MANUFACTURE AND USES OF STARCH.

A most valuable paper on this subject was recently read before the London "Society of Arts" by Dr. F. Grace Calvert, F. R. S.; and as the manufacture of starch is carried on very extensively in this country, we will present the substance of the paper for the benefit of all interested.

At the beginning of the present century, starch was only used for dressing linen in private houses; now it is employed for a great many purposes, and one single print-works in the city of Manchester alone uses no less than 300 tuns of it annually. It is a most important food for man, yet it is often associated in plants with acrid poisons. Starch is thus associated in the wild chestnut; and in the root of the manioc it is mixed with prussic acid. The natives of the West Indies have found that, by heating the roots of the manioc, the prussic acid is dispelled, and the starch retained in the form of tapioca. It is an interesting fact that, although the globules of starch vary in size from the 1,000th to the 300th part of an inch—as in the case of potato starch—still, they are all of the same composition when pure and dried at 220° Fah. All starches except inuline give a blue color with iodine, and, strange to say, this color disappears when starch and iodine are heated together in a solution, but returns when it becomes cool. This blue is very beautiful, and M. Payen, of Paris, has lately succeeded in rendering it permanent. This is done by mixing some starch with ammonia-oxyd of copper, and allowing them to remain in contact for several hours, when the excess of copper is washed away, and a green precipitate is left behind. This is now boiled in water, and a solution of iodine added, when a splendid purple precipitate is formed,

The globules of starch, when heated in water, swell and burst, and they are then found to be composed of successive concentric layers, which have different degrees of solubility. Starches absorb a great deal of moisture from the atmosphere; that which is made from potatoes, when kept in a damp place, generally contains from 25 to 45 per cent of water. It is an easy matter to find out when potato starch contains much or little moisture. Thus, by placing starch on an iron plate heated to 212° Fah., if it contains only 18 per cent of moisture it will move about quickly; but if it contains 35 per cent, it will agglomerate and form into hard lumps. On the continent of Europe, great quantities of potato starch are now manufactured into artificial tapioca; and many persons, while they suppose themselves to be enjoying a rich tapioca pudding, are feasting on the product of the potato.

M. Niepce de St. Victor, of Paris, has recently made the curious observation, that when paper is saturated with starch and exposed to the rays of the sun, the starch is slowly converted into sugar. Diastaste, which exists in all grains—and especially in malt—possesses the same property in a high degree, particularly at a temperature of 150° Fah. This temperature should never be exceeded by brewers with malt in their mash tubs, as it annihilates the converting power of the diastaste, and causes serious loss.

One of the greatest triumphs of chemistry applied to physiology has been the discovery of diastaste in the saliva and pancreatic juice in the human system, by which the starch which is taken as food is converted into an isomeric substance called glycogene, which is stored by the liver, and is then converted (according to the requirements of vitality) into sugar, and then carried by the circulation of the blood into the capillaries, where it is converted into water and carbonic acid, producing the heat necessary for the maintenance of life. Chemists have also discovered the presence of starch in the skeletons of the *invertebrata*, such as the *crustacea* and several insects.

Starch presents a great similarity of composition to the fibers of plants, such as flax and cotton; and when it is treated with concentrated nitric acid, it is converted into a fulminating substance called "xylodine," which is similar in its nature to gun cotton.

Sago starch is made from a tree which grows to about 30 feet in hight. It is cut down, then cleft longitudinally, and its pith washed through a sieve. The water carries through the starch, which falls down in a deposit in shallow wooden vessels; then it is collected in lumps and dried in the sun, after which it is reduced to a coarse powder, when intended for exportation.

The manioc root, from which tapioca starch is made, is first grated into a pulp with water, and in this state submitted to a heavy pressure, which squeezes out a large quantity of prussic acid—a deadly poison. The pressed pulp is now placed on warm iron plates, and dried into what are called "cassava cakes," which are used for common food by the people. When intended for tapioca, the pulp of the manioc is not pressed; it is simply heated on hot iron plates, by which it is reduced into quite a soluble condition, and is formed into small lumps. The heat drives off the prussic acid as effectually as pressure.

Inuline starch, which is made from the roots of dahlias, has not yet been applied to arts or manufactures; but it deserves attention, as when boiled in water it does not form a gelatinous mass or coating like other starches. Dr. Calvert does not state to what purposes it would be most applicable; but, owing to the difficulty of cultivating these roots in England, as well as in the northern sections of this country, cheap starch could not be made from them. In California, however, where they are very prolific, they can be cultivated as economically as potatoes, and inuline starch may be made from them at no great expense.

The starch in wheat is associated with gluten which is the azotized substance that determines the nutritive value of flour. Until recently this has been considered a waste product in starch factories, but it has now been applied to calico-printing in Great Britain, as it has been discovered that under certain circumstances gluten is soluble in a weak alkali, and it is used as a substitute for albumen in fixing the beautiful French purple—mauve color—on printed muslins. The two principle substances of wheat—starch and gluten—are used in calico printing for mixing with the colors, the one as a fixing agent, and the other as a substitute for natural gums.

The usual mode of obtaining wheat starch is to place flour, or crushed wheat in large tubs or vats, containing a suitable amount of water, then allow it to enter into fermentation and continue this for several weeks according to the temperature of the atmosphere. In the winter season, this is carried on in heated apartments, where the fermentation continues without interruption. The putrefaction of the gluten of the wheat generates a very offensive odor in starch factories, and the fermentation produces a foul acid called *sour water*. This sour water contains alcohol, acetate of ammonia, acetic and lactic acids, bisulphate of lime, and decomposed gluten. The fermentation which first occurs in making starch is the vinous, which is carried on at the expense of the sugar and a certain portion of the starch. By this action carbonic acid, and some alcohol are formed, the latter remains in the liquor, the former passes off. The alcohol is transformed under the influence of the oxygen of the air and the gluten, into acetic acid, and it is by this acid conjointly with the lactic acid that the complete separation of the starch and gluten in wheat is effected in the vats. The ammonia comes from the decomposition of the gluten; the lactic acid is a secondary product arising from the starch. But the fermentation and the acids are not sufficient to remove or destroy the whole of the gluten which usually forms a layer on the top of the starch called *slimes* and *flummery*. This is employed in England for making pastes for calico printing; in America for feeding pigs The slimes are removed from the starch by washing and passing the liquid through seives, but formerly the starch was simply allowed to gradually settle to the bottom of wooden boxes. In present American practice, the starch water taken from the vats is allowed to flow slowly down a set of shallow wooden pans, like gold-washers' raffles, which have strips of wood nailed across their bottoms, forming a sort of stair. In passing over these the starch is deposited more rapidly and a greater quantity of it is also obtained, and what is perhaps more important, the different qualities are separated by the operation.

The starch is now lifted in seives, or drained by being placed in boxes having cloth bottoms. After this it is broken in masses of about six cubic inches each, wrapped in paper and placed into heated rooms, where these masses split up into the thousands of irregular pieces well known to every person. All kinds of starch do not assume such forms; that made from potato and such bulbous roots do not.

[To be continued.]

A COLUMN OF VARIETIES.

If apple trees are set 2 rods apart, an acre will contain just 40 of them; but if they are set only 30 feet apart, they will stand at the rate of 48.4 to the acre. An acre will contain 160 peach trees, a rod apart, and 193.6 if set 15 feet apart. If an orchard is set with apple trees, 30 feet apart, with peach trees between the rows, both ways, there will be 48 apple trees and 147 peach trees in an acre.....In the engineer's report to the trustees of the Philadelphia gas works, it is stated that the largest quantity of gas made from each pound of coal, for any full day's work, was 4.74 feet. This would give 9,480 feet to the tun of 2,000 pounds, which, at $2.50, the price of gas in New York, would amount to $23.70 cents. One retort will produce 7,000 cubic feet of gas per day.....The *Irish Country Gentleman's Newspaper* states that about one-third of Ireland is arable, one-third is pasture, and the remaining third consists of bogs and irreclaimable mountain wastes.....In the English agricultural papers are advertisements of a great company in London, who manufacture manure from blood. They state that the number of beasts, sheep, horses, calves, and pigs slaughtered in London, in 1856, was 821,705; that the yield of blood from these was 802,000 gallons, of which Odams' Blood Manure Company received 771,000 gallons.....Mr. Fairbairn has calculated that the greatest clear span at which an iron tubular bridge would support its own weight would be between 1,800 and 2,000 feet..... The Westminster bell, after being cast, required a fortnight for cooling .....£4,000,000 in value of guano are estimated to be used annually in Great Britain.....The reflection of the sun's rays in a mirror has been distinguished at a distance of twelve miles.....Watt's engines, as left by him in Cornwall, consumed 10 lbs. of coal per horse-power, per hour.....Professor Faraday has stated that an oxy-hydrogen light, displayed on the Scotch highlands, was distinguished at the distance of upwards of 90 miles..... With a given amount of brake power a train running at 40 miles per hour will run four times farther before being stopped, than it will at 20 miles an hour.....Mr. Fairbairn's experiments show that a train moving at 20 miles an hour on a level, may be stopped, by means of continuous brakes, in a distance of 72 feet, and at 60 miles an hour, in a distance of 636 feet.....If a water joint is made between an iron and a brass surface, a galvanic action is set up, which frequently eats the iron surface full of holes. If iron is cast upon brass, as it may be, no action of this kind ensues.....By recent returns it appears that the average duty of the pumping engines in Cornwall, England, has fallen off from 53,000,000 lbs. raised 1 foot by a bushel (94 lbs.) of coal—the average result attained twenty years ago—to 43,800,000 attained by the same fuel in 1858.....Mr. Hugh Taylor, M. P., has stated that some years ago he employed eighteen sailing colliers in the London coal trade. The aggregate cargoes of these vessels averaged 54,000 tuns annually. The same amount of tonnage is now carried by two steam colliers of 800 tuns each.....The total number of steam vessels owned and registered in Great Britain on the 1st of January, 1859, was 1,854; including the colonies, the number was 2,239, of a tunnage of 488,415. Of the 1,854 British steamers, 992 are of iron, 861 of wood, and 1, the *Rainbow*, of steel. 1,263 are propelled by paddles, 589 by screws, and one, the *Great Eastern*, by combined screw and paddles.....The total tunnage of the United States amounted, in 1858, to 5,049,807 tuns, of which 729,390 tuns consisted of steamers..... The first iron steamboat built on the Thames was the *Daylight*, constructed by Ditchburn and Mare, of Rotherhithe, in 1838. At the time Mr. Ditchburn undertook to substitute iron for wood in the construction of steam vessels, he was regarded by the profession as laboring under a mental hallucination.....A 600-tun wooden ship, after being three years afloat, will absorb, by soakage, from forty to sixty tuns of water, increasing the draft from six to nine inches, thereby increasing the positive resistance and reducing the speed.....Water-tube boilers were made as early as 1836, by Mr Spiller, and applied by him to the London and Westminster Company's boats.....The highest proportion of power to tunnage, in a large steam vessel is furnished by the *La Plata*, of 2,404 tuns and 1,000 horse-power.....A yacht, of which the hull was constructed of copper, was made about 100 years ago, for the grandfather of the present Marquis of Anglesea.