posing the ferrocyanide, and care should be taken to keep the volume of the solution and its acidity about as above stated. With practice the fusion can be made in about ten minutes and the whole determination in half an hour. We prefer to standardize our solutions with zinc oxide, made by evaporating a little of a solution of c. p. zinc sulfate in a weighed platinum dish, blasting a few minutes to remove all sulfur compounds, cooling and weighing. The same volume should be used in the standardization as in the regular determination, and about 10 grams of ammonium chloride or 40 grams of potassium chloride added to make the conditions the same, for it is well known that variations in the conditions change the value of the ferrocyanide solution.

Using this method, on the dried shavings from the treated tie, we obtained the following results in eight consecutive determinations: 0.881, 0.901, 0.891, 0.905, 0.896, 0.886, 0.901, 0.891 per cent metallic zinc. Using the untreated shavings, and adding to each determination a solution containing 0.0255 gram of zinc as chloride, the following amounts of zinc were found: 0.0253, 0.0251, 0.0250, 0.0252, 0.0253 gram. There is apparently a slight loss of zinc, probably due to spattering during fusion, being only about 0.02 per cent by weight of the original sample of shavings.

It is not essential to the success of this method that the zinc be determined by titration; after removing the nickel and the bromine it may, of course, be determined by any other method if desired.

So far as we were able to determine at the time this work was taken up, the only other satisfactory method for this determination was an electrolytic one devised by Mr. L. A. Stenger, of the Twin City Rapid Transit Co., of this city, and used in their laboratory. Mr. Stenger describes his method as follows:

"Five to 10 grams of borings or sawdust are taken, about 150 cc. pure water added, then 6 to 8 grams of sodium hydroxide. The mixture is heated nearly to boiling for a few minutes, then electrolyzed with a rotating platinum anode and silver-plated copper cathode for about forty minutes. The cathode area is about 250 sq. cm., and a current of about 5 amperes at six volts is employed. A tall 400 cc. beaker is used to allow some space for frothing, which can be prevented by addition of ether if desired. The cathode with the zinc deposit is removed quickly, washed with hot water and alcohol and dried. After weighing, it is replaced in the solution and the electrolysis continued for five to ten minutes. If little or no increase in weight is found, deposition is considered complete."

Mr. Stenger very kindly determined zinc in a sample of our dried shavings by the above method, and found 0.88 per cent, which is in good agreement with our results. He also tried our method as above outlined on the same sample, and on tamarack and red oak ties, one of which had been treated with both creosote and zinc chloride, and states that the method worked very well.

While we were working on this method, it was found in the laboratory of the Kettle River Co. that complete

oxidation of the wood could be obtained, even with red oak, by using potassium chlorate with the nitric and sulfuric acids in the ordinary method. Mr. Newton very kindly had their laboratory make two determinations on our sample by this method, the results being obtained 0.91 and 0.92 per cent zinc. It is evident that the agreement is as close as could be expected.

We believe that this method of fusion with alkali is adapted for the determination of minute amounts of metals in the presence of large amounts of organic matter of any sort, and have tried it on the determination of tin in canned goods, with success. A larger sample can, of course, be used if a larger nickel dish is at hand.

UNIVERSITY OF MINNESOTA
MINNEAPOLIS

HICKORY NUTS AND HICKORY NUT OIL

By GEORGE O. PETERSON AND E. H. S. BAILEY

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Since the hickory nut crop of the United States is a large one, although no accurate statistics exist in regard to it, it has seemed to us worth while to make a preliminary study of the properties of the oil. The genus *carya* of the walnut or *juglandaceae* family comprises eight species, only two of which, the *carya ovata* or shellbark hickory and the *carya amara* or swamp hickory are here considered. The shellbark nuts are of such commercial value that their oil could hardly be extracted with profit if intended for ordinary table use. The swamp hickory nuts and those called "pig nuts" are abundant and at present not utilized, except as food for hogs and squirrels.

Work on the composition of nuts has been carried on especially in the Iowa,¹ California² and Maine³ Agricultural Experiment Stations, and from two of these the analyses of hickory nuts (presumably *C. ovata*) are presented for comparison with our own analysis.

TABLE I—CHEMICAL COMPOSITION OF HICKORY NUTS

	Maine Sta.	Iowa Sta. meats	P. and B. meats
Refuse.....	62.2(a)	68.0	62.8
Edible portion.....	37.8	30.0	37.2
Water.....	1.4	3.97	3.45
Protein.....	5.8	20.5	13.2
Fat.....	25.5	64.6	70.2
Carbohydrates.....	4.3	..	..
Ash.....	0.8	2.2	1.73
Fuel value per pound in calories.....	1265	3226 (calc.)	3310 (calc.)
Crude fiber.....		2.3	2.0
N-free extract.....		6.40	9.42

(a) Per cents in this column refer to whole nuts.

The methods of analysis used were in general those of the "Official and Provisional Methods of Analysis," *Bull. 107*, Bur. of Chem., U. S. Dept. of Agr., with such modifications as seemed expedient. All desiccations were carried out in air instead of hydrogen.

HICKORY NUT OIL

In extracting the oil from the meats it was decided to use the pressure method rather than the extraction

¹ "The Chemical Composition of Nuts Used as Food," *Proc. Ia. Acad. Sci.*, **10**, 108-111.

² "Nuts and Their Use as Food," *Farmers' Bull. No. 332*.

³ *Maine Agr. Expt. Sta.*, **1899**, 87.

method, as the former is the commercial method, and the only one used for extracting edible oils. For extracting the oil a cylindrical press was constructed by using an iron cylinder with an inside diameter of $3\frac{1}{4}$ inches and a height of 7 inches into which was fitted a close-fitting piston. The cylinder was set on an iron plate perforated with several $\frac{1}{8}$ inch holes, and holes were drilled in the cylinder near the lower end to facilitate the running out of the oil. When hydraulic pressure was applied to the piston the oil exuded from the holes and collected in a metal pan in which the press had been placed. A pressure of 150 to 300 atmospheres was applied to the piston. A second pressure was applied to the material after breaking up the press cake and heating the press and the press cake to 50–60° C. The following table shows the yield of oil from the various samples, the total per cent of oil present, and the actual per cent of oil extracted:

TABLE II

Kind of sample	Yield in per cent	Total per cent of oil present	Per cent of oil present extracted
<i>C. Ovata</i> —Whole, cracked, cold-pressed.....	15.8	26.5	59.5
Hot-pressed.....	2.0	..	7.5
<i>C. Ovata</i> —Meats alone cold-pressed.....	30.6(a)	70.2	42.7
Hot-pressed.....	17.5	..	23.2
<i>C. Amara</i> —Whole, cracked, cold-pressed.....	22.1	..	..
Hot-pressed.....	3.8	..	..

(a) Only 100 atmospheres pressure.

The oils, as at first obtained, were cloudy, and the hot-pressed were darker than the cold-pressed. After filtration through filter paper the oils became bright and clear, and were of the appearance and consistency of Italian olive oil. They possessed an agreeable hickory nut odor and flavor.

The following table gives the constants as obtained from both these oils and for comparison those obtained at the Maine Experiment Station.¹

TABLE III—CONSTANTS OF HICKORY NUT OILS

	<i>C. amara</i>	<i>C. ovata</i>	Maine Expt. Sta.
Specific gravity at 24° C.....	0.9119	0.9119	0.9164
Refractive index at 20° C.....	1.4699	1.4699	1.4696
Hegner number.....	95.6	95.7	
Reichert-Meißl number.....	0.48	0.47	
Iodine value.....	105.2	106.8	102.8
Saponification value.....	190.0	189.6	

The similarity of the two oils is very evident. Perhaps the most important factor for comparison of the different classes of oils is the iodine value, for this is a measure of the unsaturated glycerides present, and thus determines whether the oil is drying, semi-drying or non-drying. The iodine value here obtained for hickory nut oil seems to classify it with the semi-drying oils. Here belong cottonseed oil, corn oil, rape seed oil, Brazil nut oil, and beech nut oil. In the following table is shown a comparison of constants of hickory nut oil with those of cottonseed oil and those of the non-drying oil, *viz.*, olive oil.

These figures show that hickory nut oil resembles very closely cottonseed oil, and would be difficult to distinguish from it.

The hickory nut oil is very agreeable as a salad oil,

¹ *Loc. cit*

TABLE IV

	Hickory nut oil	Cottonseed oil	Olive oil
Specific gravity.....	0.9119 at 24° C.	0.9203 at 19° C.	0.9100 at 24° C.
Refractive index.....	1.4699 at 20° C.	1.4748 at 15° C.	1.4670 at 20° C.
Iodine value..	106.0	106.0	82.0
Saponification value.....	190.0	192.0	190.0
Reichert-Meißl number.....	0.48		0.6
Hegner number.....	95.7	95.6	95.4

so that if it can be obtained at a sufficiently low cost, it can be used for this purpose. The *C. amara* or the *C. porcine* (pig nut), which are now considered as absolutely of no value, would yield at least a gallon and a half of oil per bushel and the nuts need only be crushed before they are pressed.

SUMMARY

- I. The food value of hickory nuts is high.
- II. The oils from the two species of hickory nuts, *C. ovata* and *C. amara*, are practically identical and are similar to cottonseed oil.
- III. The oil retains the flavor of the hickory nut, and is practically equal to olive oil.
- IV. The possibility of extracting the oil on a commercial basis should be further investigated.

CHEMICAL LABORATORIES
UNIVERSITY OF KANSAS
LAWRENCE

THE ANALYSIS OF MAPLE PRODUCTS I

AN ELECTRICAL CONDUCTIVITY TEST FOR PURITY OF MAPLE SYRUP¹

By J. F. SNELL

The most commonly used adulterant of maple sugar is granulated sugar, which is, of course, chemically identical with the predominating constituent of the pure material. For the detection of such adulteration we are dependent upon measurements of the small quantities of the non-sugar constituents, the percentages of which in the syrup are necessarily decreased by the addition of the practically pure sucrose, together with the proportional quantity of water necessary to convert it into a syrup. The ash, the soluble and insoluble ash, the alkalinities of these, the malic acid value, and the amounts of precipitate produced by lead subacetate and by normal lead acetate are alike lowered by such adulteration, though not necessarily in proportion to the amount of adulteration.²

Sucrose being a non-conductor of electricity, and the salt constituents conductors, it is reasonable to

¹ This test was described at the Washington meeting of the American Chemical Society in December, 1911, but publication was deferred until further experiments could be made, particularly (1) upon the effect of adulteration on the conductivity value and (2) upon the relation between the conductivity of the syrup and that of its ash solution. This later experimental work has been carried out under my direction by Mr. J. M. Scott, to whom my thanks are due for very competent assistance. This assistance was rendered possible by the Dominion Government Grant for the Advancement of Agriculture. Through the courtesy of Prof. Frank T. Shutt, M.A., F.R.S.C., the present paper was read before the Royal Society of Canada at Ottawa, May 28, 1913.

² The effect of such adulteration upon the various analytical values will be discussed in a later paper.