

## ON THE PRACTICAL TEACHING OF CHEMISTRY IN SECONDARY EDUCATION.

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THERE is a strong tendency, in modern education, to be mindful of the child's intellectual organization and to modify the teaching according to its requirements. Empirical sciences are taught and learned as they were made, that is to say, proceeding from the concrete to the abstract, from the known to the unknown, from facts to laws. That form of teaching may not seem to be the most logical; it is the most fruitful. When teaching geography, the shortest and straightest way may seem to be, first to give an account of the form of the earth and of its relations to other planets, then a brief description of the continents and oceans and last to pass to the study of the various countries. Experience shows that such teaching conveys little more than meaningless words to the child's mind. On the contrary, if he is told about the objects in the immediate neighborhood of his house, then about the surrounding of his town or village and afterward about his country, he can compare that which precedes with that which follows and understands what he is learning. The shortest way between two points is not always the straightest. If it were so, there would be no such phenomenon as the refraction of light.

The first elements of language, geography, botany, zoology, are now generally taught according to the natural principles of the analytical method. Although the teaching of the elements of the physical sciences is not quite so advanced, the same method has been followed in some excellent text books published principally in the United States and England. I wish to show its advantages in the teaching of a branch to which no attempt has yet been made to apply it, viz., the practical teaching of chemistry.

Chemistry is a practical science, the methods of which cannot be fully understood without a certain amount of practical work. Nevertheless, such are the difficulties which we encounter when we desire to give a practical training in chemistry to young pupils that only a few secondary schools have a chemical laboratory and compel their pupils to do chemical work for themselves. I believe most of these difficulties could be easily overcome if we were to apply a method more in accordance with the teaching of modern pedagogy.

In those secondary schools where pupils are exercised in practical chemical work, but two distinct classes of work are undertaken: 1st. The preparation of those important inorganic compounds the molecule of which is composed of but a few atoms. 2d. Very simple analyses of salts, which generally do not go beyond the qualitative determination of one metal and one acid radical. Both courses comprehend chemical synthesis and analysis, that is to say the rupture and the construction of molecules. Instead of these courses I would propose one in which *molecules of distinct nature, such as are found in natural organic compounds and more especially in plants, would be not decomposed, but isolated*. Instead of making up or destroying chemical compounds, the student would separate bodies existing as natural organic mixtures. Before learning how to decompose ammoniac gas, how to detect manganese compounds or how to make hydrofluosilicic acid he would learn how to separate gluten from starch in corn flour or how to isolate the cellulose contained in a sample of hay. *Proximate organic analysis* would precede elemental inorganic analysis or synthesis. Such a course would be truly analytical, not only from a chemical point of view, but, above all, in the pedagogical meaning of the word. The advantages are obvious, and, among them, I desire to mention the following:

1. *The proximate method leads the pupil from the known to the unknown*. With the actual laboratory teaching the pupil is immediately brought into the presence of numberless chemicals, such as barium nitrate, ammonium molybdate, potassium permanganate, etc., the properties of which are as strange as their names. He has never heard of them in his everyday life. He cannot compare them with those bodies he meets constantly in Nature's vast laboratory. In the first practical steps in chemistry, as well as in the theoretical, the choice of such compounds to illustrate chemical phenomena openly violates an important law of pedagogy. Such a reproach cannot be made against the method I propose. According to this plan the pupil begins by operating on bodies he is completely or partially acquainted with. Most of the compounds separated, such as starch, sugar, grease, casein, gum, resin, have been frequently seen in various forms by the student, who is fully acquainted with some of their properties. Most of the reactives used to extract them from the natural mixtures in which they are found are frequently used for domestic or industrial purposes, and consequently are known to the pupil.

2. *It enriches the mind of the pupil, not with technical notions, which will be useful only to the few who may continue the study of chemistry, but with practical notions immediately available in common life, and consequently useful to the greater number of pupils*. It is almost superfluous to state that I do not pretend that the proximate method should take the place of elementary mineral analysis or of the preparation of inorganic bodies. I only affirm that it should precede them both. It should precede them not only because the laws of pedagogy require it, but also because, if it be the only practical chemical course presented to the pupil, it is the most useful. To those students who may never go further in their studies than what they may learn in secondary schools the knowledge of the preparation and properties of a legion of rare inorganic bodies is of little avail; what they want to know are the properties of those organic compounds the theoretical value of which is perhaps insignificant, but which have a great practical importance because our food, our dress, and our own bodies are composed of them.

3. *The proximate method is comparatively easy and does not present such practical difficulties as could not be overcome by beginners*. The operations performed in order to separate the organic constituents of plants and animals are of the very simplest description, and consist mainly in dissolutions, that is, in operations the pupil sees daily at home. The teacher who follows that method gets rid of the practical hindrances which arise when teaching beginners the mode of using the

complicated apparatus required in the preparation of the commonest inorganic bodies.

4. *It requires only the very cheapest apparatus and chemicals which may be found everywhere*. The cost of a chemical laboratory, the necessity of frequently renewing high priced chemicals and easily broken apparatus is perhaps the principal hindrance to a general introduction of practical work in the secondary teaching of chemistry. As a consequence of their simplicity, most of the operations of the proximate method can be performed, if necessary, with the use of culinary utensils and with chemicals to be obtained at the grocer's. The list of these products and apparatus will be given below.

5. *It does not comprehend experiments so dangerous as those which are made during a practical course of chemical inorganic preparations*. Experiments that are free from danger to the professional chemist may be dangerous to the pupil who makes them for the first time, and the feeling of a heavy responsibility compels the teacher to exercise a vigilant care, which unnecessarily complicates his work. During a course of chemical preparations, these dangers are met with from the beginning. The first preparation is generally that of hydrogen. It is not uncommon to see a pupil pour as much sulphuric acid on his hand as into his apparatus. Others have seen the professor lighting the gas as it escapes from the bottle and think there is nothing to prevent their doing the same at the very beginning of the operation. The preparation which usually follows, that of oxygen, is perhaps still more perilous, and but few of the preparations of inorganic compounds or elements are altogether exempt from danger. The proximate method is nearly free from the risks which attend the use of dangerous bodies by inexperienced hands. No inflammable or poisonous gas is prepared, no explosive bodies are used. The only possible cause of accident is the use of inflammable liquids, such as lamp oil and alcohol, but this danger is familiar to every one and consequently easily avoided.

I believe that every chemist who has had to teach laboratory work will fully understand the importance of the preceding statements. In order to fully prove them I will enter with some detail into the description of the method itself, with the hope that this explanation may help the teacher willing to give it a trial in overcoming the difficulties he might meet with while carrying it out.

A laboratory devoted to the proximate analysis of plants can be installed in any room provided it be well lighted and have a supply of water. The furniture should consist of a large table and two small ones. On the large table should be placed most of the apparatus, and a shelf on it should contain the reagents. This table will be used for general work. One of the smaller tables should be placed near the windows, and on it should stand the microscope and the balances; it may also be used as a writing table. On the other small table should be placed those apparatus likely to shake or jar the objects before mentioned (screw-press, mortar, rasp). It may be placed in a remote corner. The following list gives the necessary apparatus and reagents. It is calculated for a class of about twelve pupils. Should the class be more numerous, the glass and porcelain apparatus ought to be increased in number, while other apparatus, such as the microscope, the screw-press, the balances, can be used by over forty pupils. Should the pupils be very few, and should great economy be necessary, many apparatus, such as the screw-press, the microscope and one of the balances, may be omitted.

## APPARATUS.

Three beaker glasses not lipped and three with lip; three flasks with round bottoms and three with flat bottoms; three conical test glasses; three glass funnels; three evaporating porcelain dishes; half a dozen glass stirrers; a mortar and pestle, in porcelain; a large copper basin; a test tube support with tubes; a cylinder on glass foot with lip, graduated in cubic centimeters; a separating receiver with stop-cock and stand; a graduated pipette for delivering exactly 10 cubic centimeters; Mohr's burette with support; a chemical thermometer graduated to 300° C.; a steel spatula; a rasp; a small porcelain crucible; an iron water bath; a sieve; a still; a support with three rings; a balance to carry 1,000 grammes in each pan and to turn with one gramme when thus loaded; ditto to carry 30 grammes in each pan and to turn with one centigramme; a screw-press; a plain microscope; a densimeter.

## CHEMICALS.

Alcohol, hydrochloric acid, basic acetate of lead, acetic acid, iodine, lime, soda, ferric chloride, chloroform, filtering paper, ammonia, litmus, dry raspings of oxide, benzene, tannin, gelatine, salt, Schweitzer's solution, Fehling's solution, gasoline.

The selection of suitable organic bodies for analysis should be made with regard to two important factors, viz.: 1st. The necessity of slowly graduating the difficulties. 2d. The advisability of choosing bodies that we meet with on our farms, in our factories, or in domestic life. It is evident that a list of such bodies must vary for many reasons, the principal one being differences in the relative importance given to plants according to the agricultural region in which they are grown. Therefore, the following series of analyses must be considered merely as a fair example of one of the numerous combinations that might be made:

*First analysis. Separation of the starch contained in a sample of potatoes. Determination of its weight.* About 500 grammes of potatoes are cleaned, weighed and rasped. The raspings are mixed with water and passed through a fine sieve. The deposit of starch is collected, dried and weighed.

*Second analysis. Separation of the gluten and starch contained in a sample of corn flour. Determination of their respective weights.* 200 grammes of corn flour are mixed with a little water and placed in a piece of linen. A knot is made in order to prevent the escape of this paste. After kneading for an hour in some ten liters of water, the gluten left in the linen is dried and weighed. The starch is collected and its weight determined as in the preceding analysis.

*Third analysis. Separation of the fat contained in a sample of cocoa. Determination of its weight.* 100 grammes of ground cocoa are placed in a separatory funnel and extracted after the method described fur-

ther on, for the determination of the weight of fatty matter in vegetables.

*Fourth analysis. Determination of the weight of tannin contained in a sample of oak bark.* 50 grammes of finely ground oak bark are extracted with one liter of boiling water, the water being poured little by little on the bark contained in a separatory funnel. Tannin is determined in the filtrate after the method described further on.

*Fifth analysis. Preparation of essence of cloves. Determination of the weight of this essence contained in a sample of cloves.* 100 grammes of cloves are distilled with water and the essence determined as described further on.

*Sixth analysis. Determination of the weight of sugar contained in a sample of beet root.* 300 grammes of beet root are rasped and pressed. The juice is heated to 80° C., with a tenth part in volume of chlorhydric acid, and the sugar is determined after the method described further on. The figure obtained is that of the sugar contained in the juice. In order to know that contained in the root, it is necessary to multiply the first number by 0.96. The beet root contains 96 per cent. of juice.

*Seventh analysis. Separation of the caffeine contained in a sample of coffee. Determination of its weight.* 2 kilogrammes of finely ground coffee are mixed with 800 grammes of lime. The mixture is extracted with rectified alcohol. The alcohol is distilled. The extract is dissolved in alcohol at 50 per cent. After filtration, the liquid is evaporated until an oleaginous stratum is seen to float on the surface. This is separated and rejected. Then the evaporation is continued until the volume is much reduced. On cooling the liquid, the caffeine crystallizes. It is then dried and weighed.

*Eighth analysis. Analysis of a sample of milk.* The weight of one liter of milk is determined by means of a densimeter, and this quantity is evaporated to dryness. The weight of the residue allows us to calculate the percentage of water. This residue is washed with gasoline and weighed again. The difference observed in the two weights gives the percentage of butter. The matter is then washed with water, and the proportion of sugar contained in the aqueous liquid is determined with Fehling's solution. The percentage of casein is found by difference.

*Ninth analysis. Analysis of a sample of hay.* The proportions of water, ashes and fat contained in a sample of hay are determined further on. Then 100 grammes of hay are ground several times with small quantities of water in a mortar. In the filtered liquid, soluble proteids, gums and sugar are determined as stated further on. In the residue cellulose and insoluble proteic matter are determined after the method described further on.

The pupil who has made the above series of analyses or any other in which the same gradation has been observed is now able to undertake original work. The unexpected difficulties he will meet with and overcome, sometimes alone, sometimes with the help of his professor, will complete his practical training, while the unforeseen and highly interesting facts he will sometimes discover will prove a powerful stimulus to him.

Mr. James Pyle Vickersham says:

"New discoveries in science and new inventions in the arts are still possible, and methods of instruction should prompt the young to make them."

"I take it that education means something more than merely conning the facts and repeating the reasonings of text books. If properly instructed, pupils will desire to look beyond what they have been taught, or what they have simply learned. They will desire to do it. The highest aim of teaching is not to store the mind with the accumulated knowledge of ages, but to arm it with energy and skill; not to enable pupils merely to solve problems in mathematics, construe sentences in grammar, or answer questions in philosophy, but to inspire them with a love of study, to awaken in their minds an animating, life-giving power, that does not rest satisfied with present attainments but is ever striving to open up new truths, to express new beauty, or to contrive new ways of lessening labor or effecting good."

If the proximate method be followed, the greatest difficulties inherent to original work in chemistry can be got rid of. It is the special nature of the method that removes them. As observed before, the processes used in decomposing bodies widely differ from those put in practice in separating them from other substances, and whenever the first kind of work is applied to original research, it requires an amount of skill and knowledge to be attained only by years of study both theoretical and practical.

Moreover, none of the operations just enumerated requires great accuracy. The chemical methods used in the separation of organic bodies are far from being so precise as those used in mineral analysis, and the errors resulting from the inexperience of a beginner are generally smaller than those that arise from the imperfection of the method. Neither would greater accuracy be very useful in the proximate analysis, as it occupies itself with variable quantities, and as its purpose is to settle averages rather than isolated ciphers. In various fruits gathered from the same tree and identical in appearance, the proportion of pectine varies greatly. If the percentage found by the chemist in a fruit or in various fruits does not too nearly approach the minimum or maximum it may be considered as a fair representative of the percentage of pectine contained in the fruit, although it might not very accurately represent the quantity that existed in the particular fruit or fruits analyzed.

Any part of any plant is a suitable subject for original analysis. Except a few general facts and the composition of some of those plants which have alimentary, industrial or pharmaceutical properties, all is still unknown in the chemistry of the vegetable kingdom. Of course the method of analysis must vary with circumstances, and the talent of a good teacher consists in enabling the pupil to discern for himself the best way out of each emergency. However, a general method may be adhered to which may be modified according to the composition of the substance when this is known or foreseen, whereas, when this is absolutely unknown to the pupil, he should employ the method without modification. Various good methods have been proposed for that purpose in technical

works,\* but a special condition of chemical work in secondary education, viz., the necessity of avoiding complications in the operations, even at an occasional sacrifice of accuracy, does not allow us to adopt any of these methods without modifications. Instead of them I propose the following method. It is far from being perfect, but, so far as I know, it is the only one that has been devised for secondary education and practically and successfully tested by pupils of sixteen years old.

**First Operation.** From 500 to 1,000 grammes of fresh matter are dried at 100 or 105° C. The operation can be performed with a drying bath or a water bath heated with a solution of common salt. The difference of weight before and after the operation gives the contents in water.

**Second Operation.** From 20 to 50 grammes of dry matter are burnt in an iron crucible in order to determine the percentage of ashes.

**Third Operation.** One hundred grammes of dry and pulverized matter are placed in a separatory funnel with 250 grammes of gasoline. A little cotton has been introduced previously into the lower part of the apparatus. Then this is carefully corked and stirred as often as possible. Two days afterward the stop cock is opened and the liquid is allowed to escape into a recipient. It is replaced by new gasoline, which is used in the same manner. After three extractions have been made the residue is squeezed dry in a screw press and all the liquids are collected and evaporated. The fatty matter remaining is weighed.

**Fourth Operation.** The matter left in the press is placed again in the separatory funnel with about 500 cubic centimeters of alcohol. After a few hours stirring, the alcohol is collected. A second and a third extraction are made with new alcohol. The residue is then placed in a press and squeezed dry. The fluid is reunited to that which resulted from the extractions and evaporated to a thick consistency. Then it is treated with water, which generally determines the formation of a precipitate of resins. This is collected in a weighed filter and dried. Its weight represents the percentage of resin contained in the dry substance.

**Fifth Operation.** The filtrate from the precipitate of resin is divided into two equal parts, I and II. Part I. is treated with chloroform and a few drops of hydrochloric acid in a separatory funnel. After frequent stirring, the stop-cock is opened and the chloroform separated from the aqueous solution. Then it is filtered, in order to remove moisture, and evaporated to dryness. Should the vegetable contain a glucoside, it will generally be found, crystallized or not, in the residue. Its weight, multiplied by two, will give its percentage.

**Sixth Operation.** From 5 to 15 grammes of dry raspings of washed ox hide are introduced into part II. and left in a cool place. Two days afterward the liquid is filtered off and the raspings are left a few hours in some 10 liters of water. Then they are collected in a filter, dried at 100° C., and weighed. Their increase in weight, multiplied by two, is the percentage of tannin contained in the dry substance.

**Seventh Operation.** The residue from the fourth operation is extracted some ten times with a large excess of water. Then it is squeezed dry a third time, dried at 100°, and weighed. The tenth part of its weight is placed in a covered mortar with 200 cubic centimeters of Schweizer's solution. The mixture is frequently stirred. After some 12 hours it is filtered in a funnel stopped with a tampon of asbestos, after which a little water is used to wash mortar, funnel and asbestos. The acetic acid is poured into the liquid until it is changed from a dark to a greenish blue. The precipitate is washed by decantation with a large quantity of water for two or three days. Finally, it is collected in a weighed filter, dried, and weighed. Its weight, multiplied by ten, is the percentage of cellulose contained in the dry substance.

**Eighth Operation.** Another tenth part of the water-washed and dried residue from the fourth operation is incinerated; the weight of ashes is added to that of cellulose found previous its multiplication by ten. The sum of both numbers is subtracted from the weight of a tenth part of the dried residue from the fourth operation. The difference multiplied by ten is the percentage of insoluble proteic matter contained in the dry substance.

**Ninth Operation.** One hundred grammes of fresh substance are ground in a mortar with 500 cubic centimeters of water for several hours. This operation is repeated three times with new water. The water used is filtered and divided into two parts, I. and II. Part I. is heated to ebullition for a few minutes. If a precipitate be deposited it is collected in a weighed filter, dried and weighed. Its weight multiplied by two is the percentage of soluble albumine contained in the fresh substance.

**Tenth Operation.** A few drops of acetic acid are added to the filtrate from part I. Should a precipitate be seen, it will be collected and weighed as above, and the percentage of caseine calculated in the same manner.

**Eleventh Operation.** Part II. is evaporated till reduced to a small volume; then it is mixed with an excess of alcohol. The precipitate is collected and dried as above. Its weight, multiplied by two, is the percentage of dextrine, gums, and pectic bodies contained in the fresh substance.

**Twelfth Operation.** The filtrate from the preceding operation is distilled; all the alcohol is evaporated. The aqueous residue is heated for five minutes at 90° with a twentieth volume of hydrochloric acid and introduced into a graduated burette, then the sugar is dosed with Fehling's solution.

**Thirteenth Operation.** If the microscope show the presence of starch in the solution, from 300 to 2,000 grammes are rasped or ground, and treated with a large quantity of water, and the fluid is passed through a sieve. After a few hours, starch will be found at the bottom of the vessel. This starch is collected, dried, and weighed.

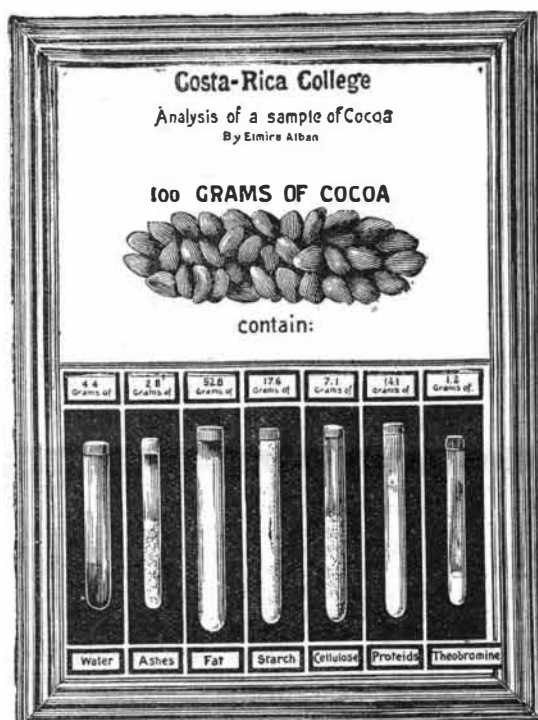
**Fourteenth Operation.** From one to five kilogrammes of finely divided matter are extracted, with

from three to fifteen liters of hot water and a little hydrochloric acid. After filtration through a linen cloth, the fluid is neutralized with lime. The precipitate, mixed with lime in excess, is collected on a piece of linen, squeezed dry with a press, and dried at 100° C. It is then ground and extracted with hot alcohol. The fluid is filtered and concentrated. Should the plant contain an alkaloid, it will generally crystallize on cooling, and by weighing, its percentage can be calculated.

**Fifteenth Operation.** If the substance emit a strong aromatic smell, from 200 to 5,000 grammes should be distilled with water, and the proportion of essence will be found by collecting and weighing the drops of oleaginous matter found floating on the distilled water.

**Sixteenth Operation.** One hundred grammes of dry matter are directly extracted in the water bath with 100 c. c. of hot and rectified alcohol. If the cooling of the filtered liquid determinate the formation of crystals, the residue is extracted again with 500 c. c. of alcohol; the liquid which results from both extractions is filtered and concentrated. On cooling it will deposit the mannite and congeners (*dulcete, perseite*) contained in the plant.

A special feature of the proximate method is that it can be used to convey instruction and inspire a love of it not only to the pupil who has made the analyses, but also to the younger pupil who may be ignorant of the very word "chemistry." To attain that purpose it suffices that the result of the analysis be presented in an objective and telling manner. Instead of writing down the names and proportions of the substances extracted from the compound that was analyzed, the pupil will present them in nature after a suitable and suggestive plan. The compound that was analyzed and the bodies extracted from it are fastened directly, or contained in tubes, on a large sheet of pasteboard. The natural mixture comes first, then the bodies that it contains, and the aggregate weight of the latter must make up the weight of the former. The figure shows the arrangement of the whole.



Thus expressed, the result of a proximate analysis will be intelligible even to little boys, while it would have been perfectly meaningless to them had it been presented to them in the usual way. If it be suspended on the walls of a lower class room, it will be a help to them in the object lessons. Thus the pupils can be made to instruct their younger school fellows, and these can be gradually and directly prepared for the chemical work they will have to undertake later on. Given to its author, such a frame will constitute a means of instruction as well as a record of good work in former years.

Life is too short to follow the longest way in studying any branch of human knowledge. The results of the actual teaching of chemistry in laboratories are great difficulties presented to the teacher, lack of interest to the pupil, and loss of time to both. The reform I propose is not something new. It is but the extension to secondary education of the analytical principles now so generally applied to primary work. I hope that those teachers who know, by experience, the soundness of these principles will not hesitate in giving the proximate method a fair trial.

## THE ADDITION OF SALICYLIC ACID TO WINE.

At the Great Marlow Petty Sessions, on June 23, before R. Hay-Murray and E. Clark, Matthew John Clifton, of Marlow, grocer, was summoned under the Sale of Food and Drugs Act for having sold, to the prejudice of the purchaser, some raspberry wine adulterated with salicylic acid and colored with Brazil wood. Mr. Wilkins conducted the prosecution and Mr. P. Rose-Innes, barrister, appeared for the defense.

Superintendent Sargent proved the purchase from Mr. Clifton's shop of a bottle of raspberry wine for which he paid 1s. on May 16 last. He was served by an assistant. He divided the wine into three parts, leaving one part with the defendant's assistant. In cross-examination this witness admitted that he had since purchased from Mr. Clifton's shop another bottle of raspberry wine for his own consumption.

Walter William Fisher, of Oxford, public analyst for Bucks, produced his certificate of analysis of the wine in question. He found it to contain about the usual quantity—20 per cent.—of proof spirit, with sugar, etc., and about 18 grains of salicylic acid. The wine was colored with what he believed to be Brazil

wood. In his opinion salicylic acid was not a proper constituent of raspberry wine. It is a drug made from carboic acid. Brazil wood is not present in raspberries, and was not, in his opinion, necessary for the manufacture of raspberry wine.

I never have been a manufacturer of raspberry wine. I do not remember having analyzed a sample of raspberry wine before this one. I am a Master of Arts, but have no medical degree. The test I used was white ribbon and gelatine. I used a variety of tests, and comparing the results with those previously obtained, I came to the conclusion that the coloring matter used was Brazil wood. I did not pursue my analysis to find cochineal. I know of no substance other than Brazil wood that would produce the color and effects I found. I am aware that cochineal is much used for cooking and coloring purposes, and that it is perfectly harmless. For discovering the salicylic acid I added perchloride of iron, which produces a violet color, which would indicate the salicylic acid or carboic acid, but the last mentioned was entirely out of the question. I believe that salicylic acid stops fermentation. I don't know that it is largely used in this country. I have found it in beer, but I don't get many samples of beer to analyze, but of 1,700 analyses I have made I only found it in two instances. I have examined samples of wine in which salicylic acid was not present.

Mr. Hay-Murray—We are called upon to decide, not whether the salicylic acid is injurious or not, but whether it was in the wine or not.

Mr. Rose-Innes contended that there could be no offense when an article was necessary and was used for a commercial and not for any improper purpose.

In addressing the bench for the defense Mr. Rose-Innes said there was nothing to show that the acid was used for a fraudulent purpose. It was much more costly than the wine itself, and was simply used to prevent deterioration of the article. He also took exception to the certificate. It was provided in the 18th section of the act that the certificate should give the exact quantities of the ingredients found, which had not been done in this case. He should prove by the very highest scientific authority that the introduction of salicylic acid in proper medical proportion was not only not injurious, but absolutely beneficial to the wine with which it was mixed.

The first witness called for the defense was Mr. Granville Sharpe, who described himself as an analytical and consulting chemist.

He had analyzed this wine and found it to contain a large quantity of raspberry juice and a small quantity of salicylic acid, and nothing injurious to health. He detected some coloring matter and found it to be cochineal, which is perfectly harmless and frequently used to intensify color. He did not find any Brazil wood. The salicylic acid was in the proportion of about 2 grains to a bottle. In cross-examination he said he tested for Brazil wood, but did not find any. He did not test the residue. He was not told what to search for in the wine.

Professor W. Lascelles-Scott said he was a consulting analyst, lecturer on chemistry and hygiene to the London Conservatoire, consulting analyst to the Royal Commissions (C.I.E.) for Victoria, the Mauritius, the India Museum, the West Riding Chamber of Agriculture, etc. He had held the appointment of public analyst for the counties of Derby, Glamorgan, North Staffordshire and the Borough of Hanley, and had had great experience in the examination of food products. He had analyzed this wine. There was no trace of Brazil wood in the wine whatever, and his tests would certainly have detected it had any been present. The color was due to the raspberry juice and a very small proportion of cochineal—a coloring matter largely used in improving the appearance of various articles of food and drink, as it was perfectly innocuous. Salicylic acid was also present in a very small quantity—700 fluid grains (one hundredth part of a gallon) of the wine only contained 0.165 of a grain of the acid, equal to 16½ grains per imperial gallon, or about 2½ grains per bottle. This was a proper proportion and sufficed to prevent secondary fermentation in the wine and to keep it in a wholesome condition.

All wines containing a good deal of sugar and but little alcohol were liable to this change—raspberry wine especially—and needed some antiseptic to make them keep at all.

Salicylic acid being effective and not at all injurious to health, was one of the very best that could be used for the purpose.

He had obtained the salicylic acid by exhausting the wine extract with pure ether, and identified it by means of perchloride of iron and the microscope. The coloring matters he recognized by a number of tests, including the spectroscope, and the specimen of silk he produced would have been colored very differently were any Brazil wood present in the wine. Had such a sample been officially submitted to him during his career of public analyst, he should have undoubtedly certified it as being "Not adulterated."

Cross-examined, the witness said he had extracted the whole of the salicylic acid from the portion of the wine tested by exhausting it seven times with ether; of this the last two portions yielded no residue whatever. The salicylic acid was absolutely necessary to preserve the wine. He was instructed to search for the acid and for Brazil wood, but the latter was absent, while of the acid there was not "18 grains" in a bottle of the wine—only about 2 grains. He had frequently analyzed raspberry wine; this was a well-made sample. He had not "made" raspberry wine himself, but, as it happened, his wife had done so once.

Mr. Wilkins—And, pray, did she put salicylic acid in it?

Mr. Lascelles-Scott—No; but I did, to "keep" it. (Laughter.)

Dr. John L. W. Thudichum said: I am an M.D., M.R.C.S., and F.R.C.P., and Scientific Referee to the Board of Trade. I agree with Mr. Lascelles-Scott that the use of salicylic acid is necessary to prevent fermentation in wine, and that it is quite innocuous. Large quantities of the acid are used in food without injury from it. If a shilling's worth of the acid were put into a bottle of raspberry wine, no harm would follow to those who partook of it.

Dr. Bond said: I am lecturer to the College of Physicians. I have had long and extensive experience in the use of salicylic acid, and have been in the habit when away from home hunting in the country of tak-

\* Among the principal, we wish to mention Wittstein's Anleitung zur chemischen Analyse von Pflanzen, Druggendorff's Chemische Analyse von Pflanzen, and, above all, Prescott's Outlines of Proximate Organic Analysis. This last treatise seems to me to be more complete and more accurate than any of the similar French or German works.