1995 for the first production batch to emerge from this plant.

Japan

In 1974, *Nihon-Hikaku* became *Nippi*, and established an affiliated company in India to produce ossein. *Nitta* did the same in 1975 by establishing *Kerala Chemicals and Proteins* (*KCP*). In 1978, the glue plant of *Koei Chemicals* was changed to gelatine production, with technical and business cooperation with *Nitta*, which also sells their gelatine. In 1983, *Asahi Gelatine* also started to make alkaline gelatine and, in 1986, collagen powder gelatine. In 1987, a second production line was added.

In 1988, *Takarazuka Gelatin* changed its name to *Konica Gelatin*. Nitta acquired a gelatine plant in Canada (*Cangel*) from Canada Packers.

In 1980, the total gelatine production in Japan surpassed 10 000 tons for the first time, reaching 15 000 tons in 1990.

Mexico

After being mainly a pigskin gelatine producer, *Duché* changed their production in 1992 for cost reasons to acid hide processing, and finally, in 2002, they started to manufacture alkaline-treated hide gelatine, which is their main product today.

Brazil

After the bankruptcy of *Leiner* in Great Britain, the Brazilian operation was taken over by the management and some investors under the leadership of H. Cobelo.

In 1983, the plant of *Inbragel* in Estancia Velha in the South of Brazil was acquired, and in 1985 the new Maringa plant was established. The attempt to produce bone gelatine in Maceio failed. The plant started up in 1986 and was shut down in 1989. The Cotia gelatine plant was also closed in 1989, but the Maringa plant expanded.

In 1983, *DGF Stoess* expanded to South America and acquired a 50% shareholding in the *Sairsa* hide gelatine plant in Mococa, north west of Sao Paulo, an attempt at a shareholding in *Leiner do Brasil* some years before having failed. The

plant was renamed *Sairsa-Gelita* and was completely modernized with German know-how and technology.

Ecuador

In 1981, Nabisco founded a plant (*Gelec*) in Ecuador with partner *Davis* Australia (33%) to secure the supply for their jelly business in the Andean area. It was and still is a very small plant producing about 800–1000 tons/annum, which has always had problems securing its raw materials.

Argentina

Rousselot acquired the *Stauffer* plant completely and started a modernization program. In 1987, the construction of a new plant was started in Santa Fe (*Leiner Santafesina de Gelatinas*) owned 40% by the Brazilian Leiner group and 60% by *Goodman Fielder* (*Davis*). In 1991 *Goodman Fielder* acquired 100% of the shares, and it became *Leiner Davis Argentina* with a production of approx. 2000 tons/annum.

India

In 1973 *Takarazuka Gelatin* formed a joint venture with *India Gelatin & Chemicals* to manufacture ossein. In 1975, *Kerala Chemicals & Protein (KCPL)* was founded with the shareholders Kerala State (26%), Nitta Gelatin (25%) and Mitsubishi Corp. (10%). The rest of the shares were public. Their business was to make ossein and pre-treated limed ossein – an intermediate for bone gelatine production exclusively for *Nitta*.

Korea

Over the years, the production of *Sammi* has been increased from approx. 500 tons/annum to more then 2000 tons/annum today of mainly hide gelatine, but some pigskin gelatine is also manufactured. In 1980, the plant of *Kyunggi* was established to make hide gelatine. With the technical assistance of *Nitta*, the plant was modernized in the late 1980s and is now called *Highgel*. In 1988, a large manufacturer of capsules in Korea, Su-Heung Capsule Co., decided to start their own gelatine operation (*Geltech*) to secure a steady supply of hide gelatine. At that time Korea was a good place to make hide gelatine because many tannery businesses had moved out of Europe for environmental reasons and this business now boomed in Korea. But now Korea is experiencing a shortage of raw material because many tanneries have meanwhile moved to China.

China

There is very little documented information about the Chinese gelatine industry during this period. Some notes were provided by the industry association about the state-owned industry, but names and places of plants were represented in different ways at different times, mainly when China decided to change the way all names were to be written in English. There was also a mix-up between gelatine and glue. The best estimation in 1982 was a total production of 2000 tons/annum

in approx. 30 locations. The plants always sourced their raw material locally because of the totally fragmented slaughtering business, and they sold their products also in very limited area around the plants.

However, this has changed completely over the past 15 years. During this period, the industry has become more and more international through acquisitions by the leading companies. A clear tendency to move more to pigskin and less to

Table 1.1 Gelatine production in the different areas in 1974 (thousands of tons).

Raw material	Western Europe	Eastern Europe & Russia	NAFTA	South America	Asia	Oceania & Africa	Total	Share
Pigskin	25	0	15	0	3	0	43	33.1%
Beef hide	17	3	5	5	8	5	43	33.1%
Bones	20	9	11	0	4	0	44	33.8%
Total	62	12	31	5	15	5	130	

Table 1.2 Gelatine production in the different areas in 1986 (thousands of tons).

Raw material	Western Europe	Eastern Europe & Russia	NAFTA	South America	Asia	Oceania & Africa	Total	Share
Pigskin	37	1	22	0	12	0	72	39.3%
Beef hide	10	2	6	17	9	6	50	27.3%
Bones	25	10	10	1	15	0	61	33.3%
Total	72	13	38	18	36	6	183	

Table 1.3 Gelatine production in the different areas in 1993 (thousands of tons).

Raw material	Western Europe	Eastern Europe & Russia	NAFTA	South America	Asia	Oceania & Africa	Total	Share
Pigskin	47	1	23	4	4	0	79	37.3%
Beef hide	16	3	2	29	6	4	60	28.3%
Bones	30	8	11	0	24	0	73	34.4%
Total	93	12	36	33	34	4	212	

bovine raw material could be seen. The necessary investments in environmental activities, effluent plants, and odor and noise protection increased everywhere, at least when a local production was purchased by a big gelatine maker. All activities related to raw material sourcing were allocated a higher priority because the growth of the industry generated more competition in the raw material markets with their limited size.

1.2.9 Period 1994–2005

France

In 1995, Sanofi decided to concentrate their business completely on pharmaceuticals and to sell *Sanofi-Bio-Industry*, of which gelatine was only a part. The buyer was a German chemical industry group (SKW Trostberg). The result was the next name change, to *Systems-Bio-Industries*, which helped to keep the abbreviation (*SBI*) alive. But this was not kept for long, because in 1998 the company was again renamed *SKW-Biosystems*, directly linked to the German parent company of the group (DEGUSSA); but the headquarters remained in France and they also kept the traditional name *Rousselot Gelatine* for their products. Suddenly, the number one and two of the world in gelatine were in German ownership, and this made competition even stronger. Finally, in 2002, this business was acquired by the Dutch Sobel Group, a company active in meat packing, rendering, and capsule manufacturing. The fifth name change in 12 years then took place, and the company was named *Rousselot* again. However, their business activities were also subject to many changes. In 1996, they became the first company to move into China, establishing a joint venture in *Kaiping* with a local producer to make bone gelatine. In 2000, *Rousselot's* total production was a little over 45 000 tons. In 2003, a further step followed with the acquisition of a 70% share in a pigskin gelatine plant (*Sanfan*) in Wenzhou. In 2003 they decided to shut down their operation in the Netherlands (*Delft*), which had been previously acquired by Sobel. And in 2004 the traditional photographic gelatine production plant in Camp-Major was shut down because of the declining demand for photographic gelatine.

In the same period, the *Weishardt* group expanded further and doubled their production of pigskin gelatine in France.

Belgium

Because of the BSE discussion in Europe, all bovine material was banned from the *PB Gelatines* plants in 2001. In 2003, the former *Leiner Davis* plants in Argentina and in the United States were acquired by *PB Gelatines*, which ranked them third in the world market.

Germany

DGF Stoess continued to modernize and expand their German plants. In 2000, the gelatine plant of *AGFA* in Heilbronn, the previous Koepff plant, was acquired from AGFA, based on a long-term exclusive supply agreement. After the bank-

ruptcy of AGFA Germany in 2005 and the declining demand for photographic gelatine in general, the plant was shut down in 2006. In 2002, approx. 75% of the business of *Leiner Davis Gelatin* (Mexico, Brazil, Australia, New Zealand, and South Africa) was acquired, and *DGF Stoess* became, by a substantial margin, the world's largest gelatine manufacturer, with a worldwide network of production sites. This process was completed in 2006 when the company established itself in China. In 2005 the company decided to change its name and to make their product brand *GELITA* also the company name, not only for the parent company in Germany but also for all their gelatine plants around the world.

Because of the changing demand for gelatine and the reduced availability of hide splits, the production of pigskin gelatine was implemented in 2001 in the Nienburg plant of *PB Gelatines* after a large expansion program which brought the capacity of this plant up to more than 5000 tons/annum. This plant also became an important manufacturer of hydrolyzed gelatine.

Great Britain

The BSE crisis had hit the gelatine industry around the world but of course the one in Great Britain most. Even gelatine based on imported raw material but made in Great Britain could not be sold any more for edible and pharmaceutical applications. As a result the DGF Stoess plant *Gelatine Products* was shut down in 2000, the Luton factory of *Croda* in 2002, and their Widnes plant in 2004. And with these actions, two well-known gelatine manufacturers disappeared from the map, and one of the important gelatine manufacturing countries in history became insignificant, with just one plant (*PB Gelatines*) left. The gelatine market in Great Britain survived the BSE crisis without huge problems, but the industry did not.

The Netherlands/Switzerland

Because of very stringent and costly environmental requirements, *Geistlich* decided that their small plant could not carry this burden, and they closed it in 2001; thus, the last gelatine production in Switzerland disappeared.

In 1997 a glue manufacturer in the Netherlands (Trommelen) started producing edible gelatine in a new plant (*Trobas Gelatine*), with considerable growth expected.

In a further consolidation step, *Rousselot* decided to shut down their Delft gelatine plant and sell the equipment to China.

In 2002, *DGF Stoess* started production in a new pigskin gelatine plant in the Netherlands, based on an innovative and completely new raw material concept linked to new technologies.

Currently, a new pigskin gelatine plant is under construction funded by private investors close to the German border.

Sweden

After a further production increase in 1995, *Extraco* became the largest pigskin gelatine plant in the world.

Italy

Italgelatine expanded further, reaching more than 6000 tons/annum, and changed in 2003 completely from hide gelatine to pigskin gelatine. *Lapi* started production of fish gelatine.

Spain

Both existing plants of *Junca* and *Rousselot* were further expanded and *Junca* started to make fish and poultry gelatine.

Eastern Europe

After the acquisition of the hide and bone gelatine plant of *Gelima*, *Weishardt* started a modernization program, and recently the production was changed to pigskin gelatine, because even in Eastern Europe quality hide splits are in short supply. The bone degreasing operation (installed in 1992) was shut down earlier.

Russia

Some years after the fall of the iron curtain and the implementation of more free trade, the Russian gelatine industry collapsed almost completely. Only small fragments in Russia, Belarus, and the Ukraine are left, with a total production of only approx. 1000 tons/annum. First, products containing gelatine were imported, and now, after the installation of local plants to manufacture those products, the gelatine required is imported.

United States

In 1997, *DGF Stoess* added a complete second bone gelatine plant to the existing one and made Sioux City the world's largest single-site gelatine manufacturing facility. In 2003, *Kind & Knox* and *Dynagel*, both owned by DGF Stoess changed their names in the market to *GELITA USA* after the remaining 50% of the *Dynagel* shares were purchased from Goodman Fielder in 1998. Because of the declining demand for bone gelatine in general and for photographic applications in particular, the old production plant for bone gelatine was shut down in 2005.

In 1997 the *Hormel* plant in Davenport was sold to *Goodman Fielder* (*Davis*), and in 2003 it was acquired by *PB Gelatines*.

In 2004 *Nitta* founded *Nitta Gelatine USA* and started to build a new pigskin gelatine plant in North Carolina, which was commissioned in 2006.

Canada

The capacity of *Cangel* was doubled in the 1990s to approx. 3000 tons/annum, and the company name was changed again to *Nitta Gelatin Canada*. The location of the plant is still one of the most critical ones of the whole industry for environmental reasons, right in the middle of the city of Toronto.

In 2005, *Weishardt* started to build a new pigskin gelatine facility in Montreal, Canada.

Australia/New Zealand/South Africa

After 1995, the new *Davis* plant in Queensland reached its planned production in stepwise fashion. In 2002, *DGF Stoess* acquired all the plants in this area after the acquisition of the main businesses of *Leiner Davis Gelatin* and started a modernization program.

Japan

From 1984 through 1997, *Nippi* modernized most of their production, which is located in the center of a town. In 1995, *Asahi* started to manufacture hydrolyzed gelatine, which had become more and more interesting for the Japanese market. The company *Miyagi Chemicals* was renamed *Jellice* in 2003. *Nitta* announced the construction of a new pigskin gelatine plant in the United States in 2004.

Mexico

In 1994, the *Panamericana de Grenatina* was sold to *Leiner Davis Gelatin* and in 2002 it became part of *DGF Stoess*, and a complete modernization program was started, which made the plant the largest facility in Mexico.

In 1996 the *Pilsa* company established a strategic alliance with *Rousselot*. Their production is exclusively the alkaline processing of hides.

Brazil

In 1994, the capacity of *Sairsa-Gelita* was doubled and the company name was changed to *Sargel*. Over the years *DGF Stoess* increased its shareholding, and in 2002 it achieved 100% ownership. In 1995 *Rebiere* built a new plant in the western part of Brazil, in Presidente Epitácio, with a capacity of approx. 5000 tons/annum, and, in parallel, the Amparo plant was modernized and expanded after the glue production was discontinued. The *Kraft* plant was also upgraded to make up to 2500 tons/annum. Their production is still completely used internally for their table jellies.

In 1998, the previous owners of the *Leiner do Brasil* business, H. Cobelo and his four partners, founded a pigskin gelatine plant (*GelNex*) in the South of Brazil, where the breeding of pigs is concentrated. In 2005 he followed this by building a new hide gelatine plant in the mid-west of Brazil. The current production of the two plants is about 5000 tons/annum, with an installed capacity of about 7000 tons/annum.

In 1998, the Estancia Velha plant of *Leiner Davis* also started to manufacture pigskin gelatine, and in 2002 the Brazilian plants of *Leiner Davis* became part of *DGF Stoess*. A further expansion program was started, and the operations of these plants and the *Sargel* operation were restructured.

Colombia

In 2001, the Australian *Goodman Fielder Group (Davis)* sold their 30% shares in the Colombian (*Progel*) businesses, which they had acquired in 1967 from Nabisco, to the Minski & Gilinski families, who now own both plants in Colombia.

The current capacity in Colombia is approx. 6000 tons/annum if enough raw material can be imported, mainly from Brazil.

Argentina

In 2003, the *Leiner Davis* plant in Santa Fe was acquired by *PB Gelatines* when *Goodman Fielder* sold the remaining parts of their gelatine business after the major purchases of their operations by *DGF Stoess*.

India

In 1999, *KPCL* (*Nitta*) expanded their activities with a new bone gelatine plant. *KPCL* thus became the second largest supplier of ossein in India, producing more than 6000 tons/annum, and also started to deliver product to other gelatine companies. The current gelatine plant has a capacity of approx. 2000 tons/annum, and a minimum of 50% of the production is purchased under a contract by *Nitta*. In the mid-1990s, the Sandesara group, a leading tea company, decided to sell their tea business and invest in gelatine. With technical know-how from *Croda*, a first gelatine operation (*Sterling*) was established, and in 1998 their first gelatine products appeared on the market. Since then, several further production lines have been established and its current production is reported to be in the range of 11 000 tons/annum. Within a short period of time they became the most important gelatine exporter in India. Another small ossein and gelatine manufacturer was established during this period by a slaughterhouse and meat packer as an integrated operation (*Rohilkhand Chemicals & Proteins*) with a production of less than 2000 tons/annum and serving mainly the domestic market. In 1997, the Mirani family, owner of an ossein business since 1973 together with Konica Gelatine (*India Gelatin and Chemicals*), decided to build up a gelatine plant with financial and technical cooperation of the Japanese companies Nichimen and *Konica Gelatin*. Being a small operation, the business was strongly hit by the closure of their main customer, *Konica Gelatin*, in 2002. In 2000, *Shaw Wallace* decided to change the name of their gelatine company to *Narmada Gelatines* because the company had been up for sale for many years, not only because it did not fit in with the other businesses of Shaw Wallace (mainly liquor) but also because of the many problems associated with the company itself. In 2003/2004 the operation was temporarily shut down by the authorities because of environmental problems (river pollution). *Raymon Gelatin* also planned to double their production during the last few years and to enter the international markets for photographic and pharmaceutical gelatine with the technical and commercial assistance from Germany, but the attempts failed.

Korea

All plants are running, but most of the time with somewhat reduced production because of a shortage of raw material.

Taiwan

Prior to 1996 there were three mall mainly pigskin gelatine manufacturers in Taiwan. *Kuang Ming*, *Taiwan Gelatine* and *Oriental Gelatine*. In 1996 the *China Syn-*

thetic Rubber Corporation set up a new plant with a capacity of approx. 2000 tons/annum in the Southern part of Taiwan. Nobody really understood this decision. Because of the limited raw material availability in Taiwan, this new plant forced the closure of the other three manufacturers but it also drove the raw material cost up dramatically. And the raw material supply is still the biggest concern, which has forced this plant constantly to reduce production. In 2005, the plant was acquired by the Japanese *Jellice* gelatine company.

China

As mentioned before, *Rousselot* went into China in 1996 to *Kaiping* (25% of the shares are still owned by a Chinese partner) and in 2003 to *Wenzhou* with a 70% shareholding. Since the beginning, production in *Kaiping* has more then doubled to 6000 tons/annum. And they did the same with the other plant, which now has a capacity of approx. 4000 tons. In 2005, *GELITA* followed and became involved in three production plants with a total capacity of approx. 8000 tons/annum. Besides these plants, five other fully Chinese-owned plants exist with a total production of approx. 4500 tons/annum of bone gelatine and approx. 5000 tons/annum of hide and pigskin gelatine. There may well be some more smaller plants, sourcing and selling only locally. Thus, for 2006, the total gelatine production will be in

Table 1.4 Gelatine production in the different areas in 1994 (thousands of tons).

Raw material	Western Europe	Eastern Europe & Russia	NAFTA	South America	Asia	Oceania & Africa	Total	Share
Pigskin	48	1	28	4	6	0	87	38.8%
Beef hide	15	3	2	30	6	4	60	26.8%
Bones	32	6	14	0	25	0	77	34.4%
Total	95	10	44	34	37	4	224	

Table 1.5 Gelatine production in the different areas in 2000 (thousands of tons).

Raw material	Western Europe	Eastern Europe & Russia	NAFTA	South America	Asia	Oceania & Africa	Total	Share
Pigskin	70	0	31	3	3	0	107	41.5%
Beef hide	16	3	10	32	7	7	75	29.1%
Bones	32	1	16	0	28	0	77	29.8%
Total	118	4	57	35	38	6	258	

Table 1.6 Gelatine production in the different areas in 2005 (thousands of tons).

Raw material	Western Europe	Eastern Europe & Russia	NAFTA	South America	Asia	Oceania & Africa	Total	Share
Pigskin	81	1	36	5	14	0	137	44.9%
Beef hide	11	4	10	47	6	7	85	27.9%
Bones	27	2	15	0	39	0	83	27.2%
Total	119	7	61	52	59	7	305	

Table 1.7 Annual world gelatine production of all grades by areas in 1974–2005 (thousands of tons).

Year	Total production	Western Europe	Eastern Europe & Russia	NAFTA	South America	Asia	Oceania & Africa
2005	305	119	7	61	52	59	7
2004	290	119	6	62	48	49	6
2003	278	118	5	60	43	46	6
2002	276	117	4	61	43	45	6
2001	264	117	4	58	39	40	6
2000	258	118	4	57	35	38	6
1999	252	111	7	54	38	36	6
1998	253	113	7	55	38	34	6
1997	248	110	8	52	35	38	5
1996	232	102	9	51	31	34	5
1995	226	101	10	46	30	35	4
1994	224	95	10	44	34	37	4
1993	212	93	12	36	33	34	4
1992	206	91	12	39	27	33	4
1991	200	90	13	37	24	32	4
1990	193	83	10	35	21	38	6
1989	190	81	12	36	20	35	6
1988	185	78	13	36	19	33	6
1988	185	79	13	35	19	33	6
1987	186	77	13	37	17	36	6
1986	183	72	13	38	18	36	6
1974	130	62	12	31	5	15	5

the range of approx. 25 000 tons. This explosion in production was necessitated by the fast-growing use of gelatine for hard and soft shell capsules and by the introduction of gelatine-based fruit gummies to the Chinese market, bringing a further increase in demand. Import restrictions and high import duties keep the market closed and protect domestic production. The photographic gelatine used in China is of very minor significance.

In this period, the change from hide and bone gelatine to pigskin gelatine continued mainly in Western Europe because of BSE fears and the declining demand for photographic gelatine. Because of increasingly stringent environmental requirements, the tanning industry has moved away from Western Europe to Russia and China. But technology changes in the worldwide tanning industry (tanning of the complete hide before splitting) have also reduced the availability of gelatine raw material in general. The availability of raw material has become the major concern of the industry, because this could limit the chances for further growth. Companies for which gelatine was not considered a core business sold these holdings to gelatine experts, thus increasing market growth of the market leaders.

The BSE crisis hit the industry worldwide despite the fact that scientific information had been produced, at a very early stage, showing that the gelatine production process would render the product safe even if infected animal material had inadvertently entered the production process. The authorities in many countries were very reluctant to lift all the implemented bans and restrictions for different gelatine types or gelatine-containing products like capsules. However, despite intense competition, this crisis has also improved the solidarity of the industry around the world and resulted in several millions of euros being spent jointly on scientific studies and publications.

Today, the industry consists of 90 production plants in 30 countries.

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