

**TAPIOCA
AND ITS
MANY USES**

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FOR MALAYA**

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A Reprint of articles contributed to the
"Pina Gazette"

BY

LEOPOLD ES CHASSERIAU

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TAPIOCA AND ITS USES.

BY LEOPOLD ES-CHASSERIAU.

No stone should be left unturned to supplement our rice shortage after receiving such timely warnings during the past year of an impending food crisis. That is why, Mr. Editor, at your special request, I here-with send you these few notes on tapioca. This contribution, the outcome of many years' experience and research, is about a subject I investigated thoroughly under its various aspects, first of all in Singapore with my father who was considered a tapioca planter of some distinction. He himself opened the two well-known Malakoff and Alma Estates in Province Wellesley. On the last named Estate we grew and manufactured tapioca for a good many years prior to the rubber boom, and later on in Kedah. Moreover, as we were anxious to get fuller information about the peculiarities and properties of the tuber with a view to making it a good commercial product, we visited Java Sumatra, Borneo, Cochin-China and Siam and we got into touch with many friendly planters in different parts of the world, all of whom displayed great keenness in exchanging views on a topic of common interest.

It is owing to the kindly assistance of these co-workers, that we were able to collect and collate these various notes and I am very glad to offer them to-day for the perusal of the inhabitants of this country, through the medium

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of the *Pinang Gazette*, hoping that they will be useful in helping to a solution of the present food problem.

It ought to be noted, as this is a matter of moment for Malaya where tapioca is grown on such a large scale, that it is used by natives in many tropical countries as their staple food. Tapioca provides a sure crop; it flourishes well in lands extending as far as 30 degrees on either side of the Tropics and it has been calculated that more than one million people consume about 1,000 grams of tapioca for their daily subsistence. The same process of analysis which shows that the grain crops of the north produce a food perfect for the needs of a cold climate also shows that in tapioca, we have the food fitted by nature to meet the needs of a hot climate.

SPECIES AND VARIETIES OF TAPIOCA.

We shall pass rapidly in review the different species and varieties of tapioca in order to come to the important question of its uses as a foodstuff, the various methods of its preparation as such and that of its derivatives.

At first, it is essential to distinguish clearly between the different species of tapioca, notably the one directly used for food, (the sweet tapioca,) so as not to confound it with the bitter kind which contains poisonous principles. The latter has no culinary value until deprived of its objectionable juices by mean of a process to be referred to subsequently. The bitter tapioca, when changed into a commercial product, is known as tapioca, flake, pearl, flour, etc.

For a very long time most botanists, Grisebach amongst others, taught that there were only two varieties of tapioca emanating from one single species; nowadays two principle species are known to exist with their many varieties. The two principle species of tapioca: (1) the bitter or useful tapioca *Manihot utilissima*. (2) the sweet tapioca *M. Aipi*. We shall confine ourselves to describe these two types, but shall note, as we go along, the peculiarities of the varieties and sub-varieties.

BITTER TAPIOCA.

The so-called bitter or useful tapioca is a lactescent plant with big, thick tubers, of a cylindrical and somewhat elongated form which are very rich in meal, containing a milky juice which is yellow, and very bitter. The stems are usually ten feet in length consisting of many ramifications, twisted in appearance and of a yellowish brown colour. The leaves, which are alternate have three, five or seven lobes and have a beautiful dark green colour above and white underneath. Every part of this plant emits a special odour similar to the aroma of bitter nuts. Its small flowers, always found in clusters, are yellow and unisexual. Its grains are black or marble-like and remind one of those of the castor oil plant. The roots are analogous to those of the dahlia and have the same morphological properties due, no doubt to an active principle they contain manihotoxine. This first species of tapiocas, just described, gives a far better return than the second.

SWEET TAPIOCA.

The sweet tapioca is also a plant, the tubers of which are thick, elongated and rich in meal; the main difference between the two species lies in the fact that the roots of the latter are red and contain a non-poisonous juice. The stem which reaches an average height of six feet is furnished with knobs; the petioles are red in colour. The leaves, made of five or six lobes are of a fine green hue and are much larger than those of the bitter sort. The fruits are slightly angular at the top and have no wings. The tubers are edible and take a shorter time in cooking than the bitter ones. The Muller tapioca or "purple top" is known in the Malay Peninsula as "obi kayu merha" and the Baillion tapioca or "pink top" as "obi kayu pouti merha" and "obi puteh alban"; these three kinds, grown in northern Malaya, together with the "obi merha" Batavia, the "obi puteh" Malacca and "obi" Singapora, these last three found in the southern Settlements, are the only ones that can be eaten without any danger of poisoning.

WHERE GROWN.

Tapioca grows in all tropical and sub-tropical countries, but is more productive in lands within a short distance from the sea. In highlands the sweet tapioca thrives much better than the bitter kind. It comes to maturity even on mountains 3,000 ft high but its growth cannot compare with that of the lowland where it is more prolific and matures earlier. Tapioca should not be raised on low ground.

as too much moisture, or too rich soil, or over-fertilization tend to an over-production of stalk.

TAPIOCA GROWN AS A FOODSTUFF.

Tapioca can be made as important in the tropics, as corn and potatoes in milder climes. It is a vegetable food par excellence, well-known in America, many centuries ago where it caught the attention of the early Portuguese navigators who imported it into the Black Continent in the XV century. It is a plant of reserve, providing a sure crop against famine in all hot countries where rice has periodical failures. In Indo-China tapioca is grown concurrently with rice in provision of an unforeseen shortage of food-stuff, though the latter crop forms the usual diet of the native. In countries where locusts pay regular and unwelcome visits, or where monkeys, rats, etc., abound, tapioca is the only plant left intact and respected by these pests in spite of the fact that they play great havoc with every other vegetable in its propinquity.

From an industrial standpoint, tapioca is the plant of the future; its trade seems capable of large extension and might before long transform some of our local industries seeing that it is now in such a great demand in Europe as well as in America. Its role as a foodstuff is indeed a very extensive one. Used as a vegetable, by most Indian tribes in America, by the natives of Africa and Asia it plays exactly the same alimentary part with them as bread and potatoes do in Europe. Its methods of preparation are various but it has one slight drawback which is to require the accompaniment of sauces and hot condi-

ments to give it a flavour. The juice contained in the tuber is of special industrial value as it enters the composition of sauces and alcoholic beverages.

VARIOUS USES

The young shoots, boiled in water make an excellent vegetable. The young leaves of the sweet tapioca, when boiled and seasoned or fried with butter make a wholesome dish very much like spinach. Tapioca flour has excellent keeping qualities and if placed in a dry receptacle without being hermetically closed will keep for a year or more; like every other flour, it has sundry uses; it is made into bread, cakes, porridge, etc..

Steerage passengers on board French liners belonging to the well-known "Compagnie des Chargeurs Réunis" have their daily ration of 600 grams of rice made good by an equivalent quantity of tapioca and this change was solely made at the special request of African native travellers who profess great fondness for this food. Tapioca meal or pomace is very often made into an industrial substance called tapioca, but in countries where it grows in abundance, it is kept in its original form until required for the table. As a manufactured product it makes a very light food, easily digested and well suited for the feeding of infants and invalids. It acquires its highly digestible qualities from the change wrought through the action of heat on starch which becomes partially soluble in water and this solubility adapts it as a food to the weakest stomachs even when the digestive organs seem to have proclaimed a life-long strike.

METHOD OF PREPARATION.

The preparations of tapioca used in its natural form as a foodstuff differ in every country. In Madagascar, tapioca is the common food of the Malgache who starts its preparation by peeling the tuber, cuts it next into slices which are dried in the sun; when the watery substance has been wholly evaporated, the slices turn white and can be consumed at this stage or after boiling in water. Another preparation called "Vonidraigia tapioca" is concocted in the following way: after peeling, the tubers are put in a bag and kept moist for three consecutive days at the expiration of which they become black and a beginning of putrefaction sets in; it is just the time when the native eats them with meat, fish, salt, etc. Like the potato, the tubers of the sweet tapioca are sometimes baked under hot ashes, roasted on burning coals or boiled in water. On the Western coast of Africa, when tapioca is prepared according to the two latter processes, it is called "haipin."

Brazilians, after boiling their tapioca tubers, add to them beans and air dried meat to make their favourite dish "Carna Secca."

In the United States and in Boston in particular, Jamiaca cakes are in great favour and are invariably served with tea, café au lait, chocolate, jams, etc.

In India and in Malaya, the Tamil cooly shows his fondness for the tuber by making frequent raids on it either during the night or even during a short interval of leisure in his working hours and disposes of

it expeditiously after the manner of the four-footed gentry.

Baked in an oven, tapioca has an exquisite flavour and in many Eurasian households and Malay Kampongs very tasty cakes, made of tapioca, sugar and cocomilk are prepared.

HINTS FROM OTHER COUNTRIES.

Locally grown trapioea is converted into the following products : (a) top flour, conac, cassava, moussache, cassareep. (b). Alcohol, beer, bitters, alcoholic beverages. (c) Commercial products other than tapioca and meal. Tapioca flour of the choicest quality is the principal substance necessary for the making of good porridge which is termed "langon, matele, matalise, etc, if a little addition of sugar is made to it. The well-known Brazilian "Cariman" is no other than a mere concoction of this superior flour into their usual form of tiny balls. In Brazil, top flour is prepared in a quaint way at first, the tapioca roots are soaked in water for five or six days after which they are ground and squeezed in water. Decantation follows next to expel the liquid. The meal or pomace is dried, strained and finally buried until it starts fermenting. At short intervals some fresh dough is added. This preparation takes the name of "water manioc" or moist flour."

In Western Africa the tapioca roots are macerated for three days; they are next ground in water and after decantation, are dried in the sun.

IN MOZAMBIQUE.

The natives scrape the tubers by means of large shells before drying them in the sun ; they are then ground with rollers, roughly covered with nails and the pulp obtained in this way is put into bags and sent to the press. The juice obtained from the pulp leaves a sediment which is broken before being spread on hot copper plates. Here is another preparation : the pulp obtained after the manner just described, is put into a bag made of palm-fibres which is hung by the top while a weight is suspended to the bottom in order to force out the juice which is white and poisonous.

According to Mr. Seurat, in Tahiti, tapioca meal is prepared in the following way. They begin by soaking the tubers in cold water for two or three days, the object of which is to facilitate the peeling off of the skin which is done by rubbing the roots with the fingers. The tubers deprived of their rind, are next washed and ground, the latter operation being done by a small sheet of corrugated iron perforated with many holes made by a nail. When flour has been obtained it is placed in a piece of cloth and squeezed into a wooden receptacle of an elongated form ; a milky but poisonous juice flows out containing meal in suspension. The liquid thus gathered rests for many hours while the meal sediment collects at the bottom of the trough. The water which is decanted contains the poisonous juice of the roots ; the meal is dried in the shade and after special preparation is made into tapioca and starch.

IN JAVA.

Tapioca is exploited in a simple way ; the stalks are cut close to the ground and the roots unearthed. The latter are peeled, washed in flowing or limpid water and ground. The pulp is worked in a tub full of water until a clarified liquid flows out through pressure. This is compressed in a piece of linen disposed above a tub where the exuding liquid is left to stand for some time so as to allow the sediments to settle. After twenty-four hours, the liquid begins to ferment and is decanted on the third day thus leaving the meal at the bottom of the tub. This product is exposed to the rays of the sun for three days and stirred from time to time in order to dry it thoroughly. Small native producers sometimes sell moist meal to industrials who make it undergo supplementary treatment. In Chinese owned factories, tapioca is manufactured by means of hydraulic machines. The grater is armed with long nails and the pulp is carried by a strong current of water into a tilting strainer, octangular or hexagonal in shape and covered with fine galvanised wire gauze or a special cloth or linen. This strainer turns slowly and receives on its surface a weak but steady flow of water which carries away all diluted sediments while the pulp falls out through the other end. Little by little the meal settles after which it is carried to the drying-kiln where the greatest care must be taken to avoid burning the flour.

In our local commerce there are two varieties of flour according to the colour and grain. The first quality is snow-white

and fine and the second though white has a little tinge of brown and a less refined grain. The great openings for this product are the United States, England, France and Holland.

Java exports the tubers cut in slices and dried, this being the mode of preparation in demand with certain flour manufacturers and in breweries.

BRAZIL.

In Guiana and Brazil, Tapioca is made into comestible flour by a rudimentary method though somewhat long and complicated. They begin by scraping and peeling the tubers which are next washed and grated on a board bristling with small nails. The grated pulp is left to stand for twenty four hours after which it begins to ferment; the pulp is afterwards put into a specially made basket, long and cylindrical in form, a known as the "adder." One end of this peculiar contrivance is fixed to a post or tree as a suspensary point while the other end is drawn away by a weight proportionate to the effort to be obtained. As a result of this kind of compression, the tapioca juice flows through the basket buckram as a whitish liquid. Once the pulp is deprived of its juice, it is dried in the sun and ground by means of rollers covered with nails or in vertical grindstones. The flour obtained in this way is edible and must not be confounded with meal. It has sundry uses like the flour of cereals, though unfortunately it does not keep longer than two or three days. All these primitive and spasmodic modes of procedure have been perfected by modern industrials in Brazil.

and the United States, and it would appear that their whole attention is fixed on tapioca meal on which lies the future of the tuber. In India, the grating of tapioca roots is done by a board covered with pieces of quartz imbedded with resin and the process is called "Simarri."

In the Congo, tapioca tubers are peeled, grated and sent to the press after which the pulp is washed several times. The flour obtained is extremely fine; it is stirred at short intervals when drying in the sun and the cyanic acid is eliminated by evaporation through the action of heat. The milling is done by a vertical grind-stone which takes the place of the grater. As previously mentioned, the nations of Africa and America use flexible baskets to press tapioca pulp, obtaining thereby a whitish poisonous juice. This liquid is not thrown away as one might be inclined to imagine; as it is very rich in tuber latex and therefore in starch the cassipa, as it is now called, is collected in decantation tubs where the meal settles.

The meal is then washed in lemon water followed by one or several washings in pure water. Choice starch is obtained in this way, well known as the "arrow root of Brazil," "mousssache," etc. After starch extraction, the poisonous liquid under the name of cassareep has further industrial uses. Moreover the pulpy substance remaining in the flexible baskets is made into couac or cassava by special treatment.

COUAC,

To produce Couac, the tapioca pomace is dried, ground and passed through a coarse sieve—an ordinary mason's sieve does

well—to separate the particles and remove the small portions of roots that were not properly grated. The flour is then spread evenly on the surface of the pan kept continually stirred by means of wooden rakes so as to equalize the temperature when it will have a rich brown or white appearance slightly tinged with yellow and form crisp sweet-smelling grains. A small amount of salt is added to the flour while it is being cooked in the pan. During the process of manufacture, the poisonous principle still existing in the flour is removed by evaporation and the fumes may be distinctly detected by smell as they rise from the pan. If this is successfully done as soon as water is applied to the flour, it will commence to swell to many times its original bulk and makes a nutritious, wholesome food. If improperly cooked, the flour will swell very slightly, if at all, and have a raw, insipid taste. Couac, which is the staple food of the natives in Guiana, can be preserved a long time in a dry condition. In case its quality leaves much to be desired, it makes an excellent stock feed and above all a choice food for fowls.

CASSAREEP.

Cassareep is made by simply boiling down the poisonous juice from which starch has been extracted until it becomes of the consistence and appearance of molasses. As the juice contains so much prussic acid, the greatest care should be taken to keep it away from children and animals until it has undergone the process of boiling. When boiled, it is the chief ingredient in many kinds of sauce in general use such as "the pepper-pot of the West Indies," "the

cabion' of Guiana," "the tucupi" of Brazil etc. Its antiseptic properties make it extremely valuable for preserving meat in a fresh condition for considerable periods. According to Mr. Bisley it makes good medicine for ocular affectations such as ulceration of the cornea, ophthalmia of newly-born babies, etc. The cabiow of Guiana is made from Cassareep to which is added some "cipipa" or fine tapioca starch, salt and spice. If cassareep and its derivatives contain a little cyanic acid, the result of perfunctory preparation, they might be the cause of dangerous complications and a well-known antidote is the use of red pepper diluted in rum.

CASSAVA.

Instead of being transformed into meal like couac, cassava is made into biscuits, cakes, pancakes, etc. Cassava which is either white or yellow is preserved for a long period in a dry condition. In Porto Rico, they call it tapioca flour and in Trinidad it is known as Cassada or yucca flour. Excellent cakes and pancakes can be made from cassava. On a hot metallic plate, a ring of the same diameter and thickness of the cakes is placed; a little cold water is diluted with flour which is deposited in the ring. As soon as the substance has gained some consistency, the ring is taken off and the cake turned upside down so as to bake the other side, after which it is dried in the sun. These cakes which are delicate and appetising owe their solidity to the ring which keeps together the starchy particles when in the baking. In Madagascar two kinds of

cassava cakes are made some of which are preserved for five or six months if well baked in an oven.

TAPIOCA BREAD.

In Porto Rico it goes by the name of Indian bread and to prepare it some corn flour is mixed up with cassava. In the basin of the Amazon, the staple food of the native is bread made of tapioca flour mixed with maize flour. Tapioca bread requires lukewarm water for its preparation which is not the case with cakes in the making of which cold water is essential.

In the Reunion and Mauritius Islands tapioca boiled in water and well seasoned is sold at the rate of two pieces for a penny; it is a little commerce taking the place of our local "apom" sellers and other tit-bit hawkers.

TAPIOCA SOUP.

The coarse flour obtained in the conac preparation makes nutritious and wholesome soup; the flour which is yellow or white swells a great deal when diluted in warm water.

TAPIOCA STEW.

Tapioca makes excellent stew either by itself or together with meat, potatoes, artichokes, etc and compares favourably with the continental ragout or the delicious Irish stew.

TAPIOCA CAKES.

To prepare a tapioca cake, dilute, say, two pounds of flour with water, seasoning same with salt, sugar and butter in reasonable quantities; add to it

four eggs; when the dough has been thoroughly mixed, place it in a receptacle for baking in an oven.

TAPIOCA PUDDING.

To make puddings, take half-a-pint of flour to which add three times its quantity of water; allow it to remain for about half-an-hour, taking care to stir it frequently. Add one pint of milk in which whisk three eggs; add sugar and spice to taste. After mixing thoroughly, the cake is baked in an oven about 30 minutes.

FRITTERS

To make fritters take half-a-pint of flour: add five parts of milk, one egg, sugar and spice to taste. Before serving, sprinkle a little sugar over them.

POORIDGE

A very simple way of preparation is to place two table spoonsful of flour in a-half-pint of water. After soaking for 20 minutes, boil for five minutes in half-a-pint of milk or water and serve the porridge.

CHOICE TAPIOCA CAKES.

Soak 500 grams of tapioca flour in milk towards evening; next morning, add butter, two eggs, two pounds bitter nuts, one gram of powdered canella or cinnamon; mix well and place in a buttered mould for baking. Unmould the cake only when nearly cold; add to it raisins or prunes. This cake has the reputation of being exquisite.

Tapioca is eaten either cooked or raw, its leaves being used to prepare various sauces. In the Senegal, tapioca leaves are consumed under that.

name, boiled in water or with sauce ; they are cut up like spinnage which they resemble very closely and are easily mistaken for such by more than the uninitiated. In Brazil, tapioca flour soaked in fresh water makes the common food. A well known Brazilian pancake called beiju is made by simply kneading tapioca flour with water. To replace oatmeal in Brazil, tapioca flour is made into a substance known as Cari-man. In the lower Dahomey where the staple food is maize and tapioca, the native is quite satisfied with boiling a tuber in water or roasting it on coals. Occasionally it is grated, made into a kind of dough and eaten while raw. The national drink is the calouiou which is generally composed of smoked fish cooked in palm oil made pungent by pimento and aromatic herbs. The Okassa is steeped to this drink which has the appearance of a viscid sauce.

CABIOU.

This dish, prepared in Guiana, consists in thickening cassareep by means of a pipa (fine tapioca flour, obtained from tapioca water after settling); salt and pimento come also into the operation.

CHIKWANGUE.

Tapioca bread is thus designated by the natives in the Congo who take it with palm oil and spice, but Europeans living in those districts prefer frying slices of it in butter and sprinkling them over with sugar.

TAPIOCA CAKES MADE WITH COCO MILK AND SUGAR.

In India, Eurasians make tasty cakes by diluting tapioca flour with cocomilk and sugar. In Guiana the ration of a work-

man per meal is 300 grams of either couac or rice and 300 grams of salt meat.

ON THE IVORY COAST.

Tapioca is a great asset as a foodstuff not only to the natives but even to Europeans living in those regions as the following quotation taken from the report of the Ollone Mission testifies (1898 1900)—“Owez le manioc nous faisions des croquettes savoureuses et ces feuilles remplacent les epinards.”—Ol. Chevallier, the great explorer says that no food can compare with the “fou ou of Dabou” (Mission 1909).

ALCOHOLIC BEVERAGES.

Tapioca roots are much used by Indians for preparing various national drinks which do not always agree with the European palate. In Tahiti, distillers produce alcohol from couac and is in great demand for making brandy. Years ago in America, they had a very strange way of preparing alcoholic beverages; tapioca cakes being masticated by a number of coolies, the product was thrown into wooden troughs to ferment and it seems that the liquor resulting from this process had not always the same blend.

In Peru, Sweet potatoes and tapioca are distilled into mazza to.

In Guiana the distillation of fresh tapioca pulp and sweet potatoes, which is allowed to ferment for forty-eight hours, makes a beautiful drink called cachery. In Brazil cachery is obtained by the fermentation of beiju water in baked tapioca cakes; this liquor has not a very attractive appearance and contains very little alcohol though it has all the effects of stronger drinks.

Vicou is the result of distilling a fermented dough, made of tapioca, potatoes, sugar and water into an acidulated beverage, refreshing and agreeable to the taste.

Payá is the produce of baked cassava dough and sweet potatoes through distillation and is easily mistaken for white wine.

Among beer-producing countries, Brazil has a comparatively large number of breweries. Brazilian beer, known as "caouin" or "obationy" is made from tapioca and maize and is much sweeter than that made from maize alone.

COMMERCIAL PRODUCTS OTHER THAN MEAL AND TAPIOCA.

The value of tapioca as a crop for the manufacture of starch and glucose, dextrine and other products derived from starch, is unequalled by any other crop per acre. An analysis of the dry tapioca root realizes 80.06 per cent of starch.

Raw Irish potatoes realize from 7 to 15 per cent, starch and maize or corn realizes 81 per cent. The quality is the potato starch is inferior to that from tapioca, the starch grains averaging seven times the size of those obtained from tapioca. Tapioca starch which is of a superior quality is extracted from the meal; the grains are hard, having little or no elasticity and are in part soluble in cold water. I herewith append an analysis of dry tapioca tubers. Starch 84.05, albuminoids .35, ash .39 water 15.21. From a ton of tapioca meal, 500 pounds of starch, designated "Cissipa" when of choice quality, are derived.

CISSIPA.

For its manufacture, water is added to grated tapioca dough before passing it

through a common sieve. This mode of washing is repeated several times, taking care to use a sieve of finer mesh on each occasion. After the last washing and sieving, the starch is carried away into decantation tanks where it is collected for drying in the sun.

In perfumery manufactures the "tapioca rose powder" is derived from sieved starch very finely coloured with cochineal which is made sweet smelling by means of perfumes.

PAPER MAKING

Tapioca starch mixed with some alum is of capital importance for sticking paper when in the making, either in the vat or in the form of dough. The starch which is dilated by the alkali and heat divides the soapy matters and spreads it evenly. A reaction takes place owing to the presence of alum resulting in an adhesive soapy product which is insoluble and in getting intermixed with the dough makes impermeable paper.

GLUCOSE

Tapioca starch occasionally takes the place of potatoes and maize in the fabrication of this viscid constituent called glucose. Commercially it is accepted that 100 parts of fresh tapioca tubers yield 30 parts of glucose. This product results from the transformation of tapioca starch by an acid which changes it into three different forms: starch syrup, sugar loaf, refined sugar. The same process will do for the three products. At first, starch is saccharified by sulphuric acid in 33 parts of hot water kept at a temperature of about 104°. According to Payer, 42 pounds of sulphuric acid are

necessary for 2,000 pounds of starch. Before the transformation takes place it is of capital importance that starch be diluted in five times its weight of water. The ceasing of the reaction can be plainly detected when the blue colouration produced by iodine is no longer seen. In order to separate the sulphuric acid from the liquid, about 40 or 45 pounds of chalk are added to the substance; a sulphate of chalk is thereby formed and is easily isolated by settling. The amount of sugar in Glucose is only one third of that obtained from sugar-cane. Glucose is used in the form of syrup, in the preparation of beer, alcohol, fruit preserves, Jams, etc.

TAPIOCA MUCILAGE

Here is an easy method of preparing this product. Take a fresh tapioca tuber of about one pound in weight. Peel and grate it after which dilute the pulpy substance in two and a half quarts of water; put the mixture into a receptacle and place it over a fire where, as it starts boiling, stir it for four or five minutes; take it off the fire adding to it little by little about 15 or 16 grams of alum in a well pulverized form; Keep on stirring the various substances until the whole becomes translucent. This mucilage has the reputation of being second to none.

GENERAL CONSIDERATIONS

Tapioca came originally from Brazil and is now widely spread all over the tropical and sub-tropical regions. In olden days, bitter tapioca was known as *juca armaga* or *mangieba* and sweet tapioca as *juca dulce* or *juca doce*. According to some ancient authors there were six varieties of tapioca.

cultivated in central America when the first Spaniards visited those countries and only one of these belonged to the sweet kind. Pohl supposes that the *Manihot* possibly may be looked upon as the stock from which all varieties of tapioca are derived. The natives of central America, have, from times immemorial drawn their vegetable food from this robust plant and even after the arrival of the white man it remained the staple of the population. Does it not seem strange to find a poisonous plant drawn from a vegetable family of poisonous plants so useful from an alimentary view point?

Mr. Sagot, in a report made to the Société Botanique de France in 1871 on this very subject said: "It is highly probable that the poison of bitter tapioca is an organic compound of little stability, hurtful by itself, but dangerous as it produces, in certain circumstances, prussic acid. The leaves of tapioca, when rumpled will emit a light odour of bitter nuts and the formation of prussic acid has been plainly observed in chemical researches connected with the tapioca tuber. This ought to explain the following puzzling facts: how tapioca water is a poison, how distilled tapioca water is a much stronger poison, how tapioca water boiled for some time and skimmed is harmless as it is used for food by the Indians in Guiana and Brazil; how grazing animals are sometimes poisoned by eating the leaves and roots of tapioca while at times no harm befalls them. It is quite obvious from the latter case that if the quantity taken be moderate and immediately the gastric juice reacts very strongly no prussic acid is produced."—For

centuries the properties of tapioca have been known in hot countries and various methods of preparation have been adopted to fight its bad effects. This robust plant has such a high nutritious value and the service it has rendered humanity in years of plenty or dearth speaks volumes for its cultivation as a foodstuff and its development as a commercial product. It is estimated that the native of Guiana who depends mostly on tapioca for his subsistence partakes of about 750 grams daily. Considered the most nutritive and most widely spread of colonial plants, tapioca has suddenly risen into prominence within the last few decades and the great progress it has made is chiefly attributed to its new uses in European industries. It differs from a few tropical plants in so far as it brings in an immediate crop and it might interest some readers to know that a large Malayan Rubber Estate valued at 2,500,000 dollars has been entirely paid for by its crops of tapioca (this has been published by the "Tropical Agriculture" a few years before the war). It is a unique plant, not only as regards its crop which never fails but it knows no sickness able to diminish or destroy its return; every insect and every animal, the wild pigs excepted, respects it; the natives hold it in high esteem almost amounting to veneration and is well acquainted with its cultivation.

This plant has then many advantages and an interest in its culture ought to be a palliative to the fears and nervousness of shareholders equally interested in colonial enterprises of long expectation such as teal coffee, cocoa, rubber, vanilla, etc., where

the virtue of patience forms the keynote. The evergrowing consumption of tapioca in Europe and in America is a good omen and at the present time the only problem confronting growers and manufacturers is to produce it as cheaply as possible without interfering of course with the large profits accruing to both grower and European consumer. We know that the tuber produces meal of the choicest flour that can be turned to so many uses, cheap alcohol that could yield additional gains if it were turned to better account.

Referring to tapioca, Mr. Prudhomme, the well-known engineer agriculturist said : " Up to the present day tapioca constitutes one of the principal food-producing plants of the equatorial zone; it has risen in certain regions (Straits Settlements, Reunion and Brazil) to the rank of an industrial plant for the production of meal and tapioca. It has a marvellous growth and moreover no sickness and no insects are known to affect it seriously ; its having undergone its probationary period is beyond doubt or question being so well-known to the natives in various countries and one could easily without much fear of blundering point out the soil that suits best, estimate approximately the output per acre and the time of maturity, etc. The solution of tapioca cultivation was reached centuries ago and the tuber may be grown on a large-scale in hot countries provided sufficient labour be available for such a purpose.

Placed in reasonable hands, no fear ought to be entertained for the success of its culture. There are other equatorial plants equally important but which are insufficiently known and sometimes cause the greatest

anxiety to planters owing to the presence of sickness which appear to threaten seriously the future of the enterprises. The cultivation of tapioca has then indisputable advantages in that respect and may, in the long run, surpass other colonial concerns." In the past, tapioca planters have been greatly handicapped through lack of modern machinery for manufacturing flake, tapioca and flour and have applied to inventors and engineers in vain for such improved artificial means, capable of replacing or reducing the large gangs of coolies necessary in the present system and thereby curtail expenses while improving the output in quantity and in quality as the sale of these products is well-nigh unlimited.

We are glad to say that with the co-operation of a few friends we have been able to produce an automatic machine that will answer the pressing needs of the tapioca manufacturer; we had it carefully examined by an expert engineer in Paris who was a few years back one of the brightest students of l'Ecole Polytechnique and after adding a few improvements surnamed the new apparatus "l'Ideal", inferring that no better one could be found.

This new machine has the great advantage of dispensing with about 60 per cent. of the labour required under the old system, while turning out a superior product so that it should be the source of enormous profits if only placed under judicious and intelligent supervision.

IMPORTANCE OF TAPIOCA MEAL OR POMACE.

The making of Tapioca meal is a matter of material importance just now ; not only because it will provide a cheap nutritious and wholesome food for the people ; but it will provide the means for storing the special products that are raised here in helping to supplement our rice shortage.

The question that naturally suggests itself is, why has tapioca meal not been made here already, especially when it is known that there are so many persons in this country (where it is largely manufactured and used) who understand its preparation ? The reason that chiefly operates in the fact that tapioca meal can only be made in the tapioca meal pan. All attempts to make it differently have utterly failed. The pan has to be of a capacity capable of manufacturing the meal on a fairly large scale.

But when it is borne in mind that the people could prepare their cassava at home, and within three hours after taking it to the pan, have it in a condition ready for food, it can plainly be seen what facilities a pan provides for those unable to procure one for themselves and will not refrain from incurring the expense of buying and erecting a pan.

A man can rise in the morning, and by the next, can have his flour made and stored. Very often indeed, after being grated and pressed by the Indian method of paited reeds, the cassava is immediately cooked for use or storage.

DESCRIPTION OF TAPIOCA MEAL PANS.

The pan is made of iron, circular in shape of 7 feet in diameter, open at the top, with slightly bevelled sides six inches deep. The bottom of the pan is level, and is about one and a quarter inches thick, in order to better retain the heat. The pan has arms which rest on a brick foundation. A brick wall nine inches thick surrounds the pan and projects in a level shape four inches above the rim of the pan. This is done to prevent the meal splashing over while being stirred. It is hung two feet six inches from the ground, so as to be at a convenient height for a man to lean over and stir the meal. On one side is an aperture for firing and opposite a couple of bricks are removed from the wall for letting out the smoke ; no chimney is needed.

HOW TAPIOCA MEAL IS MADE AND USED.

In the manufacture of the tapioca meal, a grater is necessary, which is constructed as follows :—

On a wooden wheel, 2 feet in diameter, is raised a strip of Muntz Metal or any other strong metal nine inches wide, with rough edged perforations half an inch apart. The wheel has a crank axle attached to a treadle, so that a man may set the wheel in motion with his foot, and, holding the tuber in his hand, press it from a feeding board against the revolving wheel and thus reduce it to coarse meal, which falls into a trough placed underneath for its reception.

A press is also required to force out the poisonous juice from the meal immediately after the grating is over. This is made in

the following way. The bag of grated cassava is placed on the top of a barrel or box which has holes bored in it. A plank having one end fixed to a post or tree is laid lever fashion across the bag, with weights attached to the other end, and the bag as a fulcrum. A weight of 56 lbs resting for 12 hours on 100 lbs of grated cassava is sufficient to express the juice.

METHOD OF MANUFACTURE.

So much for the apparatus needed. We will now proceed to explain the method of manufacturing the meal, or pomace. The sooner the cassava is used after being dug the better, as the fresh cassava will give good sweet meal; all acidity must be avoided. The tubers should be scraped *not* peeled, with an ordinary knife. They are then grated on the machine before described and the grated material is put in bags under pressure, where it should be allowed to remain at least 12 hours. From the juice thus extracted, if allowed to settle, a small percentage of starch may be obtained and the remaining liquid can be made into cassarep after being thoroughly clarified. After the grated cassava has been sufficiently pressed it is taken from the bags and passed through a coarse sieve—an ordinary mission's sieve does well to separate the particles and remove the small portions of roots that were not properly grated. A wood-fire is now lighted under the pan, which is allowed to become slightly warm, great care having been taken to spread the fire under the pan so as to equalize the temperature. The cassava is thrown in and, by:

means of wooden rakes, it is spread evenly over the surface of the pan, the temperature of which is gradually increased by adding light fuel. The meal must be kept continually stirred until it is thoroughly cooked, when it will have a rich brown appearance, slightly tinged with yellow, and form crisp, sweet smelling grains.

THE PROOF OF SUCCESS.

During the process of manufacture the poisonous principle still existing in the cassava is removed by evaporation and the fumes may be distinctly detected by smell as they rise from the pan. Great care is necessary to properly cook the meal. If this is successfully done, as soon as water is applied to the meal, it will commence to swell to many times its original bulk. If not properly cooked it will swell very slightly, if at all, and have a raw insipid taste. A small amount of salt is added to the cassava, while it is being cooked in the pan. After it is cooked, the meal is again sieved and allowed to cool.

The success of making meal chiefly depends on preventing any acidity starting and the handling of the material in the pan so as to secure a uniformly cooked product; and not allowing the temperature to rise, while the meal is damp, high enough to destroy the grain of the starch.

A CHINESE METHOD.

The Chinese in Kedah simply tie a portion of meal in a loose piece of cloth which is immersed in water for one hour. It swells into a large ball-like plum pud-

ding and is eaten along with his fish or sugar as the case may be. Before placing it in the water he generally adds salt and spice to his taste. There are many other ways much more palatable, a great number of which we have already described in our former articles.

We may add that tapioca Meal or Pomace properly made has excellent keeping qualities and if placed in a dry jar, well covered, without being hermetically shut, will keep for a long time, at least one year.

SELECTION OF GROUND.

Tapioca should not be grown in swampy lands nor in dry or clayey soils which are deficient in humus. In sandy places, tapioca has a very poor growth except when it contains a fair proportion of loamy substances. Tapioca thrives best in new clearings independently of the nature of the soil; it is immaterial whether the land be sloping or flat, but the tuber shows great preference for newly opened places when it is remarkable for its stoutness. Grown in black soil, Tapioca develops robust stalks but at the expense of the tuber roots while in clayey soil, the yield is very limited. Tapioca dreads shady places and the more it is exposed to the rays of the sun, the better for its growth. It prospers practically everywhere, but fears strong winds owing to the fragility of the stalk, which should be pruned to about 2 feet from the ground in places where strong gusts of wind are of frequent occurrence and the labour is available for such a purpose.

PREPARATION OF THE GROUND.

In virgin soil, the following method is usually adopted. For the first year, the land is opened up and well changkolled to about a depth of 10 or 15 centimetres (10 centimetres almost 4 inches) when rice or any other cereal is sown, the harvest of which should compensate for the cost of the new clearing; moreover, the arable soil will be made movable while a rectification of the subsoil takes place. For the second year, the changkolling or ploughing should be carried to a depth of about 20 or 25 centimetres which is ample for the tapioca roots. In case the subsoil leaves much to be desired, it would be unwise to go beyond the first layer, for reasons which speak for themselves.

Every lalang root should be extirpated from where one intends to grow tapioca, as this weed affects the crop to a great extent. For the third year and afterwards manuring is essential. Tapioca grows very well all over Malaya from land at sea-level to mountains 2,500 ft high; it is planted at any time during the year, nevertheless as the young plant requires moisture in the first few weeks, preference is given to the beginning or the end of the rainy season.

Tapioca should not be grown in moist or swampy lands which are not systematically drained; if the draining is impossible, or too costly, the land should be devoted to a more appropriate crop.

METHODS OF PLANTING.

Tapioca is propagated by means of suckers or by short stump pieces of 4 or 5 inches in length, the latter

must come from the middle part of the stalk before the appearance of flowers. The sections used for planting are cut clean by sharp knives to avoid breakages which cause them to rot. Finally, the suckers are made ready just previous to planting as they dry up very quickly.

There are many methods of planting Tapioca. 1st, the Malgachi method, 2nd, the Eurasian or Brazilian method, 3rd, the Malay method, which is of three kinds. We shall confine ourselves to describe the third method as it is the most practical for the Malay Peninsula.

THE MALAY WAY.

In highlands, after the land has been properly prepared, directions are taken by means of a rope and small holes are dug in the ground in squares or quincunxially after the manner of rubber planting. The holes are 25 or 30 centimetres in diameter and about the same in depth. When the earth in these cavities has been well broken up, the tapioca stump pieces are put in, taking great care to place them in their normal position, that is to say, with the eye or seed bud upwards. They are partially or fully covered up, but in the latter case the budding process is very slow. The stump pieces used for planting are about 5 inches in length and come from the stalks of the previous crop; they are planted 3' by 2 $\frac{1}{2}$ ' in inferior lands and 6' by 4' in richer soils.

A second method is instead of digging small holes, as mentioned above, a long narrow cut in the earth is made with the

spade or plough and the stumps are buried in a flat position ; this process has the advantage of aerating the soil the whole length of the ditch but requires more hands at the work ; the stumps are placed $3\frac{1}{2}$ by $3\frac{1}{2}$ in loamy soil and $2\frac{1}{2}$ by $2\frac{1}{2}$ in poorer soil.

Yet a third way is adopted in lowlands ; beds are made ready somewhat like rubber nurseries $3\frac{1}{2}$ feet broad by $1\frac{1}{2}$ feet high ; the stumps are planted in such a way as the buds appear sideways above the bed while the tuber roots find their food elements underneath ; this method claims the advantage of preventing all destruction of young plants during the first weeding rounds. The buds make their appearance in about 8 or 10 days after planting, though the rhizomes make no headway until the stalks are about 3 feet in height. Many tapioca planters leave only 3 branches on the stem and keep pruning them to about 6 feet instead of 10 which is the normal height of the plant, thus increasing the tuber output. The roots grow very rapidly under this method. Care should be taken when planting to leave 2 eyes above the ground, and the most suitable time for the work is when the land contains a certain amount of moisture.

UPKEEP, WEEDING AND EMBANKMENT.

Tapioca requires very little care before reaching maturity ; if the soil demands it 2 or 3 forkings and the same number of Weeding rounds might be gone through with advantage ; the process of embankment, the favourite method of our local Chinese-gardeners, is also very useful. The first forking or weeding is done by hand about

one month after the stump starts budding ; this is repeated after two months. When tapioca is seven months old, it covers the ground and the weeds are marred in their growth by the shady leaves of the robust stem.

CROPS.

The tuber roots are generally found 2 or 3 together, sometimes five, six and even more, but one of them is always conspicuous for its stoutness among the rest. The roots are rough and dark in appearance while the second membrane is yellow or red. The tubers come to maturity in ten or fifteen months, everything depending upon the nature of the soil and the variety under cultivation ; but as a general rule, the longer the tubers are kept in the ground after the ripening stage the poorer they become in meal. The harvesting is a very simple one ; the stems are pulled up very lightly and the roots are unearthed. It is only when the soil is of clay that the gathering in of the crops may be more elaborate. The most propitious time for the work is at the close of the rainy season. As the tubers have a tendency to rot they should not be left lying about for a long time. Some planters are even of opinion that tapioca should be made use of on the very day of harvesting.

YIELD PER ACRE.

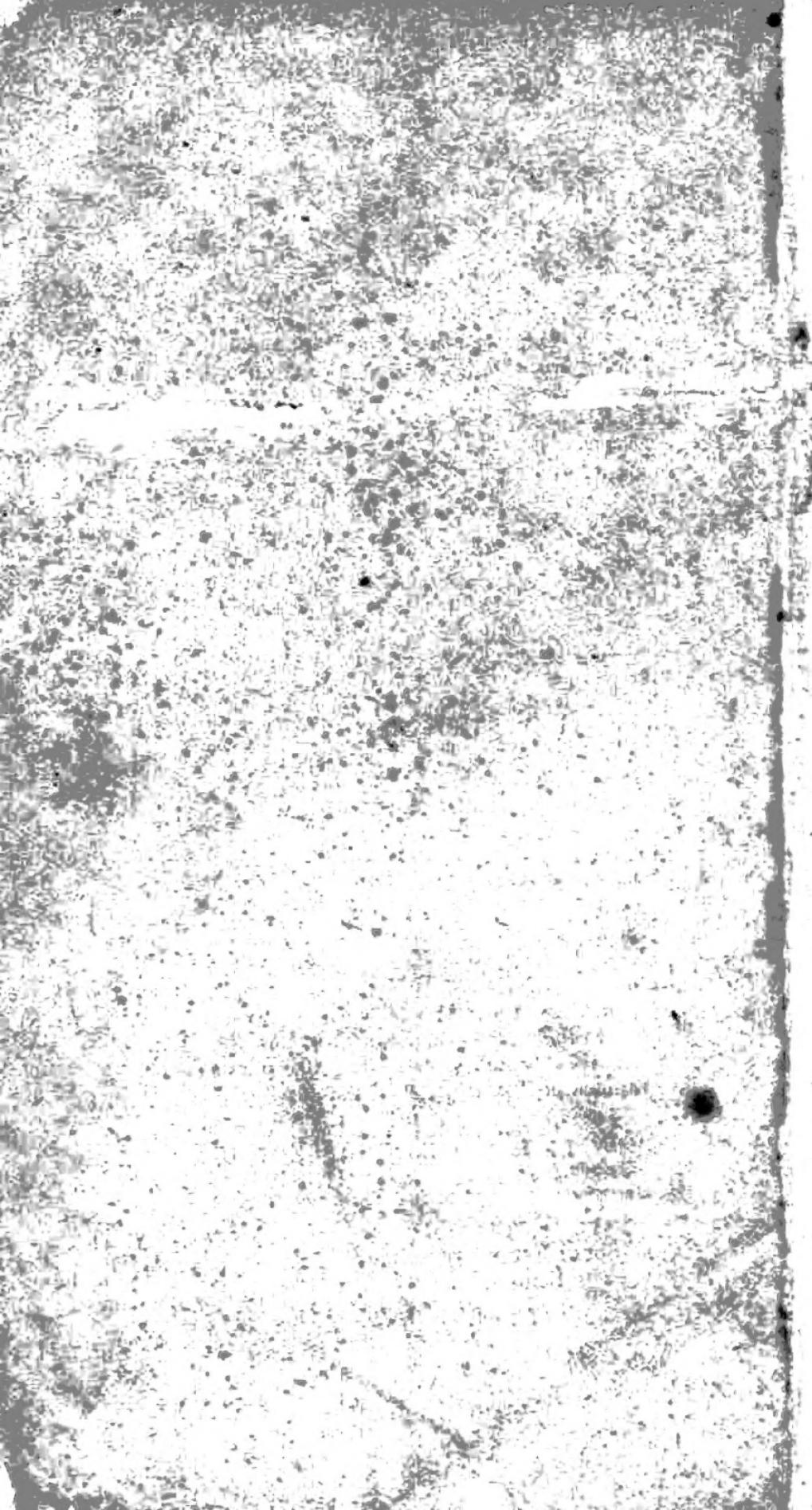
The number of tapioca plants per acre varies from 4,000 to 5,000 independently of the method adopted. Nevertheless these indications are in no way absolute and expert planters draw their own conclusions after giving due consideration to the

following points which are of capital importance in tapioca culture; nature of the soil, climate, altitude, rains, previous crops, variety grown, &c. The following is an example of tapioca return per acre in land of inferior quality. To make explanations clearer, we take it that the acre plot is an oblong 220-yds by 22 or 4,840 square yards. Tapioca is grown in small trenches a yard broad which would give 220 ditches of 22 yards long in the whole field in question. The distance between each tapioca sump is $2\frac{1}{2}$ ft so that the ditch will grow 25 plants or 5,500 stumps per acre. From an economical point of view, land which has been purposely cleared up for tapioca culture, should with advantage grow rubber or coco trees 30 feet by 30 feet taking care to leave a free space of about 3 or 4 ft on either side of the young tree. This will ensure the latter with full development, while the grower will gather in 3 or 4 tapioca crops during the first 3 or 4 years. According to the reasons set forth above, the maximum number of tapioca plants per acre is 4,000, each of which yield 5 to 8 catties of tuber, thus making 200 pikuls per acre. Every pikul of tuber roots turns out 15 to 20 catties of tapioca which comes to 30 pikuls of tapioca per acre.

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