

II. Actual rotation of a 1 dm. tube full of *l*-amyl *d*-valeryl-*d*-tartrate  
11.32°

The difference per 1 dm. tube is thus 3.24°. In comparison with the usual difference, in such cases, of about 0.28° per 1 dm. due to the purely physical influence for solvents, a difference of 3.24° is enormous<sup>1</sup>.

The conclusion is plain: The principle of optical superposition is false, and the principle I have formulated must take its place.

NEW YORK UNIVERSITY,  
February, 1907.

---

**THE ESSENTIAL OIL OF THE PACIFIC ARBOR VITÆ.**

BY W. C. BLASDALE.

Received January 23, 1907.

The Pacific arbor vitæ (*Thuja plicata*), which is known locally under the name of red or canoe cedar, bears a close resemblance to its better known eastern analogue (*Thuja occidentalis*), the so-called white or swamp cedar, but attains a much greater size than the latter, and differs from it in its habit of growth and in a number of minor characters. It forms one of the most important constituents of the dense forests of Eastern Washington and Oregon, and at the present time is being cut in enormous quantities for the manufacture of shingles, for which purpose the unusual durability of the wood renders it especially valuable.

An essential oil derived from the eastern species of arbor vitæ is an article of commerce, though sold under the name of Oil of Cedar Leaves. The present supply is produced in Eastern Vermont and in Maine and is used in the preparation of ointments, as an insecticide and in the composition of certain liniments used as a remedy for rheumatism. It has been examined by Jahn<sup>2</sup>, Wallach<sup>3</sup> and Semmler<sup>4</sup> and its important constituents found to be *d*-pinene, *l*-fenchone, *d*-thuyone, and probably inactive carvacrol. No examination of the chemical constituents of the Pacific arbor vitæ appears to have been made and the writer availed himself of an opportunity afforded while acting as Collaborator of the Bureau of Forestry some years ago to secure sufficient material for a preliminary study of it.

About 13.8 kilos of the air-dry foliage were distilled with steam till the distillate was no longer turbid. On standing a dark brown oil separated, the total amount being about 400 cc. The oil possesses a penetrating terpene-like odor. Determination of the physical constants gave the following results:—

<sup>1</sup> Had the correcting 0.21° been subtracted instead of being added in the above calculation as might have been done with equal right, the final difference would have come out even greater: nearly 5° per 1 dm. tube.

<sup>2</sup> Jahn. Chem. Centr., 1884, 39.

<sup>3</sup> Wallach, Ann., 272, 99; 275, 179.

<sup>4</sup> Semmler, Ber., 25, 3343.

Boiling point, 150° to 225°.

Specific gravity at 15°, 0.8997.

Index of refraction, 1.4575.

Angular rotation in a 100 mm. tube + 1° 45'.

The results obtained by Powers from authentic samples of the oil of *Thuya occidentalis* were:—

Specific gravity, 0.915 to 0.925.

Angular rotation, — 8° to —14°.

The oil was then distilled with a Cohen fractionating apparatus, twice under a pressure of 120 mm. and once under atmospheric pressure. The following were obtained:— Below 160° 10 cc., 160° to 165° 8 cc., 165° to 170° 5 cc., 170° to 175° 7 cc., 175° to 180° 8 cc., 180° to 185° 5 cc., 185° to 190° 12 cc., 190° to 192° 20 cc., 192° to 194° 20 cc., 194° to 196° 24 cc., 196° to 198° 50 cc., 198° to 200° 110 cc., 200° to 205° 35 cc., 205° to 210° 20 cc., 210° to 225° 25 cc. There remained in the flask about 15 cc. of a heavy tar of high boiling point. The angular rotation of these fractions, when examined in a 100 mm. tube ranged gradually from +16° 15' in the 160° fraction to —45' in the 194° to 196° fraction, and again gradually rose to +5° 55' in the 205° to 210° fraction. Successive distillations of the different fractions changed appreciably the amount of rotation, and in every case formed small amounts of tarry decomposition products.

Since the fraction boiling between 198° and 200° evidently contains the most important constituent of the oil, it was examined further with the following results:—

Specific gravity at 15°, 0.9142.

Index of refraction, 1.4532.

Angular rotation in 100 mm. tube, —52.'

On treating with a dilute solution of potassium permanganate or with dilute nitric acid, as employed by Wallach in separating thuyone from fenchone, the oxidation was complete. With sodium bisulphite a crystalline addition product was very slowly formed and by treatment with bromine in a ligroin solution a white crystalline product, which melted at 121° was obtained. In all these respects the compound agrees with thuyone. The thuyone obtained by Wallach boiled at 203°, had a gravity of 0.9126, a refractive index of 1.4495, and showed an angular rotation of +68. It seems probable that the present oil consists of a mixture of the two optically active modifications, which, however, can not be separated by distillation.

Various attempts to identify the constituents of the higher and lower boiling fractions did not lead to conclusive results.

The wood of this species is characterized by a striking odor, which is popularly attributed to the presence of an oil and it has been assumed that the latter is the cause of the unusual resistance to decay which character-

izes the wood. An extraction of some of the shavings with alcohol yielded some resinous matter, but other solvents failed to remove appreciable amounts of soluble constituents. Some six kilos of shavings of the dry wood were then treated with steam till about fifty liters of distillate had been obtained. The latter was turbid and retained the peculiar odor of the wood. On standing, no oil separated, but on shaking with petroleum ether and allowing the latter to evaporate some two grams of white crystals, which possessed the odor of the wood in a marked degree, were obtained. Recrystallization of these gave a pure white compound, which melted at  $80^{\circ}$ . It is soluble in a great variety of organic solvents, but does not crystallize readily. A single combustion gave  $C = 73.23$ ,  $H = 7.72$ . The molecular weight obtained by the freezing point method using glacial acetic acid as solvent was 157. Apparently the formula of the compound is  $C_{10}H_{12}O_2$ . The small amount of material available made further study of it impracticable.

UNIVERSITY OF CALIFORNIA, BERKELEY, Jan. 14, 1907.

[CONTRIBUTION FROM THE CONTRACTS LABORATORY, BUREAU OF CHEMISTRY  
PUBLISHED BY PERMISSION OF THE SECRETARY OF AGRICULTURE.]

### THE UNIFICATION OF REDUCING SUGAR METHODS.

BY PERCY H. WALKER.

Received Jan. 21, 1907.

Munson and Walker have recently published<sup>1</sup> uniform methods and tables for the determination of *d*-glucose and invert sugar alone, and invert sugar when mixed with sucrose. The authors hoped to take up the study of maltose and lactose. It is regretted that Mr. Munson was unable to continue the work, and the writer, therefore, undertook to complete the work alone.

Commercial lactose was repeatedly recrystallized by dissolving in hot water and pouring into alcohol with constant stirring. The fine crystals were dried at first by drawing air over them for three days, and then dried for five days over calcium chloride.

Von Lippman<sup>2</sup> states that lactose prepared in this manner has the formula,  $5C_{12}H_{22}O_{11} + 2H_2O$ . The product obtained, however, had a composition represented by the formula,  $C_{12}H_{22}O_{11} + \frac{1}{2}H_2O$ . A water determination made according to the method used by Brown, Morris and Miller<sup>3</sup> gave 2.43 per cent. This determination was made as follows: The powdered lactose was placed in a small flask connected by a T tube with another small flask containing  $P_2O_5$ , and the remaining limb of the tube connected with an exhaust pump. The system was exhausted and the flask containing the lactose kept at  $30^{\circ}$  for two hours, cooled to room tem-

<sup>1</sup> This Journal, 28, 663 (1906).

<sup>2</sup> Die Chemie der Zuckerarten, 3 Auflage—1526.

<sup>3</sup> J. Chem. Soc. Trans., 71., 76.