1793

Sonderdruck

aus der Fachzeitschrift „Die Stärke“

Jahrgang 14, Heft 6, Seite 212–218

1962

The Potato Starch Industrv in the USA

History and Economic Background

While the potato starch industry in the United States is not nearly as old as the European, it has been established for a long time. Potato and wheat were the leading starches in America in the nineteenth century. Potato starch was first produced in 1811 in a small plant in New Hampshire. The U. S. Tariff Commission reported that by about 1880 there were more than 150 potato starch factories operating in Maine, New Hampshire, Vermont, Michigan, Wisconsin, Ohio, and Minnesota. The industry, from the beginning up to recent times, has been largely made up of numerous small plants instead of several large factories as found in corn starch manufacture.

Many years ago in Maine and other States, special varieties of potatoes were grown for starch manufacture much as is done in Europe. These varieties were not of good cooking quality but contained a relatively large amount of starch. In the past several decades, however, the American economy has been such that it is apparently impossible to grow profitably special types of potatoes for industrial use. Thus, all American potato production is in varieties used for food. About 15% of the total potato crop (average annual total crop for last five years, 257 million hundredweights) is normally made up of substandard potatoes unsuitable for the food market because they are too small, too large, misshapen, or damaged. Nearly all of the cull and surplus potatoes that are not fed to livestock are used in starch manufacture.

Except for the early period, potatoes have never brought at the starch factory a price commensurate with the growing cost. In spite of the fact that potatoes used for starch production must be sold by the grower at a low price, starchmaking is to be regarded as an integral part of a healthy potato industry. Diversion of cull and surplus potatoes to starch factories has done much to improve the quality of food stock and establish more orderly marketing in the potato industry. Some manufacturers are engaged in food processing and starch manufacture in the same plant. Lower grade potatoes from „field run" stock, together with peelings and trimmings from the food processing line, are ground for recovery of starch.

Late in the nineteenth century potato starch lost its strong position in the general starch field to corn starch, which could be made at a lower price in the United States. Potato starch then entered the category of specialty starches. By 1900 the number of potato starch factories had decreased to around 60 and a decided trend developed toward concentration of the industry in Maine. In 1920 there were about 20 factories in Maine with a combined daily capacity of somewhat less than 75 tons of starch. Although the total productive capacity of Maine's starch industry has increased markedly since that time, owing to the construction of new plants and modernization of existing facilities, the number of plants has remained nearly the same. In the last 20 years an extensive potato starch industry has been established in the Western States, principally in Idaho.

The history of the American potato starch industry thus consists of three phases:

1. The period from about 1850 to about 1900, in which it was a leading allpurpose starch.

2. The period from about 1900 to late in the 1930's when it was a specialty starch greatly overshadowed by corn and tapioca starches. During this interval much of the high quality potato starch used by American industry was of necessity imported.

3. The recent period in which an upsurge has occurred in the production of potato starch. Except for the occasional years of short crops, rather large quantities of potato starch have been produced each year for the past two decades. A revival in the general usage of this starch has made it competitive with corn starch, to a certain extent, in several applications. However, it should be kept in mind that over thirty times as much corn starch as potato starch is used when one considers the large amounts of corn starch converted into glucose sirup, dextrose and dextrins in addition to the quantity of corn starch used as such.

Potato starch production is confined to the northern states where late crop potatoes are stored throughout the winter. It is difficult to operate a plant economically unless the raw material is available over a period of several months each year. The operating season or „campaign“ is from about October to about June of the following year, to comprise around 200 operating days. Rarely, though, is the supply of cull potatoes sufficient and distributed so that plants can operate at capacity throughout the season.

Most of the potato starch factories are owned by companies. It is common for the companies to have part of their group of stockholders made up of growers who supply potatoes to the factory. Some of the starch plants are owned by grower cooperatives. Factory operators usually cannot pay more than about 25–35 cents per 100 pounds of potatoes for starch manufacture since the yield of starch is of the order of 1/10 the weight of potatoes ground and starch ordinarily sells for about 6 cents per pound at the point of manufacture[1].)

Cull potatoes sold at 25–35 cents per 100 pounds offer only a „salvage“ outlet for growers. During periods of potato surpluses in several recent years, the U. S. Government has paid a subsidy of 30–60 cents per 100 pounds potatoes diverted from the food market to starch processing. In the past few years, the raw material cost paid by Maine starch processors has been somewhat under 3 cents per pound of starch recovered. Maine potatoes ordinarily yield about 10% starch based on the weight of raw material ground. Potatoes grown in the Northwest yield about 12.5% starch at the plants.

Production Statistics

At present there are 21 potato starch plants in Maine, with a total estimated productive capacity of 334 tons of starch per day. These plants are all located in Aroostook County, in the northern part of the State, where potato production is most concentrated. Two of these plants have a daily capacity of 30-tons of starch; one has a 25-ton capacity; three have capacities of about 20 tons each; eight have 15-ton capacities and seven produce less than 15 tons a day. The newest plant in Maine began full-scale operation at the start of the 1961–62 campaign and is most modern in every respect. This plant has a capacity at least as large as any other in the State and was established at a total cost of $ 1,720,000; it has facilities that will permit converting much of its starch output into modifications and derivatives. Maine's factories first approached the 100 million pounds annual level of production in the 1950–51 campaign and reached 112 million pounds in 1956–57. Maine starch production for each of the four campaigns following 1956–57 was well below the record figure. However, total production for the 1961–62 campaign is expected to be high due to the potato surplus.

Potato starch production was started in Idaho in 1941 with establishment of two plants. Additional plants were built in 1942 and 1944, which along with the increased production in Maine, took care of the essential needs for potato starch during World War II when imports of foreign starches were quite low. During the War, potato glucose sirup was produced in Idaho and other locations in the Northwest. This was an emergency proposition during the time when beet, cane, and corn sugars and sirups were scarce; production of potato glucose sirup was stopped at the end of the War because it was uneconomical. Potato alcohol was also produced in Idaho, Maine and elsewhere in the United States during the War. This was continued for a few years following the War during potato surplus years, but alcohol production from potatoes has been small and sometimes nil in recent years.

In the postwar period, other potato starch plants were established in Idaho. There are now nine starch plants in that State: two have estimated productive capacities in the range of 45–50 tons of starch a day; five plants have capacities in the 25–30 tons per day range; the remaining two plants can produce nearly 20 tons of starch daily.

Modern potato starch plants have been built in the last 10 years in the following other locations: Moses Lake, Washington (45 tons of starch estimated daily capacity); Monte Vista, Colorado (one more than 20-ton capacity and another nearly 30-ton capacity); Grafton, North Dakota (25-ton capacity).

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[1]) During the 1961–62 season, the large crop caused potatoes to be available at lower than the usual price and starch prices fell to $4^1/_2$ to 5 cents per pound at the plant.

Total annual capacity for producing potato starch in the United States is estimated at about 290 million pounds, based on a 200-day campaign. Up to the present, however, the largest amount ever produced in one season was about 155 million pounds. Productive capacity is roughly divided as follows: $46^{0}/_{0}$ in Maine, $38^{0}/_{0}$ in Idaho, and $16^{0}/_{0}$ in Colorado, Washington, and North Dakota combined.

Production Methods

There is great variation in the processing details and in the equipment used to produce potato starch. While many of the older Maine plants have been modernized, there is wide latitude in selection of equipment and in arrangement of the individual steps comprising the processing. Maine plant operators have made definite contributions toward improved technology in starch manufacture, extending throughout all phases. Better equipment and processing methods have been adopted as they became available through developments of American and European machinery manufacturers. Rasps of more efficient design were developed and, more recently, hammer mills have come into common use for disintegrating potatoes. Vats have long been passé as the principal piece of equipment for washing starch; tabling has given way almost entirely to use of centrifugals for purifying the starch. Maine processors led in the adoption of rotary "turbo" (ring story) and continuous-belt driers.

Idaho starch processors were the first in the United States to grind potatoes using a type of disintegrator that combines features of a centrifuge with those of a vertical hammer mill. In this disintegrator, a vertical rotor with hammers in horizontal plane rotates at high speed within a 360 °-screen enclosure. The potato macerate is swirled against the perforated cylinder, and the finely-comminuted pulp is forced through the holes. Following disintegration of the potatoes, the pulp is screened to separate the free starch and then reground to liberate more starch. Screens ranging from 80- to 120-mesh are used to separate the coarse fiber and 120- to 150-mesh screens for removing much of the fine fiber. Horizontal, continuous centrifugals are used to remove the "protein water" ("fruit water"). Settling vats are employed in the Idaho plants to remove the small quantity of remaining fine fiber and insoluble impurities that settle at the top in the so-called „brown starch" layer. The purified starch is dewatered by rotary vacuum filters.

Idaho plant operators were the first in the United States to use cyclone "flash" driers. Although there is some variation in the number of stages and in the air temperature used, conditions employed in one of the leading plants will be used as an illustration. Predrying of the moist starch from the vacuum filter is effected in a screw conveyor through which 143 °C air passes countercurrently. The partially dried starch then drops into a high speed blower where it is mixed with 143 °C air. The moisture laden air and starch are separated in a cyclone dust collector. This is repeated by passing the starch through three additional blowers and cyclone separators. A fifth blower cyclone cools the starch before bagging.

Figure 1[2]) in its sections (a) and (b) presents a flow chart of the operations as practiced in the more modern American potato starch plants. The equipment and scheme of processing are similar in many respects to those employed in European starch plants; some of the equipment used by the United States plants in washing and purifying potato starch is made in Sweden and Western Germany. Section (a) depicts all the principal operations in brief form and section (b) charts details in the purification, separation, and final operations. The disintegrator used is of the vertical hammer mill type, the action of which was described in the preceding discussion of Idaho plants. The centrifugal rotating sieves, first used in Europe, have been installed in several of the newest United States factories. In construction, they bear some resemblance to a centrifugal pump, but with slotted sieve plates in place of the impeller vanes. The pulp slurry enters the rotating sieve through a central feed pipe and then flows radially outward along sieve plates. Centrifugal force drives the starch milk through the slots in the sieve plates, from which it is discharged through an outlet. The coarse pulp, which cannot pass through the slots, is

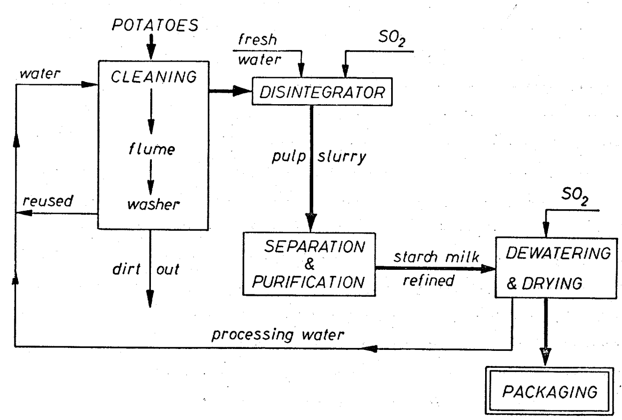

Figure 1 a.

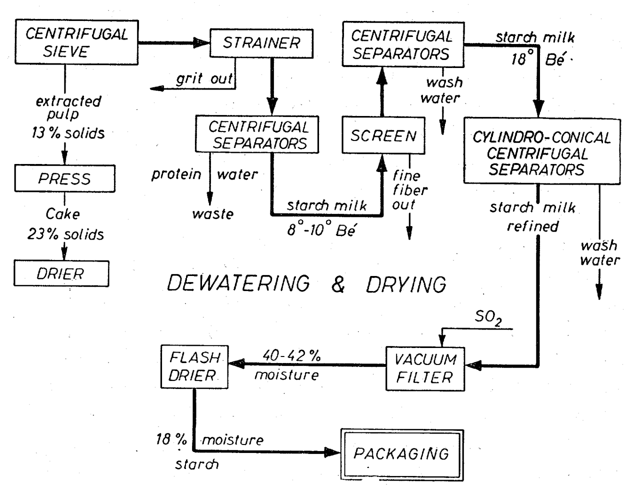

Figure 1 b.

[2]) From "Potato Processing", edited by W. F. TALBURT and ORA SMITH, Avi Publishing Co., Westport, Conn., U.S.A. (1959); Chapter 15, "Potato Starch", of this book describes in detail the methods of manufacturing potato starch in the U. S.

discharged through a separate outlet. Several centrifugal sieves are usually employed in series. An advantage over ordinary screen separation is that the percentage solids content of the waste pulp from the centrifugal sieve is about three times that of pulp from the conventional screen. In operations of the factory whose flow chart is given, the extracted pulp having 13% solids content is pressed to 23% solids and then dried to provide a component for livestock feed.

The final purification of starch milk is carried out by passage through a battery of cylindroconical centrifugals. These compact vertical units provide efficient removal of soluble impurities and separation of the starch from the wash water by centrifugal force. Dewatering and drying are conducted by the same methods described in the discussion of Idaho plants.

Byproducts of Starch Manufacture

The extracted pulp (pomace) is no longer discharged to streams and rivers. Where it is at all practicable, the pomace is used as livestock feed either in dewatered or dried form. The soluble constituents of the potato occurring in the "fruit water" present a much more difficult problem. While several methods of utilizing or disposing of the "fruit water" constituents have been seriously considered, none has been commercially adopted in the United States up to the present. It is of course desirable to create saleable byproducts at the same time that a step is taken to reduce the stream pollutional effect due to discharged organic compounds.

The "fruit water" typically contains about 1% solids and at most up to 3% solids. Nitrogenous compounds constitute about 60% of the total solids. Up to two-thirds of the nitrogenous constituents are free amino compounds and one-third is protein. The nonnitrogenous constituents of the "fruit water" are sugars, acids, inorganic salts, and a number of minor constituents.

In removing the nitrogenous constituents from the "fruit water", one can consider the alternatives of preparing a powdered concentrate containing several of the principal amino compounds or of isolating purified individual compounds. Laboratory studies have shown that ion-exchange is an effective method for separating amino compounds from the other constituents (4a, 4b). Certain of these free amino compounds, for example asparagine and glutamine, give some promise of finding medicinal applications. A concentrated mixture of the principal amino compounds, in addition to potential pharmaceutical uses, might also be of value as a nutritional supplement, food flavoring agent, or nutrient in industrial fermentations.

Another approach to the problem of utilizing "fruit water" constituents is to evaporate under reduced pressure most of the water to provide a liquid concentrate. It has been found possible to make a fluid, stable concentrate containing as high as 60% solids. It is apparently better, from the standpoints of stability and fluidity of the product, to remove the protein by heat coagulation before preparing the concentrate. We have information that such a concentrate containing all the noncoagulable soluble constituents of the "fruit water" should be useful as a nutrient in fermentations.

In some situations, starch factory operators may want to consider aerobic microbiological treatment of "fruit water" to reduce the pollutional effect of the organic constituents (6). While such a solution may not lead to a saleable byproduct, it can accomplish a great reduction in the B.O.D. (biochemical oxygen demand) of the waste. A similar fermentation is carried out commercially in the United States on milk waste (5).

Starch Fractions, Modifications and Derivatives

Potato starch fractions are available in the United States, but as far as the writer is aware, all of this material is imported from The Netherlands. Following extensive research in America and elsewhere, Dutch chemical engineers developed a successful process and built a plant that can produce sizable quantities of amylopectin and amylose daily. Production of corn starch fractions, using regular corn, was instituted in the United States in 1961. (Corn breeding research by industry in cooperation with the United States Department of Agriculture's Northern Utilization Research and Development Division and Crops Research Division has resulted in development of corn having starch containing 60—70% amylose; some experiments have yielded kernels containing starch having up to 70—80% amylose.) Uses for amylopectin and amylose are still largely in the experimental stage. Amylose derivatives are finding some use in industry.

Most of the potato starch is sold in the native, unmodified form. Sizable tonnages, however, are also converted annually into dextrins, pregelatinized starch, "thin-boiling" starches (by acid treatments), and oxidized or "chlorinated" starches (usually by treatment with sodium hypochlorite). The use of oxidized potato starch is on the increase in adhesive and sizing applications in which it is desired to have increased paste clarity and diminished tendency to thicken on cooling.

Oxidation of starch by periodic acid produces a specific type of oxidation to give "dialdehyde starch". Dialdehyde starch can be made economically by a process employing electrolytic regeneration of periodate; by regulating the extent of treatment, products can be formed that represent a wide range of aldehyde content. Dialdehyde starch is made commercially from corn starch in the United States but none from potato starch, according to the writer's information. Dialdehyde starch has yielded promising results experimentally in the preparation of high wet strength paper and in the tannage of shoe sole leather in conjunction with vegetable tannin.

Much research has been conducted on the production of starch esters, such as starch acetate, and on ethers, such as allyl starch and hydroxyethyl starch. A considerable tonnage of hydroxyethyl ether of potato starch is produced by two manufacturers in the United States, and this derivative has been imported from The Netherlands in large amounts for the past several years. Some derivatives, in which only a minor part of the hydroxyl groups of the starch molecule are substituted, are available that disperse in water to give pastes of unusually high consistency.

Starch phosphate is a new derivative in which there is much interest both in the United States and Europe. This derivative, now made on a pilot-plant scale, has a promising potential use as a thickener in sauces for frozen foods; the phosphate imparts a consistency that is stable against freezing and thawing.

Utilization of Potato Starch

American potato starch is used in its various outlets in approximately the following proportions, expressed in percentages: paper, 60; textiles, 30; food, adhesives and miscellaneous, 10. Since corn starch is by far the leading domestic starch in the U.S.A., potato starch generally has to offer some advantage in order for it to find use in a particular application.

During the period prior to World War II domestic potato starch nearly always sold at a higher price than corn starch. Imported potato starch at times sold at about twice the price of domestic corn starch. For many years this price relationship confined the use of potato starch to special applications in which its unique properties make it preferable. The availability of imported tapioca starch at a price generally competitive with corn starch was another factor limiting the demand for potato starch during the decade preceding World War II. Tapioca imports reached the high level of 433 million pounds in 1937, which can be compared with 685 million pounds of corn starch sold that year in the USA for use as starch (1). The demand for domestic potato starch in 1937, however, was sufficient to result in the sale of only 17 million pounds of starch.

Starch and derived products produced from corn in the United States in the 1959 calendar year amounted to the following in thousands of pounds (3): starch — 2,193,167; glucose sirup — 1,900,960; dextrose — 867, 250; dextrins — 195,198.

Most of the tapioca starch used in the United States during the 1930's was imported from the Netherlands Indies (now the Republic of Indonesia). Outbreak of the war in the Pacific late in 1941 cut off imports from this source. As a result of the expansion and modernization of the American potato starch industry started in 1938, the factories were able to furnish a sufficient supply of this starch for the most essential uses and to replace in part the unavailable imported root and tuber starches.

Following the close of World War II, importation of tapioca starch was resumed. Thailand and Brazil are now the principal countries that ship tapioca starch to the United States. While the annual amounts of tapioca starch imported into the United States are subject to considerable variation, the quantity has been below 200 million pounds in most of the recent years on which reports are available (2). This is still a large enough tonnage to furnish strong competition for corn starch and potato starch, particularly in paper sizing.

In recent years potato starch and corn starch have sold in the same general price range, with potato starch frequently cheaper. Much of the time in the past few years potato starch has sold at 5 to 7 cents per pound at the plant, but the 1961 potato crop surplus resulted in lowering this figure to $4^1/_2$ to 5 cents per pound. Because of the competitive situation, corn starch and imported starches have also been at lower price levels during 1961—62 than experienced in the immediately preceding years.

Paper

Potato starch is used for four purposes in paper manufacture: (a) beater sizing in which the cellulosic fibers are cemented together preparatory to sheet formation; (b) tub sizing, in which the preformed sheet is passed through a dilute size solution; (c) calender sizing, in which a smooth finish is imparted, and (d) surface coating, which is an optional step in finishing high-grade papers. Starches and dextrins are also used to a great extent in the United States in combining and sealing paperboard in the fabrication of folding, corrugated, and laminated "solid-fiber" boxes.

Cold-water-soluble potato starch is considered outstanding in its performance in beater sizing. This type of soluble potato starch, produced for many years in The Netherlands, is made by drum drying cooked starch.

Potato starch is well liked for use in coating smooth white paper. The unusually strong binding power of potato starch is an advantage here in holding the white pigments and clay. Potato starch has replaced much of the casein formerly used in paper coating.

Textiles

Most of the potato starch used in the textile industry is employed in the sizing of cotton, worsted, and spun rayon warps. In this application the starch tightly binds the loose fibers to the surface of the thread and thereby strengthens the warp to resist abrasion during weaving. Potato starch pastes penetrate farther before gelling than do cereal starch pastes and consequently impart added strength due to this property. The toughness and flexibility of potato starch film relative to other starches permits warps to be woven at lower humidity than would otherwise be possible.

The smooth clear pastes obtained with potato starch also have other advantages in warp sizing. The smooth finish on the warp is easy to remove in the desizing step. The low tendency of potato starch pastes to "set back" or retrograde to a gel is of advantage following shutdowns. Potato starch is used to a considerable extent in the finishing of cotton sewing thread and in cloth finishing. The smooth surface obtained on cloth provides a superior "feel".

Food

Much of the potato starch utilized in the food industry is used in bakers'specialty items, such as Swedish and German style breads, in crackers and in matzoth. It is also used as a thickener in soups and gravies.Potato starch has been pelleted successfully to make puddings similar to those ordinarily made from tapioca starch. Pregelatinized potato starch is used in considerable quantity in "instant" puddings, in which its properties are preferable to those of cereal starches. The dry formulation of instant puddings is principally soluble starch, sugar and flavoring. Upon addition of cold milk, the starch quickly dissolves and then sets to a gelled pudding.

Potato starch is used in the confectionery industry for the following purposes: (a) as a medium for molding cast candies such as jelly beans, "orange slices" and gum drops; (b) as a bodying agent and to impart smoothness and stability to caramels and marshmallow; (c) as a thickening agent in synthetic jellies; (d) as a dusting agent, perhaps mixed with powdered sugar, for candy gums, chewing gum, etc. Thin-boiling starch rather than thick-boiling starch (unmodified) is ordinarily used as an ingredient in candy manufacture.

Adhesives

Although some potato starch used in adhesives is of the thin-boiling and oxidized modifications, most of it is used in the dextrinized form for this purpose. It is a well known fact that films of dextrins made from root and tuber starches, such as tapioca, sweetpotato and potato, have greater flexibility and resistance to checking than dextrins of cereal starches. Potato dextrins are used in many applications in which their specific properties make them desirable; for example, as a binder in sand paper, abrasive cloth, bookbinding and rug sizing, each of which requires a dextrin of high paste tackiness and of flexible residual film. Potato dextrin films are also outstanding for their ease in remoistening; this property is desired in mucilages used for gumming stamps, labels, envelopes, paper tape, etc.

Miscellaneous Uses

There are a number of miscellaneous uses of starch that cannot be classified under the general categories discussed above. Examples of these uses include utilization of starches as (a) hygroscopic additive in baking powder; (b) fermentation raw material; (c) binder for tablets; (d) binder and extender for sausages; (e) builder for soap; (f) separator in dry cell batteries; (g) raw material for nitrostarch manufacture; (h) consistency stabilizer for oil well drilling "muds"; (i) attractant in insecticidal mixtures; (j) boiler feed water treating agent; and (k) clarifying agent for waters used in mining operations. The miscellaneous uses of potato starch undoubtedly include some of these listed. Manufacturers and distributors of potato starch, for business reasons, hold as confidential information concerning some of the lesser uses of their product.

Outlook for Potato Starch

The American potato starch industry has made great strides during the past 20 years in providing its consumers with more and higher quality starch than heretofore available. The established uses for potato starch support a constant demand for the product. It is impossible to predict exactly how fluctuations in the size of future potato crops may affect the volume of starch production. However, many leaders in the potato industry believe that there will be closer grading of tablestock potatoes in the future along with marketing agreements that permit shipment of only the better grade potatoes to the food market. This should tend to provide an adequate supply of culls even in years of only moderate volume of potato production. Continued growth of the potato starch industry depends primarily upon whether the manufacturers can continue to match the competition of other starches in quality, supply, and price.

Summary

The development and present status of the American potato starch industry are discussed. This industry uses cull and surplus potatoes of the same varieties as used by the food trade. The 21 plants in Maine have a combined productive capacity of about 334 tons of starch per day; the 9 plants in Idaho have a total daily capacity of about 276 tons; the combined daily capacity of the 4 plants in Colorado, Washington and North Dakota is about 119 tons. The total annual capacity for potato starch production in the U.S.A. is about 290 million pounds, based on a 200-day campaign. Up to the present, however, the largest amount ever producted in one season was about 155 million pounds.

The methods and equipment used in the more modern American plants are quite similar to those used in the European plants. Sizable quantities of the starch are converted into dextrins, acid-treated starch, and oxidized starch. A considerable amount of hydroxyethyl starch is now being produced in the U.S.A.

The extracted potato pulp is dewatered and dried for use in animal feed. Experiments have been made in the preparation of liquid concentrates and in the recovery of amino compounds from the processing water ("fruit water,,), but this is not yet done commercially.

American potato starch is used in its various outlets in approximately the following proportions, expressed in percentages: paper, 60; textiles, 30; food, adhesives and miscellaneous, 10.

Zusammenfassung

Die Entwicklung und der gegenwärtige Stand der amerikanischen Kartoffelstärkeindustrie werden besprochen. In dieser Industrie werden minderwertige und überschüssige Kartoffeln der gleichen Sorte verwendet, die auch als Speisekartoffeln gehandelt werden. Die 21 Fabriken im Staat Maine besitzen eine Produktionskapazität von insgesamt etwa 304 t pro Tag, die 9 Betriebe im Staat Idaho haben eine tägliche Kapazität von ungefähr 251 t, und die Kapazität der 4 Anlagen in Colorado, Washington und North Dakota beträgt insgesamt etwa 109 t. Unter Zugrundelegung einer Kampagne von 200 Arbeitstagen beträgt die jährliche Produktionskapazität für Kartoffelstärke in den USA ungefähr 132 Millionen kg. Bisher war jedoch 70 Millionen kg die größte Menge, die jemals in einer Kampagne erzeugt wurde.

Die Verarbeitungsmethoden und die in den modernen amerikanischen Betrieben eingesetzten Maschinen sind denen der europäischen Fabriken ähnlich. Ein sehr großer Teil der erzeugten Stärke wird zu Dextrinen, säureabgebauten Stärken und zu oxydierter Stärke verarbeitet. Darüber hinaus werden heute in den USA beträchtliche Mengen an Oxyäthylstärke erzeugt.

Die ausgewaschene Kartoffelpülpe wird entwässert und für die Verwendung in Futtermitteln getrocknet. Es sind Versuche angestellt worden zur Gewinnung von flüssigen Konzentraten sowie in der Abtrennung von Aminoverbindungen aus dem Fruchtwasser, doch konnten bisher noch keine wirtschaftlichen Verfahren entwickelt werden. Der Absatz der in Amerika hergestellten Kartoffelstärke verteilt sich auf die einzelnen Gebiete nach den folgenden angenäherten prozentualen Anteilen: Papier 60, Textilien 30, Lebensmittel, Klebstoffe und verschiedene andere Anwendungsgebiete 10.

Résumé

Le développement et l'état actuel de l'industrie américaine de l'amidon de pommes de terre sont discutés. Dans cette industrie, on utilise les mêmes pommes de terre de qualité basse et les pommes de terre de surplus que dans le commerce du provisionnement. Les 21 usines en Maine ont une capacité de production totale d'environ 334 tonnes courte d'amidon par jour; les 9 usines en Idaho ont une capacité totale d'environ 276 tonnes courte par jour; la

capacité totale des 4 usines en Colorado, Washington et North Dakota est d'environ 119 tonnes courte par jour. La capacité annuelle totale de production d'amidon de pommes de terre aux Etats-Unis est d'environ 132 millions de kilos; cette figure est basée sur une saison de 200 jours. Jusqu'à présent, la production maximale achevée en une saison a été d'environ 70 millions de kilos.

Les usines modernes américaines emploient des méthodes et équippement semblables à ceux en usage en Europe. Des quantités assez fortes d'amidon sont, converties en dextrines, en amidon traité à l'acide et en amidon oxidé. Des quantités importantes d'amidon hydroxyéthylé sont produites maintenant aux Etats-Unis.

La pulpe de pommes de terre extraites est déshydraté et saiché pour emploi en nourriture d'animaux. Des experiences ont été faites sur la préparation de liquides concentrés et sur le recouvrement de produits aminés de l'eau du procès; mais ceci n'a pas encore été commercializé.

L'amidon de pommes de terre américain est utilisé en differentes façons dans les proportions approximatives, données en pour centages, de: papier, 60; textiles, 30; nourriture adhésives et miscéllannées, 10.

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(Arrived: 10. 3. 1962)