

THE EXAMINATION OF CHINESE AND JAPANESE WOOD OIL.

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CHINESE WOOD OIL.

DURING recent years the trade in Chinese wood oil has assumed considerable proportions, and its chemical examination has consequently become a matter of importance both to buyers and sellers. This fact, coupled with the very interesting nature of the oil itself, has induced a number of chemists to devote themselves to its investigation, and a number of papers dealing with the general chemistry and analytical examination of the oil have been published in English, American, and Continental journals. Notwithstanding this, it cannot be said that chemists are in complete agreement as to the properties which should characterise the genuine oil, and for some time past trade disputes culminating in

arbitration cases have been of somewhat frequent occurrence. Having for several years been much interested in the examination of this oil, I have thought that it might not be without interest if I were to place some of my results and conclusions before this Society.

This oil is obtained, as is well known, from the seeds of the *Aleurites cordata*—a tree which grows extensively in China and other parts of the East. Other species of *Aleurites*—as, for example, *Aleurites Fordii*—also occur, and it is probable that the commercial oil often represents a product obtained from more than one species. I shall revert to this later.

According to a recently-published United States Consular Report, it would appear that Szechuan oil is preferred in Hankow on account of its lighter colour, and that the province of Szechuan accounts for 30 per cent. of the total production, Hunan and Kweichow producing 50 per cent., and Hupei (chiefly in the region of Ichang) 20 per cent. Lewkowitsch ("Chemical Technology and Analysis of Oils, Fats, and Waxes," fourth edition, vol. ii., p. 60) states that, in the preparation of the oil, the seeds are roasted in a flat dish over a naked fire, are then crushed between stones, and the oil expressed from the crushed mass in primitive wooden presses. This account of the preparation of the oil is confirmed by several independent statements made to me by persons who have resided for a considerable time in China, and who are familiar with the method of expression adopted by the natives. This crude method of obtaining the oil, considered in conjunction with the fact that the production is in the hands of a large number of very small producers, and that the oil in question is a powerful drying oil, is of considerable importance, since it affords a partial explanation of the somewhat widely varying analytical results which have been obtained by chemists in the examination of this oil, and which have been recorded in the literature of the subject. The small quantities of oil produced by the various individuals are collected by Chinese middlemen, and sold to merchants in Hankow, who clarify the oil in tanks, and then pack it for shipment. In colour the oil varies very considerably, the dark oils having as a very general rule a more markedly unpleasant taste and smell than the paler ones.

The analytical determinations which are of the greatest importance are the specific gravity, the iodine value, the refractive index, the viscosity, and the manner in which the oil polymerises when heated. I propose to refer in the first place to these estimations, and to deal later in the paper with several supplementary methods of examination.

Specific Gravity.—Since the specific gravity of Chinese wood oil is higher than that of any other fatty oil, with the exception of castor oil and possibly of tallow-seed oil, the determination of that number is clearly of great importance. The numbers recorded in literature vary somewhat considerably, but many of the earlier ones are of less value than they might otherwise have been owing to some apparent confusion between the Chinese and the Japanese oil, and also to the fact that in some cases the nature of the ratio oil : water is not clearly stated. Among later and more reliable numbers may be mentioned those of Lewkowitsch ("Chemical Technology and Analysis of Oils, Fats, and Waxes," fourth edition, vol. ii., p. 63) 0.9412 to 0.9418; Kreikenbaum (*J. Ind. and Eng. Chem.*, 1910, 2, 205), 0.9401 to

0.9454; and F. Browne (*Chem. News*, 1912, **106**, 15), 0.9402 to 0.9431. Jenkins (*ANALYST*, 1898, **23**, 113), in a paper communicated to this Society, gives 0.9343 and 0.9385 for two samples; but as he uses the terms "Japanese wood oil," "Chinese wood oil," and "tung oil," as synonymous, the value of these numbers is considerably diminished. Rowland Williams (*J. Soc. Chem. Ind.*, 1898, **17**, 304), in a paper entitled "Japanese Wood Oil," gives numbers ranging from 0.9413 to 0.9432, and it is tolerably clear from these and the other results he gives that these were samples of the Chinese oil. Boughton (*Seventh Int. Cong. App. Chem.*, 1909, Section 1, 89) records numbers for five samples of China wood oil which he had received directly from the United States Consul at Hankow, and for two further samples which had been pressed for him from the nuts. Six of these gave numbers ranging from 0.9408 to 0.9428 at 15.6° C., but one of the five samples from Hankow had at the same temperature a specific gravity of 0.9346, which is far below any number recorded by other observers for the Chinese oil, and which must tend to throw considerable doubt on the purity of the specimen.

Iodine Value.—Since this number depends so largely on the precise method adopted and upon the conditions under which the test is carried out, and as this information is not given in many of the earlier papers, it would serve no useful purpose to refer in detail to the numbers recorded, but it may be said that numbers varying from 150 to 170 have been given. In some cases, however, it is probable that the Japanese oil had been used. Boughton (*loc. cit.*) has made a special study of the extent to which the iodine value varies with different experimental conditions, and finds that variations in temperature have much less effect on the Hubl than on the Hanūs method. For several reasons I prefer the Wijs method, and the iodine values recorded in the table given below have been determined in the following manner:—About 0.1 gm. of the oil was taken, dissolved in 20 c.c. of purified carbon tetrachloride, 30 c.c. of the ordinary Wijs solution were added, and the reaction allowed to proceed for three hours in the dark.

Refractive Index.—Since the refractive index of wood oil is considerably higher than that of any other fatty oil, the determination of that value is of the greatest importance from the analytical point of view. Comparatively few numbers are recorded in the literature of the subject, but it may be mentioned that Boughton gives 1.5238 at 15.6° C., which is approximately equal to 1.521 at 20° C., the temperature at which my own observations have been made.

Viscosity (Time of Efflux).—As the viscosity of tung oil is considerably higher than that of any other fatty oil which would be likely to be used as an adulterant, a determination of that number is very useful, although, as will be seen from the results recorded below, there are wide variations even in the case of oils of undoubted genuineness. It must not be overlooked, moreover, that the viscosity of wood oil may be very considerably increased by heating it to a temperature short of that required for its solidification. The viscosities given in the following table have been determined in a standard Redwood viscosimeter at 15.5° C. From a circular recently issued by the New York Produce Exchange, it would appear that C. V. Bacon has made a large number of viscosity determinations, using a Tagliabue instrument, and that he attaches considerable importance to the results.

Heat Polymerisation Test.—One of the most interesting and characteristic properties of wood oil is that of solidifying to a jelly when heated to a sufficiently high temperature, a change which appears to be due to the polymerisation of the glyceride of elæomargaric acid, of which the oil largely consists. Since the hardness of the resulting jelly is considerably diminished by the addition of other fatty oils, it will be seen that a test based upon this property is capable of yielding very important indications. Several attempts have been made to make such a test quantitative. Thus, in a circular issued by the New York Produce Exchange, to which I have referred already, a method devised by C. V. Bacon is tentatively put forward as a method to be adopted in the United States. Since this test has not, so far as I am aware, been published in any scientific journal, it may be well to give the following description of it :

“ Into a test-tube of $\frac{3}{4}$ inch diameter and 4 inches in length there are transferred about 10 c.c. of pure China wood oil ; into another test-tube there is transferred a similar volume of pure China wood oil adulterated to the extent of 10 per cent. A sample of the oil to be tested is treated in a like manner, and these are placed in a proper support and immersed in an oil bath which has a temperature of about 288° C., so that when the tubes are in it a temperature of 280° or 285° C. (maximum) can be maintained. The oil bath containing the tubes is maintained at this temperature for exactly nine minutes, the tubes are then withdrawn and the test sample is compared with the pure oil, and the same oil adulterated with 5 and 10 per cent. of foreign oil. After the tubes are withdrawn from the oil bath, each tube should be stabbed from the top to the bottom with a small bright spatula. Pure oil will give a hard, clean cut, and when the knife is withdrawn the incision will look like a straight line, while an oil having as low as 5 per cent. adulteration will invariably be softer, and the incision will have a peculiar feathered effect ; an adulteration of 10 per cent. will be soft and pushy, while an adulteration exceeding 12 per cent. in many instances will remain entirely liquid.”

In the same circular a further test is described as being one at present used by New York importers and varnish-makers. This is described in the following words :

“ For Hankow and Shanghai wood oil, 100 grms. should be heated in an open basin (6 inches in diameter) as soon as possible to a temperature between 540° and 560° F., and if it solidifies in about six to six and a half minutes, cuts dry, and is firm in body, without discoloration and without being sticky, it should be passed as a good delivery. For Canton and Hong-Kong wood oil deliveries, the time should be from four and a half to five and a half minutes in an open basin as above. Should a longer time be taken by presumably pure wood oil, other tests confirming purity shall be positive.”

This latter test is, in my opinion, an unsatisfactory one, since it is impossible to control the high temperatures necessary or to keep them at all constant, owing to the shallowness of the containing vessel and the large cooling surface. As soon, moreover, as solidification commences, it is impossible to continue the stirring, with the result that, if the application of heat be continued, the bottom portions of the oil will char, whilst the top portions are still in a soft and sticky condition. The main objection to Bacon's method lies in the fact that it involves comparison with a

standard sample, which in turn implies that wood oil is practically constant in its polymerising properties. If all genuine wood oils were known to polymerise in precisely the same manner, there would be some justification for drawing definite conclusions from the indications furnished by such a method, although even then they could not, from their very nature, be more than roughly quantitative. There can be no doubt, however, that such is not the case, and consequently it is not wise to attempt to draw too definite conclusions from the results of the heat test, valuable as its indications are. It may be mentioned in this connection that F. Browne (*loc. cit.*) has described a method of applying the heat test which is, in my opinion, superior to that of Bacon, and less open to criticism, inasmuch as he recognises that genuine oils may vary somewhat in their setting properties; but the temperature to which the oil is heated is so high that the differences between the setting period of a genuine oil and one adulterated with, say, 10 per cent. of some other fatty oil is only two or three minutes. As the result of a considerable amount of experience, I have been led to attach more importance to the hardness of the jelly obtained under standard conditions than to the time required for bringing about polymerisation, and I have devised the following method of carrying out the test, which is capable of yielding definite and concordant results :

About 5 c.c. of the oil to be examined are introduced into each of two test-tubes 6 inches long by $\frac{5}{8}$ inch diameter. These are then immersed in a bath containing melted paraffin wax at a temperature of approximately 100° C. The temperature of the bath is then raised to 250° C., taking about fifteen minutes for the operation. As soon as that temperature is reached the time is noted, and the source of heat adjusted so that the temperature of the bath is maintained constant at 250° C. At the end of half an hour one of the tubes is withdrawn, allowed to cool, and, when cold, is broken, and the jelly examined. The other tube is kept in the bath at 250° C. for a further period of half an hour, at the end of which time it also is withdrawn and allowed to cool; it is then broken, and the hardness of the jelly observed. Chinese wood oil of good quality should give at the end of half an hour a fairly firm jelly, which, at the end of one hour, should become quite hard. It is advisable in all cases to carry out comparison tests alongside of the oil under examination, using for the purpose a sample of oil known to be of good quality.

I have not found it possible to express the hardness of the solidified cylinders by means of numbers, but with a little experience it is very easy to distinguish between a sample of genuine oil and the same oil containing a small percentage of some fatty oil, such as soya bean or sesame. In referring to the polymerisation experiments, I have used the words "very hard," "hard," and "fairly hard," to denote the consistency of the polymerised oil, since such expressions are quite sufficient for the purpose. In addition to the degree of hardness of the solid cylinders of oil, some attention should be given to their physical characters. When cut with a knife or broken across, the cut or fractured surface should be smooth and free from stickiness, and small portions when rubbed in the hand should break down completely into a soft crumbly mass, which should not adhere to the fingers.

In the following table I give the results of the examination of seventeen samples of Chinese wood oil from Hankow :

Sample.	Iodine Value.	Sp. Gr. 15°/15° C.	Saponification Value.	Refractive Index at 20° C.	Time of Efflux at 15·5° C. Seconds.	Polymerisation One Hour at 250° C.
No. 1	169·9	0·9419	196·6	1·5207	2178	Very hard.
„ 2	168·4	0·9406	193·8	1·5181	1636	Hard.
„ 3	166·5	0·9426	194·3	1·5190	1946	Fairly hard..
„ 4	166·4	0·9417	193·0	1·5170	1880	„
„ 5	168·8	0·9430	195·6	1·5195	2017	Very hard.
„ 6	170·0	0·9440	194·5	1·5180	1849	Hard.
„ 7	168·6	0·9416	193·0	1·5150	—	Fairly hard..
„ 8	171·0	0·9414	192·0	1·5170	—	Hard.
„ 9	169·7	0·9437	194·1	1·5176	1997	„
„ 10	173·0	0·9420	192·5	1·5165	1722	„
„ 11	176·2	0·9417	192·0	1·5168	1605	„
„ 12	172·6	0·9429	196·0	1·5180	1740	„
„ 13	174·2	0·9427	194·6	1·5182	1690	„
„ 14	173·7	0·9430	195·0	1·5194	1820	„
„ 15	172·8	0·9440	194·6	1·5193	2047	„
„ 16	169·5	0·9420	195·2	1·5160	1804	„
„ 17	169·6	0·9433	195·2	1·5187	1820	Very hard.
Average ...	170·6	0·9425	194·2	1·5179	1850	

On reference to the above table it will be seen that the specific gravities of the seventeen oils in question range from 0·9406 to 0·9440, and these results, which are confirmed by a very much larger number, may be regarded as approximately the limits of variation for the genuine oil. I am not prepared to say that no pure Chinese wood oil has a specific gravity below the lower limit mentioned above, but a result appreciably below 0·940 is in itself sufficient to cause a sample of oil to be regarded with suspicion.

With regard to the iodine value, it will be seen that the average of the results is 170·6, and it may be taken that a genuine oil should not give numbers differing from that by more than a few units, using the Wijs method, and adopting the conditions I have specified.

The saponification value is not, in the majority of cases, of very much importance; but as it may sometimes be useful, it should always be determined. It is interesting to note that my limits agree fairly closely with those recorded by Rowland Williams (190·7 to 196·1), in the paper to which reference has already been made.

The refractive index rarely falls below 1·517, and an oil giving a result below 1·515 at 20° C. should be regarded with suspicion.

As I have already pointed out, the viscosity of this oil appears to vary within somewhat wide limits, but the numbers I have given will suffice to indicate the kind of result which may be expected in the case of genuine oils.

A paper dealing with the oil derived from the seeds of *Aleurites Fordii* having appeared in the Bulletin of the Imperial Institute (1907, 5, 134), I wrote to Professor

W. R. Dunstan asking him if he could let me have some of this oil. Although he had none of the oil left, he kindly supplied me with a quantity of the nuts of *Aleurites Fordii*, as well as with some of the *Aleurites cordata*, and I desire to take this opportunity of expressing to him my thanks for this courtesy. From each of these I prepared a quantity of oil by petroleum extraction, and found that the former had a specific gravity of 0.9427, and the latter of 0.940. Both these oils, however, were abnormal in respect of their polymerising properties, and for that reason I have not included the other analytical results. Whether this abnormality is due to the method of extraction adopted or to the fact that the nuts were several years old, I am not prepared to say, but it is certain that both oils were markedly inferior in their polymerising power to any genuine sample of the commercial oil that I have examined. This result gives point to the remark I made in criticising Bacon's method, that all samples of genuine wood oil cannot be expected to polymerise in exactly the same manner. There is no doubt that Chinese wood oil, like all other oils, varies within certain limits, both in respect of its chemical and physical properties. As a matter of fact, botanical and geographical origin, climatic variations, differences in treatment during the manufacture of the oil, and the duration and conditions of storage, unquestionably affect its properties, and I am, therefore, very strongly of opinion that it is not advisable in determining its purity to adopt any single method which involves a comparison with an oil possessing certain properties in a maximum degree. Of course, if any purchaser desires to buy wood oil on the results of the polymerising test alone, I see no reason why he should not do so. It must not be overlooked, however, that it may quite well happen that oil which does not reach a certain high polymerisation standard may nevertheless be free from adulteration.

Supplementary Tests.

Drying Test.—About 0.3 to 0.4 grm. of the oil is spread in a thin film on a glass plate and heated in an air-bath for one hour at a temperature of 105° C. The genuine oil dries completely to a crinkly, rubber-like substance, which can be removed without difficulty from the glass surface, and which is free from softness or oiliness. Under these conditions the oil gains from 2 to 3 per cent. in weight.

Iodine Test.—As is well known, if a solution of iodine in chloroform or some other suitable solvent be added to the oil, almost immediate solidification takes place. This is a very useful qualitative test, and McIlhiney (*J. Ind. and Eng. Chem.*, 1912, 4, 497; ANALYST, 1912, 410) has recently been carrying out experiments with the object of ascertaining whether it might not be made quantitative. In the method he has put forward tentatively, an excess of a solution of iodine in glacial acetic acid is added to a weighed quantity of the oil dissolved in the same solvent. The products of the reaction are then extracted with petroleum ether, and the amount of oil which has not undergone solidification, and which is soluble in the petroleum, is weighed. I have made a few experiments with this process, and have obtained results which appear to indicate that when this test is fully worked out it will be found to be a very useful one.

Optical Activity.—A number of samples of oil which I have examined have been practically inactive, although in one case a slight dextro rotation (+ 1° for a

100 mm. tube and sodium light) was observed. Tallow-seed oil, on the other hand, is known to be appreciably lævo-rotatory.

Bromine Thermal Value.—This number was determined by the method recommended by Hehner and Mitchell—viz., by adding 1 c.c. of bromine to a solution of 1 grm. of the oil in 10 c.c. of chloroform, the mixture being kept in a vacuum jacketed test-tube. The following results were obtained in the case of six samples of the oil:

			Rise in Temperature. °C.		Iodine Value. Rise in Temperature.
Sample A	...	...	24·10	...	7·00
Sample B	...	...	24·76	...	6·80
Sample C	...	...	25·57	...	6·51
Sample D	...	...	24·98	...	6·92
Sample E	...	...	24·72	...	7·00
Sample F	...	...	24·56	...	7·17

For purposes of comparison I give below the values obtained in the case of three samples of the Japanese oil:

			Rise in Temperature. °C.		Iodine Value. Rise in Temperature.
Sample A	...	...	24·70	...	6·40
Sample B	...	...	23·10	...	6·45
Sample C (prepared in laboratory)			24·50	...	6·27

It will be seen that the average value (6·9) obtained by dividing the iodine value by the rise in temperature is substantially the same as that given by Jenkins (*loc. cit.*) in his paper on wood oil. There appears, however, to be no reasonable doubt that the two samples of oil with which Jenkins worked were Japanese oil, and for this it will be seen that my average value is somewhat lower—viz., 6·37. In both cases, however, the value is appreciably higher than with the great majority of fatty oils.

Hexabromide Test.—It has been shown independently by Hehner and Mitchell, and by Jenkins, that when wood oil is treated with bromine under the conditions laid down by the former authors (*ANALYST*, 1898, **23**, 310), no ether-insoluble bromide is formed. I have confirmed the correctness of these observations, working with the seventeen samples of Chinese wood oil referred to above, and with four samples of the Japanese oil. In no case was there the slightest formation of precipitate, even when the flask containing the mixture was kept in iced water and allowed to stand for twenty-four hours. On the other hand, perilla, candle nut, and tallow-seed oils all yield more or less hexabromide; and as these oils are possessed of high drying properties, and are produced in large quantities in China and the East, the test may be one of considerable importance, and is, in any case, one which should always be applied. In addition to the above-mentioned oils, it would, of course, aid in the detection of linseed oil. Tea-seed oil, as might be expected, does not yield any insoluble bromide. I have been able to detect with considerable ease the presence of 10 per cent. of perilla oil, but it should be mentioned that this oil yields a much larger proportion of the hexabromide than any of the oils mentioned above, with the possible exception of linseed.

The oil should, of course, be tested in all cases for those fatty oils such as cotton-

seed and sesame, which give characteristic reactions. I may mention, in this connection, that although I have only in one instance detected cotton-seed oil in Chinese wood oil, I have obtained the Baudouin reaction for sesame oil in a considerable number of cases. Genuine China wood oil does not give this reaction, nor does tea-seed oil. In a few instances in which the reaction was very faint it is possible that it may have been due to the fact that the wood oil had been tanked in a vessel which had previously contained sesame; but in the other cases there can be no doubt that sesame oil had been used as an adulterant, particularly as the majority of these samples were met with at a time when wood oil was commanding an unusually high price.

JAPANESE WOOD OIL.

As I have already indicated, many observers have regarded this oil as being practically identical with Chinese wood oil, and have referred to the two indiscriminately under the common designation "tung oil." Whilst resembling Chinese wood oil somewhat closely in its general characters, it appears to be chiefly obtained from the nuts of a different tree—viz., the *Paulownia imperialis* (Japanese *Kirinoki*), although it is not improbable that other seeds may occasionally be employed. The chief producing centres appear to be Wakasa and Echizen. Very little of this oil is exported from Japan, almost the whole being required for home consumption; and its chief interest to the analyst lies in the fact that the two oils are not equally suitable for certain manufacturing purposes, and that accidental or intentional substitution of one for the other may occasionally occur. I give below the results of the examination of three samples, all of which were obtained through the courtesy of the British Consul-General in Kobe:

Sample.	Iodine Value.	Sp. Gr., 15°/15° C.	Saponifica- tion Value.	Refractive Index at 20° C.	Time of Efflux at 15·5° C. Seconds.	Polymerisation Two Hours at 250° C.
No. 1 ...	158·0	0·9377	195·2	1·5083	1230	Soft.
No. 2 ...	149·0	0·9400	193·4	1·5052	1620	Soft.
No. 3 ...	151·8	0·9349	196·3	1·5034	—	Very soft.

"No. 1" was produced in Wakasa, whilst "No. 2" came from Idzumo. As to the district from which "No. 3" was derived, I am not quite sure.

In consequence of a letter which I wrote to the British Consul at Kobe, I received through the kindness of Messrs. Jardine, Matheson, and Co., Ltd., a quantity of the nuts of the *Paulownia imperialis*, from which the Japanese oil is made. A quantity of the oil was prepared from these nuts by extraction with light petroleum, and gave on analysis the following results:

Specific gravity (15°/15° C.)	...	...	...	...	0·9351
Iodine value ...	...	...	...	...	153·5
Saponification value	...	...	...	...	193·5
Refractive index at 20° C. ...	...	...	...	...	1·5050
Bromine thermal value (rise in degrees Centigrade)	...	...	...	...	24·5

When heated for two hours at a temperature of 250° C., this sample had not solidified, but was still a viscous oil. On reference to the above numbers it will be seen that with the possible exception of "No. 2" the specific gravities are very appreciably below those of the Chinese oil, which confirms the statements of Lewkowitsch and other observers. The same applies to the iodine values and refractive indices. Even greater than these differences, however, are the differences in polymerising properties, the Japanese oil remaining quite liquid under conditions such as suffice to convert the Chinese oil into a very hard jelly, which crumbles when rubbed between the fingers and becomes a dry powder.

My best thanks are due to my assistant, Mr. Frederick T. Harry, for his valuable help in connection with this work.

DISCUSSION.

Mr. HEHNER remarked that when the fatty acids from this oil were dissolved in acetone and cooled, magnificent crystals resulted. This property was possessed by no other fluid oil. The crystals retained their form as long as the vessel was kept closed: when it was opened they generally collapsed immediately into a jelly-like mass. Another remarkable feature of wood oil was that it was not capable of forming a hexabromide like other oils having a high iodine absorption—for example, linseed oil and fish oils—which might be used as adulterants. Probably the differences in the extent to which polymerisation took place were due to small quantities of botanical impurities which exercised a catalytic action.

Mr. J. H. B. JENKINS said that when he examined these oils fifteen years ago the quantity of them on the market was very small, and consequently his investigation had been much more limited than that of Mr. Chapman. He should like to emphasise what Mr. Hehner had said as to the bromine addition value: the absence of any insoluble brominated compound markedly distinguished these oils from other drying oils. It was the indirect result of Mr. Hehner's and Mr. Mitchell's valuable work on the bromine reactions that had called his attention to the peculiarities of these oils. Following those authors' method, he had compared the iodine values and heat of bromination of a wide range of fatty oils. The usual factor for converting the one into the other was found, except in the case of a strange oil which was put into his hands by a friend as "Japanese Wood Oil." In that case, however, the factor was distinctly abnormal, and led him to think that iodine must have some exceptional action on the oil. He consequently tried the effect of adding a saturated solution of iodine to the oil dissolved in chloroform, and, whilst stirring, he found the whole was converted into a jelly. The other abnormal feature disclosed in his early examination of those oils was the very high refractive index. Both samples he had dealt with (*ANALYST*, 1898, **23**, 113) were supplied as "Japanese Wood Oil"; but at that time, in common with many others, he had looked upon Japanese Wood Oil and Chinese Wood Oil as the same.

Mr. E. R. BOLTON asked what was the lowest iodine value that Mr. Chapman had found in what might be accepted as genuine wood oil. In making some experiments with a sample of Chinese wood oil which he believed to be genuine,

but of which the iodine value was very low, he had found that with this oil the time required for complete absorption was very short, about a quarter of an hour's contact with Wijs' solution being sufficient, so that some of the low figures that had been published could hardly be attributed to insufficient time being allowed for absorption.

Mr. R. Ross remarked that the specific refraction $\frac{(\mu - 1)}{D}$ of the various oils referred to in the first table worked out at 542 to 550, and of those in the last table at 537 to 538, the figure for the oil expressed by Mr. Chapman himself being 534. He had found the McKinley process of bromine absorption to be very useful, since it showed both the addition products and the substitution products, and very often enabled one to account satisfactorily for certain differences that were observed.

Mr. L. M. NASH said that at the present moment the iodine value by itself was of no assistance in judging wood oil, since linseed oil was about £4 per ton cheaper than wood oil. Mr. Chapman's figures confirmed his own views as to the refractive index, specific gravity and viscosity, all of which should be as high as possible. As to heating tests, he agreed with Mr. Chapman's criticism of the American method of heating to a very high temperature in a shallow dish, but he had found it useful to make a test by heating about 5 ounces of the oil in a dish of standard size at a temperature about 100° F. lower than in the American test, and noting the time that it took to reach the condition in which the oil was used in the factory.

The PRESIDENT asked whether Chinese and Japanese wood oils were ever mixed together. If this were done it would probably render the detection of adulterants more difficult.

Mr. CHAPMAN, in reply, said that the difficulty of detecting adulterants would certainly be increased if the two kinds of oil were mixed, but he did not think this was done to any extent. He quite agreed with Mr. Hehner's remarks as to the value of the hexabromide test, and also with the suggestion as to the influence of small quantities of impurities on polymerisation. The oil extracted with petroleum ether polymerised much less readily than oil prepared by expression in the ordinary way. The Chinese oils, however, did vary appreciably in their polymerising power, so that heat tests based upon comparison with a single standard oil must be quite useless for indicating such small amounts of adulteration as were sometimes reported. The iodine test discovered by Mr. Jenkins was an excellent supplementary test. With regard to Mr. Bolton's question, he should not like to say positively that no genuine sample yielded a lower value than those he had given, but he thought that the figures he had recorded might be regarded as representing the limits which in the present state of knowledge it would be safe to adopt. He had met with lower iodine values, but was not sufficiently certain of the origin of the samples to include them.

