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Botanical Medicine Monographs and Sundry

LABORATORY CONTRIBUTIONS FROM THE COURSE PREPARATORY TO MEDICINE IN THE UNIVERSITY OE PENNSYLVANIA.

BY PROF. J. T. ROTHROCK, M. D.

Read at the Pharmaceutical Meeting, January 15, 1884.

Mr. Thomas Ridgway Barker, in examining the ordinary liquorice root (*Glycyrrhiza glabra*) finds imbedded in parenchyma and in wood, bundles of bast fibres. These bundles have what may be called a bundle sheath in which are found crystals of calcium oxalate, shown to be such by the ordinary tests.

FIG. 1.

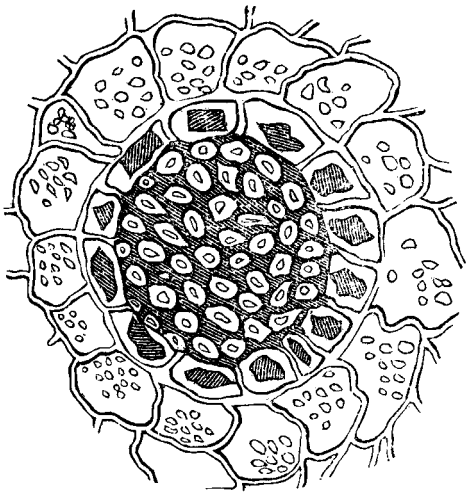


FIG. 2.

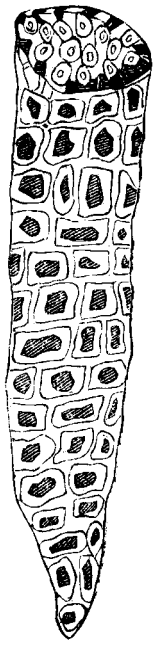


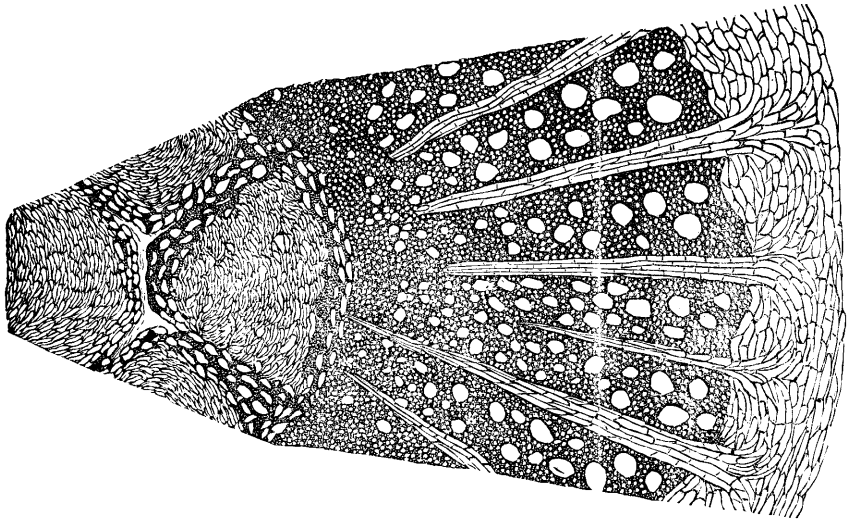
Figure 1 shows the bundle in the parenchyma, seen in cross section.

Figure 2 gives a longitudinal view of the same, divested of its surrounding parenchyma. Figures are magnified about 350 diameters.

Such crystals and crystal sheaths are not unique. They are found in the Aspidosperma Quebracho, for which see the essay by Dr. Adolph Hansen, reprinted in the "Therapeutic Gazette," October, 1880, p. 292, and are also found in the stem of the anomalous *Welwitschia mirabilis*, for a figure of which see "De Bary Vergleichende Anatomic," p. 140. There is, however, this difference between the liquorice root and the other plants, i. e. in the former several fibres are included in a single crystal sheath, while in the quebracho and welwitschia there is but a single fibre.

Mr. Jesse G. Shoemaker contributes two diagnostic characters in the stems and roots (say one-fourth of an inch in diameter) of *Gelsemium sempervirens*, which so far as seen are peculiar in their association, and which hence are of positive value. The first is derived from the medullary rays. These usually widen in a marked manner, going from the centre to the circumference, being sometimes much more than twice as broad exteriorly as interiorly. The second character is the tendency of the pith to be penetrated by several plates of large, thin-walled cells, which divide the pith more or less perfectly into four portions. This latter character, though as far as observed it varies considerably in the relations of the large cells and the ordinary pith cells, is always present and plainly enough marked to serve as a means of diagnosis. Tests upon this point have been made on both fresh and dry specimens received at different times from different places. Figure 3 illustrates these peculiarities, magnified about 400 diameters.

FIG. 3.



Mr. Charles W. Burr has detected starch in the roots of *Coptis trifolia*.

In *Coptis Teeta*, Wallich, found in the Mishmi Mountains, eastward of Assam, and recognized by Flückiger and Hanbury as the officinal coptis, starch is known to be present; though in 1873 Mr. E. B. Gross failed to detect it in our American Coptis trifolia. Mr. Burr has repeatedly verified his observation on authentic specimens.

Mr. Wm. C. McFetridge, working upon the *Apocynum cannabinum*, succeeded in isolating very readily the laticiferous vessels. The illustration shows this quite clearly on longitudinal section (Fig. 4). A transverse section shows the same tissue in a very striking manner, with this difference, that in the latter case the vessels are seen as oval, isolated openings, containing bodies of granular matter inside a very delicate cell wall. There are two special points about these vessels in this species; first the ease with which they may be studied, and second, their relation to the rather anomalous laticiferous vessels in the various cinchona barks.

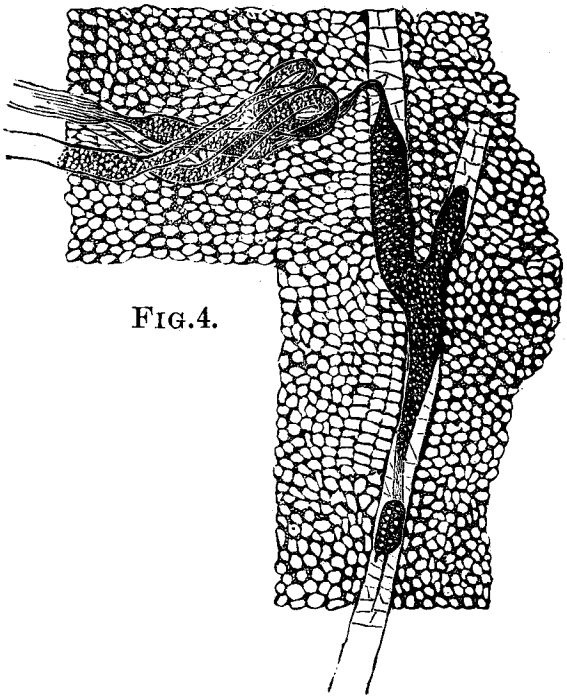


FIG. 4.

ANALYSIS OF THE LEAVES OF CEANOTHUS AMERICANUS, LINNE.

BY J. H. M. CLINCH, PH.G.

From an Inaugural Essay.

Fiye grams of the air-dry leaves subjected to a heat of 100°C. until they ceased to lose weight, weighed 4.455 grams, showing a loss of .545 grams = 10.9 per cent. amount of moisture.

Forty grams of the air-dry leaves were incinerated and yielded 1.895 grams of ash = 5.31 per cent., of which 50.526 per cent. was soluble in water, 48.629 per cent. was soluble in hydrochloric acid, .8 per cent. was soluble in boiling sodic hydrate. An analysis sliowed the presence of potassium, calcium, magnesium, aluminium, iron and silica, combined as chlorides and sulphates in the aqueous solution, and as phosphates, sulphates, and carbonates in the hydrochloric acid solution (the iron may have been derived from the mill during grinding).

Thirty grams of the powdered air-dry leaves were exhausted with pure benzol and the liquid allowed to evaporate spontaneously, yielding an extract weighing 1.507 grams = 5.64 per cent. This was treated with warm water, allowed to cool, filtered, and the filtrate tested for alkaloids and glucosides with negative results. The undissolved extract was treated with water acidulated with sulphuric acid, filtered, and the filtrate tested for alkaloids; gave a grayish precipitate with potassio-mercuric iodide, and a bright yellow precipitate with phosphomolybdic acid; negative results for glucosides. The residue was washed well with water to free from sulphuric acid, and treated with absolute alcohol; the solution was filtered, treated with animal charcoal, filtered again and evaporated, leaving a pale yellowish mass of a soft and tough consistence. It has an acid reaction, is soluble in ether, benzol, volatile oils, partly soluble in aqueous alkalies, soluble in strong sulphuric acid with a red color, and has a peculiar odor and somewhat acrid taste.

This appears to be a resin mixed with a small quantity of fixed oil, as the portion left on treatment with 80 per cent. alcohol, when boiled with potassa, was precipitated by chloride of sodium as a soap. The residue of the benzol extract after treatment with absolute alcohol consisted of wax with a small amount of coloring matter.

The drug exhausted with benzol was dried and exhausted with stronger alcohol, the extract which weighed 5.801 grams = 21.72 per cent. was treated with absolute alcohol and the soluble portion with distilled water. This solution had an acid reaction, and gave a yellow precipitate with subacetate of lead, which after decomposing with hydrosulphuric acid yielded a filtrate reducing Fehling's solution on heating, and gave

a green color with ferric chloride, and a reddish brown color with solution of potassa, showing the presence of an “iron-greening” tannin. A concentrated solution failed to give precipitates with solutions of gelatin and tartrate of antimony and potassium, but gave precipitates with cinchonine and quinine, and reduced nitrate of silver in the specular form when heated. These reactions appear to indicate that it is identical with or closely related to caffetannic acid.

The filtrate from the precipitate by subacetate of lead was freed from lead by H_2S and concentrated. Phosphomolybdic acid and potassio-mercuric iodide failed to produce precipitates, but Fehling's solution was reduced without heat (glucose). The remaining solution was evaporated to dryness; the residue liad very little odor, and at first a sweet taste, passing into that of pop-corn, and was considered to be glucose and extractive matter.

The alcoholic extract insoluble in water gave with dilute sulphuric acid a nitrate in which phosphomolybdic acid and potassio-mercuric iodide gave precipitates the same as in acid solution of benzol extract, and negative results for glucosides.

The alcoholic extract insoluble in dilute sulphuric acid, was entirely soluble in dilute ammonic hydrate and reprecipitated by an acid; it was blackish brown, brittle, opaque, inodorous and tasteless, and in concentrated alcoholic solution had an acid reaction. It was partly soluble in boiling water, not wholly precipitated on cooling, and partly soluble in ether, the solution having a green color; it is an acid resin mixed with coloring matter, and in alcoholic solution gives a precipitate with lead acetate and a green color with ferric salts. That portion of the alcoholic extract which was insoluble in alcohol was found to consist of some coloring and extractive matter.

The leaves previously exhausted with benzol and alcohol, yielded to cold water 12.795 per cent. of extract containing gummy and coloring matter. A decoction of the leaves did not become blue with iodine. 8 pounds of the air-dry leaves distilled with water yielded about 10 grains of a light yellow oil having a strong aromatic odor and a distinct acid reaction.

The precipitates obtained with the benzol and with the alcohol extract by potassio-mercuric iodide were separately treated with stannous chloride and potassa; on exhausting with ether and evaporating,

minute apparently crystalline residues were obtained which were not further examined.

XANTHIUM STRUMARIUM, LINNE.

BY MATTHEW VENABLE CHEATHAM, PH.G.

Abstract from an Inaugural Essay.

The cocklebur is one of the first plants making its appearance in the spring, and the hogs, which in some of the Southern and Western States are allowed to run at large during the fall and winter to eat the mast, are very fond of the young plant, but almost invariably die after eating them; warm lard and other fatty substances being used as antidotes with only poor success.

The writer extracted the bruised dried fruit, 195.21 grams, with benzin and obtained 29 grams of a yellowish, non-drying fixed oil having the specific gravity .900 and a peculiar odor somewhat resembling that of freshly extracted flaxseed oil; from the soap prepared with it, oleic acid was obtained, and glycerin was found in the mother liquor of the soap.

With strong alcohol a resinous extract was obtained. The portion soluble in diluted acetic acid gave precipitates with potassio-mercurio iodide, with iodine and with tannin, but not with picric acid; ferric chloride produced a green color, and sugar followed by a drop of sulphuric acid caused a yellowish color slowly changing to carmine and to bright violet red. Ether extracted from the acid solution the principle giving these reactions; but the small quantity subsequently taken up by ether from the same solution rendered alkaline by potassa, did not give these reactions.

Of the resinous substance left after treatment with acidulated water, 4 grams were given to a small dog, producing no visible effects. This substance was freely soluble in ether and alcohol and slightly soluble in potassa and ammonia; ferric chloride added to the alcoholic solution gave a deep green color probably due to a little tannin.

The principle obtained above, though probably not pure, the author thinks may be different from the xanthostrumarin of Zander (“Amer. Jour. Phar.,” 1881, p. 271), the latter being precipitated with picric-acid and not precipitated with tannin.

SOAP MANUFACTURE AND THE SOAP OF COMMERCE.

BY ALFRED SMETHAM, F.C.S.

In a paper read before the Liverpool Chemists' Association, Nov. 8th, 1883, the author first briefly described the raw materials employed by the soap maker, and then proceeded to the processes adopted for their conversion into soap. The boiler first supplies himself with a weak solution of caustic and then melts in a pan a quantity of the fat to be operated upon. The specific gravity of the lye—as the solution of alkali is called—should not in the first instance exceed 1.050—1.060. The heat is maintained by means of, steam, the direct use of a fire being now practically obsolete. The first action of the caustic is to produce an emulsion, and when this is properly formed more alkali is added, the strength of the lye being gradually increased. The reason why a weak lye must be used in the first instance is that soap is insoluble in a strong solution of caustic, and the particles of fat would, by the use of a strong lye, become encased in an insoluble layer of soap, which would prevent further action from taking place. The lye is added in until an excess of caustic is found in the pan. More oil or fat, or, where required, rosin is then added, and the fat or rosin saturated by subsequent additions of lye. When the operator, by examining the texture of the soap, considers the reaction complete, the watery solution of soap and glycerin is decomposed, by the addition of salt, in a solution of which soap is insoluble. The soap then rises to the surface in a finely divided state, and after complete separation the spent lye is removed. After the removal of the lye the soap is again heated, and, if necessary, some weak lye added, so that the soap may assume a "close" texture, as it is called. When this is complete the soap is removed, usually by pumping, to another vessel, where it is "crutched." This consists essentially in stirring the mass by rotating arms moved by machinery, by which means the soap is brought into condition, and if of too great consistency more water is added. It is now ready for the frames, composed of slabs of wood or iron placed together in a rectangular form, and made in such a manner that when the soap has solidified the sides may be removed. The soap is left in the frames until it is completely set. When this has occurred, the block is taken out and cut into slabs by means of a wire pulled through it in a horizontal direction. The slabs thus formed are placed upon a table with a movable arm, across which wires are

stretched, and the slabs are by this means again divided into bars. It is then, if it be a pure soap, ready for packing. Sometimes, however, it is desired to make up the soap in tablets of given weight. It is then cut up into pieces of the requisite weight and stamped in a press with dyes, the presses usually being worked by hand.

This, then, is a brief outline of the manufacture of a genuine soap; but the exigencies of the case render it necessary to produce a variety of soaps, at cheap prices. This has been brought about by competition and the inability of the public to discriminate between a well-made and a common soap, and consequently it is impossible for any firm manufacturing only pure soaps of high quality to hold its place in the struggle for existence. The cheaper soaps, being more readily soluble in water, produce a lather more quickly than a pure soap, and as the public does not as a rule make comparative trials as to the lasting powers, and is almost invariably led away by a cheap article, the sale of the best soaps has of late fallen off considerably, and the cheaper kinds have taken their place.

Although I have used the term pure soap to represent a soap manufactured from fat and alkali alone, it would be unfair to designate the common soaps adulterated, as we shall see on considering their nature.

A pure tallow soap will only take a certain proportion of water, and it becomes necessary to mix other substances with it if the percentage of water is increased. A substance which is useful in this respect, and which at the same time has detergent properties, is silicate of soda. This is the substance known as soluble glass, but it is usually sold to the soap boiler in solution. It is composed of silicic acid and soda, in various proportions, and is formed of two kinds, the neutral and the caustic. The neutral has a specific gravity of about 1.370, and contains about 65 per cent. of water. The proportion of silicic acid is about 26 per cent., and the remainder is soda and impurities. The caustic silicate is a much heavier solution, and has a specific gravity of of about 1.700. It contains about 43 per cent. of water, 33 per cent. of silicic acid and the remainder alkali and impurities.

These solutions are either used alone, or in combination, and are added to the soap before finishing. It is necessary to “crutch” well to insure the complete mixing, and the crutching should be continued until the soap

is about to set. The silicated soaps generally contain a larger proportion of water than pure soaps, besides the actual weight of silicate, and they can, therefore, be produced at lower prices. The detergent power of these soaps is greater than would be indicated by the pure soap contained in them, and in many districts this variety finds a market more readily than the better qualities. I should here point out that the value of a soap is not altogether determined by the composition. A pure soap may be produced from a discolored tallow or oil, which as a rule injures the appearance and causes it to command a less value in the market.

A form of silicated soap which obtains a large sale is the mottled. This differs essentially from the mottled soap manufactured a few years back, which was pure and necessarily of a high standard. It is usually manufactured from bleached palm oil, or from palm nut oil or cocoa nut oil as the chief ingredient. It is usually run with silicate to a considerable extent and contains a variable amount of fatty acids—the quantity depending on the quality it is desired to make. The mottling is produced generally by the addition of ultramarine, which gives to the soap a bright appearance.

Some samples, sold at low prices, have come under my notice which have not only been run with silicate but contain from 6 to 8 per cent. of common salt and not more than one quarter of their weight of fatty acids. The salt is of no value as a detergent agent, and must be looked upon simply as a “make weight.” It is only with soaps made from palm nut and cocoa nut oil that the salt will combine properly. The peculiar behavior of these two soaps in salt water renders them valuable for marine purposes. Very considerable experience is required in making a soap of low quality which shall be firm to the touch and present the appearances of a good soap, and the difficulty is increased in the case of common mottled soap, where it is necessary to have the mottling equally distributed throughout the mass. The methods by by which this is attained are kept, as a rule, as trade secrets, but no great difficulty is experienced when the matter is approached on scientific principles.

In the common soaps which are usually used for scouring, etc., the proportion of soda in excess of the fatty acids may be greater than in those used for finer purposes or for toilet use. The choice of the fat must also be regulated by the purposes to which the soap is intended to be put.

The details of the manufacture require careful attention, and can only be mastered after long experience, but it is necessary that all the processes should be carried on in the lines I have indicated. The peculiar behavior of each kind of soap would occupy more time than is at my disposal, nor would it serve to elucidate the processes; but it is important that the manufacturer should be conversant with their properties. As a rule, the larger the amount of stearin or palmitin there is in the fat operated upon the harder will be the soap.

Before closing the remarks upon the manufacture I may just refer to two methods which are occasionally resorted to, to improve the appearance of common soaps. The first of these consists in placing the soap in an oven or stove, so that it may become surface died and present a hard "skin." The second of these consists in dipping the soap in a strong solution of brine or other liquid. The salt has a great affinity for water and removes it from the surface of the soap but the soap itself is quite insoluble. This process improves the the appearance considerably, and prevents the soap having a sticky consistency on the exterior of the bar.

In treating of the second part of my subject, it may be well to preface my remarks with a brief account of the methods by which I have arrived at the results which I propose to state, as showing the quality of the soaps found in the market. I have now in my possession upwards of three hundred analyses of soap from different sources, which have been submitted to me at various times. In analyzing these I have found the following processes the most convenient and accurate.

The water is determined by drying in an air-bath a weighed portion of the soap at a temperature of 120°C. At this temperature the soap swells up and the water is soon expelled without any loss of the fatty matters or danger of losing the substance. The weight is taken after about three hours, and subsequent weights are made at intervals of about an hour until the weight is constant.

To obtain the percentage of fatty acids I find it best to weigh out about 3 grams of the soap in a porcelain or platinum basin, including in the weight of the basin a small stirring rod about 3 inches long. The soap is then dissolved in a small quantity of water in the basin, and when completely dissolved, about 5 cc. of dilute sulphuric acid are added. This decomposes the soap, setting free the fatty acids and forming sulphate

of soda. The solution is then gently warmed—preferably on a water-bath—until the whole of the fatty acids have risen. It is then allowed to cool, and the fatty matter will usually form a solid cake. If this does not occur a weighed quantity of purified wax must be added and the whole re-melted. When the cake is formed it is simply moved a little from the side, and the liquid from below, which should contain no fat, is poured off. The cake is re-melted with distilled water and allowed to settle as before. This is continued until the washings are free from acid. The cake is then melted in a water oven and again allowed to cool, and the water which still adheres is removed by gently touching with filter paper, and the basin is again placed in the water oven and weighed until the weight is constant. From the figures obtained the percentage of fatty and resinous acids is calculated.

The soda is determined by adding to the filtered solution from a given weight of soap an excess of standard acid and titrating back the excess of acid by means of standard alkali, using cochineal as indicator.

The percentage of silicate is obtained from the silicic acid found. To obtain this I prefer to ignite about 2 grams of the soap in a platinum dish until the volatile matters are dispersed. After cooling, the ash is covered with a glass and treated with an excess of hydrochloric acid. It is then evaporated to dryness, taken up with dilute acid, well washed and then ignited and weighed.

These are the constituents which it is usually necessary to determine, but it is sometimes required to make a more complete analysis. When this is desired it is a good plan to dissolve the soap in alcohol and filter. By this means most of the adulterating materials are separated. The clilorine is best estimated after decomposing the soap with nitric acid and allowing the fat to solidify, as in the estimation of fatty acids, by precipitating with nitrate of silver and weighing the resulting chloride.

The percentage of free alkali is important. It can be obtained by precipitating the clear alcoholic solution with carbonic acid, but I prefer to titrate the solution with standard acid, using phenolphthalein as indicator. The results are good.

In making out the analysis of a soap it must be remembered that the fatty constituents actually exist as fatty anhydrides and not as fatty acids, and if, therefore, we determine the whole of the constituents of a

soap and include the fatty matters as the estimated acids we shall find that the figures will add up to about 103 per cent. This is due to the absorption of water by the fatty anhydrides in decomposition. The actual percentage of fatty acids should always be placed as a foot . note.

In making a choice of the soaps usually found in the market is is difficult to know which to take as representative, but it will, perhaps, be sufficient to divide them into two classes, the pure and the silicated. The analyses given of the average qualities of these soaps show the the following:

Soaps.	Fatty Acids.		Soda.		Hydrated Silicate of Soda.		Water.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
Pure.....	63·18	53·74	8·31	6·38	.....	.....	28·13	36·89
Silicated.....	56·91	26·26	7·45	5·30	8·58	1·04	31·41	58·97

—*Phar. Jour. and Trans.*, Jan. 5, 1884, pp. 534-537.

A "RENNET" FERMENT CONTAINED IN THE SEEDS OF WITHANIA COAGULANS.[1]

BY SHERIDAN LEA, M.A., Trinity College, Cambridge.

The Report of the Royal Gardens at Kew for 1881 contains abstracts of correspondence in which it was pointed out that, in order to introduce a cheese-making industry in India, some vegetable substitute must be found for the ordinary animal rennet, since cheese made with the latter is unsaleable among the natives. In response to the above "Surgeon-Major Aitchison brought to the notice of the authorities at Kew that the fruit of *Puneeria*[2] *coagulans*, a shrub common in Afghanistan and Northern India, possesses the properties of coagulating milk;" and experiments showed that an aqueous extract of the seed-capsules of the above plant does somewhat rapidly coagulate milk.

I was recently requested to make some eperiments on the seeds of *Withania* to determine whether they contain a definite ferment with the properties of ordinary rennet, and the applicability of such a ferment to

1 Communicated by Professor M. Foster, Sec. R.S.—From the "Proceedings of the Royal Society."

2 The genus *Puneeria* is now reduced by botanists to *Withania*.

cheese-making purposes.

The material supplied to me consisted of an agglomerated dry mass of seed-capsules and fragments of the stalks of the plant. When crushed in a mortar the whole crumbled down into a coarse powder, in which the seeds were for the most part liberated from the capsules. I picked out the larger pieces of stalk, sifted out the finer particles, chiefly earth and fragments of the capsules, and then by a further sifting I separated the seeds from the other larger particles. The seeds appeared to be each enveloped in a coating of resinous material, presumably the dried juice of the capsules in which they had ripened.

Taking equal weights of the seeds, I extracted them for twenty-four hours with equal volumes of (i) water, (ii) 5 per cent. sodic chloride, (iii) 2 per cent. hydrochloric acid, (iv) 3 per cent. sodic carbonate. Equal volumes of each of the above were added in an acid, alkaline, and neutral condition to equal volumes of milk, and heated in a water-bath at 38 °C. The milk was rapidly coagulated by the salt and sodic carbonate extracts, much less rapidly by the other two; of the four, the salt extract was far the most rapid in its action. All subsequent coloring-matter is scarcely soluble in either ether or alcohol, so that no advantage is gained by a preliminary treatment with these before extraction with the salt solution. I have also endeavored to get rid of the color by treating the seeds as rapidly as possible with successive quantities of water before making the final extract. By using a centrifugal machine I was able to wash the seeds six or seven times with large volumes of water without their being exposed for any considerable time to the action of the water. Each portion of water was highly colored and the seeds were thus freed from adherent coloring-matter. But, apart from the fact that some, though not much, ferment is thus lost, no special advantage is obtained, since the seeds are themselves colored, and even after prolonged treatment with water the final extract is always of a dark brown color.

In order to obviate the disadvantages of this coloring matter, if disadvantage it is, I have found it best to prepare very concentrated active extracts of the purified seeds, so tliat it should only be necessary to add a very small quantity of the extract in order to coagulate the milk and obtain a colorless curd. This I have done by grinding the dry seeds very finely in a mill and extracting them for twenty-four hours with such a volume of 5 per cent. sodic chloride solution that the mass is still

fluid after the absorption of water by the fragments of the seeds as they swell up. From this mass the fluid part may be readily separated by using a centrifugal machine (such as is used in sugar refining), and it can then be easily filtered through filter-paper; without the centrifugal machine the separation of the fluid from the residue of the seeds is tedious and imperfect, 40 grams of the seeds treated as above with 150 cubic centims. of 5 per cent. sodic chloride solution gave an extract of which 0.25 cubic centim. clotted 20 cubic centims. of milk in twenty five minutes, and 0.1 cubic centim. clotted a similar portion of milk in one hour. When added in these proportions the curd formed is quite white. The presence of the coloring-matter is however, perhaps on the wliole unimportant, since even if a larger quantity of the ferment extract is added in order to obtain a very rapid coagulation the coloring matter is obtained chiefly in the whey, the curd being white.[3]

The question of preparing an extract which should be capable of being kept for a considerable time is perhaps of importance. Ordinary commercial rennet usually contains a large amount of sodic chloride and some alcohol. One specimen I analysed contained 19 per cent. of common salt, and 4 per cent. of alcohol. I have, therefore added to the 5 per cent. chloride extract mentioned above, enough salt to raise the percentage of this to 15 per cent., and also alcohol up to 4 per cent. The activity of the extract is not appreciably altered by this, and such a preparation corresponds very closely in activity with a commercial solution of animal rennet with which I compared it. The possibility of making extracts which may be expected to keep is thus indicated, but of course time alone will show whether the activity of the ferment is impaired to any important extent by such keeping.

I may add in conclusion that I have coagulated a considerable volume of milk with an extract such as I have described, and prepared a cheese from the curds. I have also given a portion of the extract to a professional cheese-maker who has used it as a substitute for animal rennet in the preparation of a cheese. The product thus obtained, and the statements of the person who has made the experiment for me, lead me to suppose that extracts of the seeds of *Withania* can be used as an adequate and successful substitute for animal rennet—*Pharm. Jour. Trans*., Feb. 2, 1884, p. 606.

3 It is extremely probable that some stage in the growth or ripening of the seeds of *Withania* might be found at which the development of coloring-matter is slight, while at the same time the ferment is present in considerable quantity.

SOME AFRICAN KOLAS,

IN THEIR BOTANICAL, CHEMICAL AND THERAPEUTICAL ASPECTS.[4]

BY E. HECKEL AND F. SCHLAGHDENHAUFFEN.

Among the vegetable products .of the African soil, there is perhaps none more interesting and valuable than those which under the various names of “kola,” “gourou,” “ombéné,” “nangoué,” and “kokkorokou,” are used as articles of consumption throughout tropical and equatorial Africa, as equivalent to tea, coffee, maté and cacao. Used under the form of seeds, probably from time immemorial, by the native tribes, these products are of varying botanic origin, and their history has been up to the present time imperfectly known; but the authors have been able to avail themselves of the observations of some recent travelers to clear up some obscure points.

The products which are included by the authors under the name “"kola” (the various synonyms quoted being special to particular countries) consist of seeds, yielded by two families of plants and differing very much in appearance. The kind most widely distributed, the “true kola,” which by some of the natives is called the “female kola,” comes from the Sterculiaceæ; another variety, called by the author “false kola,” is known among the negroes as simply “kola,” or “male kola.” Before the authors' researches only the “true” or “female” kola was known, and it had been ascertained to be yielded by the *Sterculia acuminata*, P. de Beauv. (*Cola acuminata*, R. Br.). To this Messrs. Heckeland Schlagdenhauflen are able now to add information concerning the “male” kola, hitherto unknown, and to give reasons for believing that various other species of *Sterculia*, besides *S. acuminata*, yield kola seeds.

Dealing first with “female” kola, the authors describe at length *Sterculia acuminata* from specimens, the description agreeing with Oliver's description of var. *a* (Fl. Trop. Af., L, 220.) According to the best information, the tree—which is from 30 to 60 feet high, and in general aspect resembles tlie chestnut—grows wild upon the western coast of Africa comprised between Sierra Leone and the Congo or Lower Guinea, reaching into the interior about five or six hundred miles, where it appears to follow the limits of the palm. Upon the eastern coast it appears to be unknown in places where it has not been introduced by

4 Abstract of a lengthy memoir read before the Union Scientifique des Pharmaciens de France (*Journ. Pharm. et de Chimie,* [5], vii, p. 553; viii, p. 81, 177.)

the English. Dr. Schweinfurth, speaking of the country of the Nyams-Nyams, near lake Nyanza, says that among the imposing forms of vegetation a *Sterculia* of the kola kind predominates and is called locally "kokkorokou." In the country of the Momboutous (24° E. long., 3° N. lat.), too, upon asking for kola he was supplied with the fruit in its rose-colored envelope; but the only information he could obtain there concerning it was that the nuts were found in the country in the wild state and were called "nangoué" by the natives, who chewed slices of it whilst smoking. Karsten, in his "Flore de Colombie," describes the plant as growing wild in the moist hot woods near the southern coast of Venezuela, but the authors believe it was probably introduced there about the same time as it was introduced into Martinique, and that it was sown by African negroes, who brought it into those countries in the same manner as they are known to have introduced *S. cordifolia* for the sake of its delicious fruit. It has also been introduced successfully by the English into the East Indies, the Seychelles, Ceylon, Demerara, Dominica, Mauritius, Sidney and Zanzibar, and by the French recently at Guadelope, Cayenne, Cochin China and the Gaboon. In all these stations the kola tree flourishes best in moist lands at the sea-level, or a little above. At Sierra Leone some fine trees are found at an elevation of 200 or 300 metres, but not higher than that.

The kola tree commences to yield a crop about its fourth or fifth year, but it is not until about its tenth year that it is in full bearing. A single tree will then yield an average of 120 lbs. of seed annually. The flowering is nearly continuous after the tree reaches maturity, so that a large tree bears flowers and fruit at the same time. There are two collections; the June flowering yielding the fruit in October and November, and that of November and December in May and June. When the fruit is ripe it takes a brownish yellow color. In this condition dehiscence of the capsule commences along the ventral suture, exposing red and white seeds in the same shell. It is at this period that they are gathered. It has been stated that there exist two varieties of kola, one yielding exclusively red seeds and the other white; but the authors have been repeatedly assured that this is not the case, and that one and the same capsule may contain fifteen seeds varying considerably in size, white and red together, without the white being considered less ripe than the red. The carpels are from 6 to 9 centimetres long and 3 to 5 thick and the spongy pericarp is about 2 or 3 millimetres thick. As many as five or six ripe carpels may result from a single flower, and these may each contain from five to fifteen seeds; but sometimes carpels are met

with containing only a single seed. The seeds removed from their envelope weigh, according to their development, from 5 to 25 or 28 grams. The epiderm is the principal site of the coloring matter, and beneath it the cotyledonary tissue consists of a mass of cells gorged with large starch granules comparable to potato starch. It is in these that the alkaloids caffeine and theobromine are found in the free state.

The collection is conducted with great care and is made by women. The seeds are removed from the husk and freed from the episperm. In order to maintain their value among the negroes it is necessary to keep them in a fit state and in good condition. They are, therefore, carefully picked over, all damaged and worm-eaten seeds being removed, and the sound seeds are then placed in large baskets, made of bark and lined with "bal" leaves (*Sterculia acuminata*, Car., or *S. heterophylla*, Beauv.?) ; the seeds are heaped up and then covered over with more "bal" leaves which, by their thickness, resistance and dimensions, contribute not a little to the preservation of the seeds by keeping them from contact with dry air. Packed in this manner the seeds can be transported considerable distances, remaining free from mould for about a month, during which time it is not necessary to submit them to any treatment in order to preserve them fresh beyond keeping the "bal" leaves moist. But if it be desired to keep them beyond that time the operations of picking and re-packing have to be repeated about every thirty days; the seeds, being washed in fresh water and fresh "bal" leaves placed in the baskets. The baskets usually contain about 3 cwts. of seeds. It is in this condition that "kola" is sent into Gambia and Goree, where the principal dealings in the seeds are carried on. In Gambia they are sold in the fresh state to merchants traveling with caravans into the interior, who dry them in the sun and reduce them to a fine powder, which is used, mixed with milk and honey, by the tribes of the interior to make a very agreeable, stimulating and nourishing beverage. It most frequently arrives at Sokota and Kouka in the Soudan and Timbuctoo, where large sales of the seeds are made, in the fresh condition; from the Soudan markets it is carried by caravans to Tripoli, and from Timbuctoo into Morocco. As might be expected the value of the Kola increases as it makes its way into the interior of Africa, and the authors state that some of the tribes furthest removed from the sea pay for the dry powder with an equal weight of gold dust. Kola plays an important part in the social life of many of the African tribes, and the authors mention some of the occasions upon which it is used in terms almost identical with those in a paper read at an evening meeting of the Pharmaceutical

Society eighteen years ago (*Pharm. Journ.*, [2], vi., 450.) An interchange of white kola between two chiefs is indicative of friendship and peace, whilst the sending of red kola is an act of defiance. An offer of marriage is accompanied by a present of white kola for the mother of the lady; the return of white kola is. equivalent to acceptance of the suit, whilst red means rejection. The absence of a supply of kola from among the marriage presents would endanger the whole arrangement. All the oaths are administered in the presence of kola seeds; the negro stretches out his hand over them whilst he swears and eats them afterwards.

Fresh kola is used as a masticatory, as is also the dried powder, by the tribes in the interior. When fresh the taste of the seeds is first sweet, then astringent and finally bitter. When the seeds become dry the bitterness diminishes, giving place to a sweeter flavor; but upon steeping them in water for a couple of days the original bitterness is nearly restored. Preference is given for mastication to seeds containing only two cotyledonary segments, it being asserted that they are less rough than those with four to six segments; but the authors did not find anything in their chemical examination to explain this preference. The practice of kola mastication, which is always accompanied by the swallowing of the saliva, does not injuriously affect the teeth, as is the case with the betel nut, but tends to render the gums firm, and exercises a tonic influence on the digestive organs. The seeds are reputed to clarify and render healthy the most foul waters, and to render tainted meat edible, and when chewed, either fresh or as a dry powder, and the saliva swallowed, to be a sure preventive against dysentery. They are also said, like *Erythroxylon Coca*, to possess the physiological property of enabling persons eating them to undergo prolonged exertion without fatigue, which is probably to be attributed to the caffeine they contain. Further it is said that kola exercises a favorable influence upon the liver, and that white people, living in those regions, who chew a small quantity before meals escape constitutional changes due to affections of that organ. They are also believed by the negroes to have aphrodisiac properties. With respect to the assertion that the pulp or powder of the seeds thrown into foul water has the property of cleaning it, an experiment made by the authors would appear to show that any action in this direction would be due to the formation of a kind of mucilage, which would act mechanically like the white of an egg.

It has been pointed out that the name “kola” is applied in Africa indifferently to several Sterculaceous seeds other than those of the two

varieties of *Coca acuminata*, although these are the most valued in the native markets. It is probable that the African plants capable of yielding seeds resembling the true kola are *Cola Duparquetiana*, Baill., *C. ficifolia*, Mast., *C. heterophylla*, Mast., *C. cordifolia*, Cax., and perhaps *Sterculia tomentosa*, Hend. But the authors think it doubtful whether these seeds contain caffeine,. otherwise they would be as much sought after as the true kola.

In order to determine chemically the composition of kola seeds, the authors made a large number of experiments; the details fill many pages in the original paper. The dry seeds were first operated upon, and the process which appeared to give the best results was to exhaust the dried powder successively with chloroform and alcohol. The chloroform percolate was a yellowish liquid; this was evaporated to dryness, and the residue treated with water, which separated a fatty substance with an odor recalling that of cacao butter and entirely saponifiable by caustic potash. The yellow liquid upon concentration after filtration, deposited silky needles of caffeine, but when the solution was rapidly evaporated and the residue treated with water, ether or chloroform it no longer completely dissolved without using a considerable quantity and boiling, and upon such a solution cooling a small quantity of a compound crystallizedoutin microscopic prisms and octahedra which proved to be theobromine. The substances separated by chloroform from the dry nuts, were—caffeine, 2.348 per cent.; theobromine, 0.023 per cent.; tannin, 0.027 per cent.; fat, 0.583 per cent.

The kola powder was then dried and exhausted with alcohol. A mahogany colored extract was obtained which when treated with boiling water dissolved entirely, but the solution on cooling deposited a large quantity of coloring matter. The aqueous solution was precipitated with triplumbic-acetate, the precipitate decomposed with sulphuretted hydrogen, and a liquid obtained, free from bitterness, containing a considerable quantity of a tannin giving an intense green color with persalts of iron, and a soluble coloring matter that formed lakes in contact with metallic solutions; the residue of the aqueous solution, after removal of excess of lead, was found to contain only glucose and a small quantity of fixed salts. The coloring-matter deposited upon the cooling of the boiling water used in dissolving the alcoholic extract differed in its nature from the soluble coloring matter It appeared to be an oxidation product from the tannin and presented considerable analogy to cinchona red; in order to distinguish it, therefore, the authors have

named it “kola red.”

The composition of the alcoholic extract from the dry nuts (5.826 per cent.) was found to be—tannin, 1.591 per cent.; kola red, 1.290 per cent.; glucose, 2.875 per cent.; fixed salts 0.070 per cent.

The entire composition of the kola nut is compared by the authors with that of tea, coffee and cacao as follows :

	Cacao (Mitscherlich)	Coffee (Payen).	Tea Green	Tea Black (Peligot).	Kola (Authors').
Fat	53·00	13·00	0·28	.....	0·585
Proteid Matters	13·00	13·00	3·00	2·80	6·761
Theobromine	1·50	.....	.....	.....	0·023
Caffeine	.....	2·25	0·43	0·46	2·348
Essential Oil	0·04	0·003	0·79	0·60	undet.
Resin	.....	.....	2·22	3·64	.....
Sugar	0·5	15·50	.....	.....	2·875
Starch	.....				33·754
Gum	.....	.....	8·58	7·28	3·040
Cellulose	.....	34·00	17·08	26·18	29·831
Coloring Matters	.....	.....	17·24	19·20	2·561
Coloring Matters	5·00	.....	2·22	1·84	1·290
Extractive	.....	.....	22·80	19·88	.....
Tannin	.....	.....	17·80	12·88	1·618
Ash	3·60	6·697	5·56	5·24	3·395
Water	6·00	12·00	.....	.....	11·909
	100·00	100·00	100·00	100·00	100·00

These results, it is pointed out, differ somewhat from those obtained by Attfield (*Pharm. Journ.*, [2], vi, 457,) especially in the recognition of the presence of a second alkaloid and of tannin. The proportion of caffeine is higher than that observed in any coffee, or, except in rare instances, in tea, and exceeds that of theobromine in cacao. The alkaloid exists in kola, as in tea, uncombined, but in coffee, according to Payen, it is present as chlorogenate of potassium and caffeine. It is worth mentioning that the authors report the presence of a considerable

proportion of caffeine and some theobromine in the pericarp, but the material at their disposal was too scanty for an exhaustive investigation in this direction. The leaves, wood and bark were also examined for alkaloid, but gave negative results. As in the case of coffee, kola undergoes a considerable loss of caffeine (three-fourths) during roasting, while the quantity of essential oil present is augmented.

Some experiments have been made with this kind of kola in the treatment of the atonic diarrhoea to which Europeans are frequently liable in tropical countries. The results have been fairly satisfactory, and through the efforts of M. Heckel the medicine has been supplied to some French colonial stations for a systematic trial. The preparations used are an aqueous extract, an alcoholic extract and a wine. The alcoholic extract is made by exhausting fresh kola with 5 parts of 60° alcohol and the wine by macerating the same proportions of kola in a sweet white wine during a fortnight. Neither of these preparations, however, completely exhaust the kola, at least as far as the caffeine is concerned. The preparatien of an aqueous extract presents considerable difficulty in consequence of the quantity of starch, which forms an unmanageable magma.

Concerning the “male kola” or “kola bitter,” as before stated, nothing definite was known, and as recently as the year 1882, it was referred erroneously to a species of Sterculia. In the “Flora of Tropical Africa,” Oliver says: “The kola bitter of Fernando-Po is the product of trees belonging to the Guttiferæ. The authors were led by this remark to attempt to obtain from various parts of the eastern coast specimens of the plant yielding “kola bitter,” and although the flowers did not reach them they received specimens of the branches, leaves and fruits, together with a sufficient quantity of seeds to allow of a complete analysis being made. All the specimens received from various places corresponded in their characters, and showed that the kola bitter is the produce of a single Guttiferous species and not of several. From the material at their disposal the authors refer it to a new species, *Garcinia Kola*, Heekel.[5] The plant is described as a tree of variable aspect, 10 to 20 feet in height, bearing towards the base of the branches large opposite leaves (12 in. long by 7 in. broad,) with short petioles, whilst at the extremity of the branches the leaves are much smaller (5 in. by 2 in.) The leaves are oval, slightly dilated at the base, mucronate at the

5 The plant yielding "bitter kola" was identified as a species of *Garcinia* by Dr. Maxwell T. Masters eight years ago, and was partly described and the fruit figured by him in the *Journal of Botany* for March, 1875.— Editor *Phar. Jour.*, February 2, p. 610.

apex, without stipules, full green on the upper surface and greyish underneath. The fruit is a berry the size of an apple, with a rugose epiderm covered entirely with rough hairs. It presents three or four divisions, each containing a large oval cuneiform seed, rounded on the external and angular on the internal face; the seeds are covered with an abundant sourish yellowish pulp, constituting a true arillus. The fruit has at the base the persistent calyx still adherent to the peduncle, and sometimes the persistent corolla, and at the apex the persistent stigma. The plant is reported to occur all along the eastern coast of Africa and of Senegal, intermixed with the *Sterculia acuminata*, flourishing under the same conditions, but less widely distributed. In its known characters the plant would appear to be closely allied with *Garcinia Morella*, which, however, is essentially an Asiatic species. The seeds present one convex and two plane surfaces, the former being towards the circumference of the fruit. They are covered by an apricot-yellow episperm, below which is a large yellowish-white macropodous embryo, devoid of cotyledons, and with numerous depressions on its surface. The tissue is denser and closer than that of true kola and crackles under the teeth; it consists of a compact mass of very homogeneous cellular tissue, interspersed here and there with laticiferous vessels of varying size containing resin, the cells constituting which are filled with starch granules larger than those occuring in true kola.

Upon chewing these seeds a strongly bitter, astringent and yet aromatic taste is perceptible, which is quite different from that of true kola, and approaches in its aromatic flavor that of green coffee; it is this aromatic flavor that is esteemed by the negroes. It is worthy of remark that although the use of these seeds does not produce any notable stimulant effects or ward off fatigue, they are as much sought after and fetch nearly as high a price on the eastern coast as the true kola. In the interior, however, they are unknown. The authors are of opinion that these seeds owe their properties to the resin they contain, which is slightly stimulant. By the negroes they are thought to exercise an aphrodisiac action, which the authors consider doubtful, and as a masticatory, they are said to be a valuable remedy for colds.

An examination of fresh male kola nuts for caffeine gave negative results, the chloroform, ether and alcoholic percolates being all free from alkaloid. Besides coloring matter, tannin and glucose, two resins were separated. One of these was brown, hygrometric and soluble in ether

and melted at the temperature of the water-bath; the other was yellowish-white, soluble in ether, alcohol, acetone and acetic acid, insoluble in carbon bisulphide or petroleum spirit, and had a high melting point.

A large proportion of the paper is devoted to a study of the constitution of caffeine and several of its derivatives, in reference to the identification of the alkaloidal substances obtained by the authors from the female kola.— *Phar. Jour. and Trans.*, Jan. 26, 1884, p. 586.