THE TALLOW TREE AND ITS USES.

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The botanical characters of this member of the *Euphorbiaceae* are too well known to require description; but hitherto no accurate account has been published of its various uses. Although it has become a common tree in some parts of India and America, its value is appreciated only in China, where alone its products are properly elaborated.

Analytical chemistry shows animal tallow to consist of two proximate principles—stearine and elaine. Now, what renders the fruit of this tree peculiarly interesting is the fact that both these principles exist in it separately in nearly a pure state. Nor is the tree prized merely for the stearine and elaine it yields, though these products constitute its chief value; its leaves are employed as a black dye; its wood is hard and durable, and may be easily used for the blocks in printing Chinese books and various other articles; and, finally, the refuse of the nut serves for fuel and manure.

The *Silingia Sabifera* or tallow tree is chiefly cultivated in the provinces of Kiang-se, Kiang-nau, and Chih-kiang. In some districts near Hang-chau the inhabitants defray all their taxes with its produce. It grows alike on low alluvial plains and on granite hills, on rich molds on the margin of canals, and on the sandy sea beach. The sandy estuary of Hang-chau yields little else. Some of the trees at this place are known to be several hundred years old, and, though prostrated, still send forth branches and bear fruit. Some are made to fall over rivulets, forming serviceable bridges. They are seldom planted where anything else can be conveniently cultivated, but generally in detached places, corners about houses, roads, canals, fields, etc.

In winter, when the nuts are ripe, they are cut off with the twigs by a sharp bill hook attached to the extremity of a long pole, which is held in the hand and pushed upwards against the twigs, removing at the same time such as are fruitless.

The harvesting accomplished, the capsules are taken and gently pounded in a mortar to loosen the seeds from their shells, from which they are separated by sifting. To facilitate the separation of the white sebaceous matter enveloping the seeds, they are steamed in tubs having convex, open wicker bottoms, and placed over caldrons of boiling water. When thoroughly heated they are mashed in the mortar and then transferred to bamboo sieves, kept at a uniform temperature over hot ashes.

As a single operation does not suffice to deprive them of all their tallow, the steaming and sifting is therefore repeated. The article thus procured becomes a solid mass on falling through the sieve, and, to purify it, is melted and then formed into cakes for the press. These receive their form from bamboo hoops, a foot in diameter and three inches deep, which are laid on the ground over a little straw. On being filled with the hot liquid, the ends of the straw underneath are drawn up and spread over the top, and, when of sufficient consistence, are placed with their rings in the press. This apparatus, which is of the rudest description, is constructed of two large beams placed horizontally so as to form a trough capable of containing about fifty of the rings, with their sebaceous cakes. At one end it is closed and at the other adapted for receiving wedges, which are successively driven into it by ponderous sledge hammers wielded by athletic men.

The tallow oozes in a melted state into a receptacle where it cools. It is again melted and poured into tubs smeared with mud to prevent adhering. It is now marketable in masses of about eighty pounds each, hard, brittle, white, and opaque, tasteless, and without the odor of animal tallow. Under high pressure it scarcely stains bibulous paper; it melts at 104° Fah. It may be regarded as nearly pure stearine; the slight difference is doubtless owing to the admixture of oil expressed from the seed in the process just described. The seeds yield about eight per cent of tallow, which sells for about five cents per pound.

The process for pressing the oil, which is carried on at the same time, remains to be noticed. It is contained in the kernel of the nut; the sebaceous matter which lies between the shell and the husk having been removed in the manner described, the kernel and the husk covering it are ground between two stones, which are heated to prevent clogging from the sebaceous matter still adhering. The mass is then placed in a winnowing machine precisely like those in use in Western countries. The chaff being separated, the white oleaginous kernels are exposed, and, after being steamed, are placed in a mill to be mashed.

This machine is formed of a circular stone groove twelve feet in diameter, tapering at the edge, and is made to revolve perpendicularly by an ox harnessed to the outer end of its axle, the receiver turning in a pivot in the center of the machine. Under this ponderous weight, the seeds are reduced to a mealy state, steamed in tubs, formed into cakes and pressed by wedges in the manner before described, the process of mashing, steaming, and pressing being likewise repeated with the kernels.

The kernels yield about thirty per cent of oil. It is called *tsing-yu*, and sells for about three cents per pound. It answers well for lamps, though inferior for this purpose to some other vegetable oils in use. It is also employed for various purposes in the arts, and has a place in the Chinese pharmacopoeia because of its quality of changing gray hair to black, and other imaginary virtues. The husk which envelops the kernels and the shell which encloses them, and their sebaceous covering, are used to feed the furnaces; scarcely any other fuel is necessary for this purpose. The residuary tallow cakes are also employed for fuel; a small

quantity of it remains ignited a whole day. It is in great demand for chafing dishes during the cold season.

Finally, the cakes which remain after the oil has been pressed out are much valued as a manure, particularly for tobacco fields, the soil of which is rapidly impoverished by that plant.

Burnt Iron and Burnt Steel.

Iron which has been damaged by reheating is designated "burnt iron" by the workman, who also gives the same name to iron which has been excessively heated and exposed in the puddling furnace after balling. No amount of heat applied to iron in the blast furnace or in the early stages of puddling produces burnt iron.

Burnt iron is brittle, its fracture is short, it displays the so called "crystalline" structure, and it has lost the fibrous structure and silky fracture of good iron.

When steel has been raised to a yellow or white heat and then suddenly cooled, it becomes brittle and no longer capable of tempering, is worthless for the ordinary uses of steel until again raised to a welding heat, and rolled or hammered and allowed to cool gradually. Burnt steel has a coarse granular fracture, the facets of the granules being, for the most part, either rounded or conchoidal. The conchoidal facets serve practically as a distinguishing characteristic.

I have examined many samples of burnt iron and find in all of them some particles of black oxide, more or less abundantly diffused throughout the mass of iron, suspended or entangled within it. I find no such particles of oxide in burnt steel, nor any other indication of internal oxidation of iron.

Important practical decisions often depend upon the determination of whether certain defects of particular samples of iron are due to burning or to other causes. I have devised a very simple means of answering this question. I take about a decigram of fresh borings or coarse filings, put them into a dry narrow test tube, then pour upon them about three centimeters of nitric acid diluted to sp. gr. 1.20. If the iron is burnt, the particles of dark oxide become separated from the metallic iron as it dissolves, and are suspended in the liquid, rendering it dark and turbid. They ultimately disappear and are thus distinguishable from particles of carbon, etc. This action is easily recognized by treating equal quantities of borings of burnt and good iron simultaneously in the same manner, and comparing.

I find that ordinary sound wrought iron contains a small quantity of carbon, the most important function of which appears to be to prevent burning by its reducing agency. As soon as the carbon is removed, oxidation commences when the iron is heated, and this oxidation is not merely superficial but extends throughout the mass. The higher the temperature and the greater the amount of exposure to the atmosphere while heated, the greater is the quantity of carbon required for protecting the iron. This is, I believe, the reason why all attempts to make merchantable iron by the Bessemer process are a failure. The high temperature and the violent exposure of melted metal to the air forced through it causes oxidation of the iron to commence even in the presence of much carbon. This oxidation or burning of the iron commences in the Bessemer converter, when the proportion of carbon is brought down to about 0.25 per cent. 0.20 per cent, may be stated as the practical minimum to which it is possible to bring down the carbon of Bessemer metal without destroying malleability, but this is rarely reached. About 0.28 is the lowest ordinarily aimed at by the manufacturer.

I find that iron attains its maximum toughness, when it is otherwise pure, and its carbon is reduced to the lowest possible proportion without oxidation of the iron commencing.

Thus the success of the maker of armor plates, ship bolts, etc., depends upon his skill in exactly touching, without passing, the point at which the oxidation of carbon ceases, and that of the iron is about to begin. By skillfully conducting his last reheating processes by means of a reducing flame, he is able to work down to the lowest possible trace of combined protecting carbon, and thus obtain the maximum of toughness and extensibility.

I find, as a result of a large number of varied experiments, that whenever steel is raised to any temperature above the lowest visible red heat, and more or less exposed to the action of atmospheric air, its carbon is oxidized with a rapidity proportionate to the temperature and degree of exposure. These experiments have extended through a series of various conditions, from low heat and closed annealing furnaces to the great heat and excessive exposure of the Bessemer converter. This oxidation occurs not only at the surface, but proceeds inwards. It is now well known that certain gases can pass readily through heated iron, and thus the permeation of the oxygen and exclusion of the carbonic oxide no longer presents a difficulty. I, therefore, explain the structure and properties of "burnt steel" as the result of suddenly solidifying it, from the viscous condition which it attains at a welding heat, and thereby imprisoning the carbonic oxide evolved by the oxidation of the carbon. By slower cooling, the carbonic oxide would have become either occluded or expelled. This explanation accords with the fact that burnt steel may be cured, as above stated, by welding up the cavities or "toads' eyes," as the workmen call them, which are visible on the fracture of such steel. These, according to my explanation, are the minute bubbles formed by the carbonic oxide suddenly arrested in various stages of evolution or collapse.

According to the above, the workmen's term "burnt" is not correctly applied in either case, the rottenness of both the iron and the steel being caused by the presence of intermingled particles of combustion-products breaking the continuity of the metal. The carbon is burnt in the case of the

"burnt steel," the iron itself in the "burnt iron."—*Journal of the Chemical Society.*

Light, Heat, and Electricity from Motion.

The celebrated Jacob Perkins when in London, in 1837, exhibited at the Adelaide Gallery the phenomena produced by the contact of soft iron with steel in motion, and which he described at the time as follows:

"The action of a soft iron disk upon hard steel, such as a file, is exhibited four times a day. This has been regularly kept up for three years, yet it has undergone very little wear. I am of opinion, in fact, that if the file had never been held upon it until it had attained its full velocity, there would not have been any loss of metal. I do not know to what extent the combustion of steel by soft iron may have been carried in the United States, but our experiments are so brilliant as to excite the highest admiration, and to induce numbers to repeat their visits to the Gallery. Our disk is a foot in diameter and an eighth of an inch thick. It requires about a three horse power to drive it, and revolves about 6,000 times in a minute. It is very accurately fitted up with friction wheels. The blaze of light, which rises about 12 inches, perpendicularly, from the point of contact, is so vivid that few persons can look steadily at it even at noon day. The stream of light is about an inch and a half thick at the distance of a few inches from the point of contact; and at the distance of 7 or 8 feet, it spreads out to about 10 inches. The sparks not unfrequently touch the ceiling, which is about 20 feet high; a ring of fire is seen all around the disk, appearing like a band of light about five eighths of an inch wide. Of what does this light consist? It is manifestly different from that of the sparks, which all fly off in a tangent. In operating with the disk, it never becomes warm; the file, however, has to be held at least two inches from the sharp end, as it becomes highly heated. The whole appearance, in fact, is very interesting, and when fully investigated, I am well convinced that some of the phenomena will be found to depend upon electricity."

Brandy from Wood Shavings.

C. G. Zetterlund has been making some experiments in the distillery at Hulta to make brandy out of shavings. For this purpose, they were boiled in an ordinary kettle under a pressure of 0.116 kilograms of steam to the square centimeter. There was then put into the kettle: Shavings (pine and fir, very wet), 9.0 cwt.; sulphuric acid, 1.18 sp. gr., 0.7 cwt.; water, 30.7 cwt.—Total, 40.4 cwt.

After boiling eight and a half hours, the mass of shavings contained 3.33 per cent grape sugar, and after eleven hours cooking, 4.38 per cent. A farther increase in the quantity of sugar could not be attained. There was obtained in all, from the 40.4 cwt., about 1.77 cwt. of grape sugar, or 19.67 per cent of the weight of the shavings. The acid was neutralized by lime, so that the cooled mash ready for fermentation contained one half degree of acid, according to Lundersdorf's acid tester. The mash had a temperature of 30°C. when the yeast prepared from only 20 pounds of malt was added. At the end of 96 hours, the mash had done fermenting, was then distilled and yielded 61 quarts of 50 per cent brandy at +15°C., perfectly free from all flavor or smell of turpentine, and of a very pure taste.

It is more than probable that the manufacture of brandy from shavings on a large scale would succeed if it were ascertained, by experiment, with how much water the acid must be diluted, and how long it must be boiled, for both of these circumstances exert a great influence over the production of sugar.

If it were possible to convert the whole of the cellulose in the shavings into sugar, each hundred weight of air dried shavings would yield about seven gallons of brandy of fifty per cent. The shavings of the leaf bearing trees would probably give the best results.—*Journal of Applied Chemistry.*

EFFECTS OF FROST ON PLANTS.—It has been a disputed question whether plants, killed by frost, die in freezing or in thawing. That the former is the case, at least in some cases, has been satisfactorily demonstrated by Professor Göppert, of Breslau. The flowers of certain orchids, as, for example, the milk white blossoms of *Calanthe veratrifolia*, produce indigo, but only by a chemical reaction that takes place upon the death of the parts. When they are crushed, or the vitality of the cells is otherwise destroyed, they turn blue at once. Now this change of color occurs immediately upon freezing, which proves that life then ceases. Certain other species are said to show the same thing.

A FRENCHMAN named Wilbaux has taken out a patent to use an elastic type for printing on glass, with fluor spar rendered adhesive by some such material as printing ink. Sulphuric acid of suitable temperature is then allowed to act on that portion of the glass. The hydrofluoric acid generated in this way would etch the glass on the places printed on. When completed, the whole is washed off with warm water or lye.

TO KEEP GUM ARABIC FROM MOLDING.—Solutions of gum arabic soon mold and sour, and finally lose their adhesive property. It is said that sulphate of quinine will prevent this, while it imparts no bad odor of its own. The addition of a solution of a few crystals of this salt to gum arabic will prevent the formation of mold quite as effectually as carbolic acid, and by analogy it is safe to suppose that the same salt could be used in writing ink, mucilage, and possibly glue.