of all others. Since price and profit are the two uppermost thoughts in the minds of these particular manufacturers, they are, of course, reluctant to hire chemists to control their raw ingredients or the finished products.

The matter of factory sanitation to include sterility of products should be covered by law and by enforcement. To my mind this is of great importance. Tomato products are considered unfit for food when they contain more than 100,000,000 bacteria per cubic centimeter, and milk when it contains a much smaller number, to mention only two products; yet I have seen drug preparations on the market containing ten times that many bacteria, which preparations were to be administered to the sick, a class who have a well-recognized low resistance to bacteria of all kinds.

And let me emphasize again that more effective control of drug products by the state and city governments is urgently needed. The city and state should take up this question more actively than has been done in the past; they should pass laws that will cover patent medicines and crude drugs as well as pharmaceuticals.

In conclusion, therefore, it is desirable for state and municipal drug officials to enlarge their field of activity and not limit their efforts to a consideration of comparatively simple products, such as tincture of iodine and spirits of camphor, but to join with us, who are operating under the federal law, in our efforts to ever widen the circle of effective drug control. The Bureau of Chemistry regards it not only as a duty but as a pleasure to lend assistance by suggesting specific lines of work to be undertaken or by giving intensive training in so far as our funds will permit to such investigators as may be assigned to this most important regulatory undertaking.

DOMESTIC AND IMPORTED VERATRUM (HELLEBORE), *VERATRUM VIRIDE* AIT., *VERATRUM CALIFORNICUM* DURAND, AND *VERATRUM ALBUM* L. II. CHEMICAL STUDIES.*

BY ARNO VIEHOEVER AND JOSEPH F. CLEVENGER.

Chemical Studies.

The work on the different species of Veratrum, reported in Part I,† has been continued. The first paper dealt with the botanical characteristics and the microchemical tests useful in the differentiation of the species. The object of the present studies was to ascertain the amount of alkaloids occurring in two commercial forms, *Veratrum album* L. and *Veratrum viride* Ait., and the amount of total and acid-insoluble ash present. Some preliminary consideration has been given to the isolation of the active principles and to pharmacological data reported in literature.

CHARACTER OF ALKALOIDS.

The character of the alkaloids of *Veratrum album* and *Veratrum viride* has received much attention in the past, but apparently no chemical work has been

* A brief discussion of literature on comparative pharmacological work is included.

† A. Viehoever, L. Keenan, and J. F. Clevenger, "Domestic and Imported Veratrum (Hellebore), *Veratrum viride* Ait., *Veratrum californicum* Durand, and *Veratrum album* L. I. Botanical Studies," JOUR. A. PH. A., 10, 581–593 (1921).

done on *Veratrum californicum* Durand. A tabulation of the results reported by various investigators with respect to the alkaloids present in *Veratrum album* and *Veratrum viride* is given in Table I.

TABLE I.

NATURE OF ALKALOIDS IN *Veratrum album* L. AND *Veratrum viride* AIT.

Veratrum album L.	*Veratrum viride* Ait.
Pelletier and Caventou[13] (1820) isolated a substance considered to be veratrine.	Worthington[33] (1838) isolated an alkaloid considered identical with veratrine.
Simon[23] (1837) found veratrine and jervine.	Richardson[16] (1857), Scattergood[21] (1862) found veratrine and probably jervine; Percy[14] (1864) confirmed the presence of veratrine.
Will[30] (1840) reported jervine, veratrine and sabadilline.	Bullock[2] (1865) isolated two alkaloids; Wood[31] called them provisionally viridia and veratroidia; Bullock denied the presence of veratrine.
Weigand[28] (1842) confirmed the presence of veratrine.	Maisch[9] (1869) suggested alkaloids identical with those of *V. album.*
Maisch[9] (1869) suggested alkaloids identical with those of *V. viride;* reported absence of veratrine.	Peugnet[15] (1872) and Mitchell[10] (1874) proved the identity of viridine with jervine.
Peugnet[15] (1872) and Mitchell[10] (1874) demonstrated the identity of jervine with viridine found in *V. viride.* Peugnet found an alkaloid, veratroidine, identical with that of *V. viride.*	Peugnet[15] (1872) found veratroidine to be different from veratrine.
Weppen[29] (1873) confirmed the presence of veratrine and jervine.	Mitchell[10] (1874) reported jervine and veratroidine.
Mitchell[10] (1874) isolated jervine; also veratralbine, an alkaloid.	Wormley[32] (1876) reported jervine and veratrine.
Wormley[32] (1876) reported veratrine and jervine.	Bullock[13] (1876) reported veratroidine as a mixture of jervine[4] and resin.
Tobien[24] (1877) found jervine and veratroidine, the latter discovered by Bullock[2] (1865) in *V. viride.*	Robbins[17] (1877) reported the presence of jervine and veratridine, and the absence of veratrine.
Wright and Luff[34] (1879) considered the veratralbine of Mitchell as possibly a mixture of alkaloids.	Wright and Luff[34] (1879) considered veratroidine as a possible mixture of more than one base.
Wright and Luff[34] (1879) found jervine, rubijervine, pseudojervine, veratralbine, very small amounts of veratrine, and apparently no cevadine.	Wright[35] (1879) found jervine, rubijervine, very little pseudojervine, cevadine, and traces of veratrine and veratralbine.
Salzberger [20] (1890) found jervine, rubijervine, pseudojervine, protoveratrine, protoveratridine.	
Bredemann[1] (1906) isolated jervine, rubijervine, pseudojervine, protoveratrine.	

It appears that the character of the alkaloids of *Veratrum viride* is closely analogous to that of the alkaloids of *Veratrum album.* The information on the chemistry of *Veratrum album* seems to be more specific than that pertaining to *Veratrum viride.* Salzberger,[20] who worked with large amounts of *Veratrum album,* up to 300 kilos of material, isolated at least four, possibly five or more alkaloids, these results having been recently verified by Bredemann.[1] No recent work on *Veratrum viride* is at hand. The latest information available is that of Wright,[34] who, together with Luff, in making a comparative study of *Veratrum viride* and *V. album,* found certain alkaloids present in both species, the main difference being that cevadine, the predominating alkaloid in *Veratrum viride,* was apparently absent in *V. album,* and that veratralbine, predominant in *Veratrum album,* was present only in traces in *V. viride.* As Wright used less than 42 pounds of *Veratrum*

iride, further work with larger amounts appears desirable to verify previous findings and especially to confirm the presence of cevadine.

AMOUNT OF ALKALOIDS.

Wright reported that *Veratrum viride* contained only one-fifth (0.08%) of the amount of alkaloids found by himself and Luff in *Veratrum album* (0.4%). Bullock,[2] however, states that the amount of alkaloids present in *Veratrum viride* is decidedly larger, and that the low results obtained by Wright were due to the precipitation of alkaloids with resin. Data in the literature illustrate the variation in the amount of alkaloids in both *V. album* and *V. viride*.

TABLE II.

AMOUNT OF ALKALOID REPORTED IN *Veratrum album* AND *Veratrum viride* AIT.

Substance.	Alkaloid (%).	Author.	Year of Analysis.	Remarks.
	Veratrum album			
V. album	0.42	Wright and Luff[34]	1879	Referred to as roots in text.
V. album	1.3–1.54	Kremel[7]	1889	
V. album	0.57	Pehkschen[12]	1890	Plants growing wild. Referred to as powdered rhizome in text.
V. album	0.29	Pehkschen[12]	1890	Cultivated. Referred to as powdered rhizome in text.
V. album	0.66	Pehkschen[12]	1890	Commercial sample. Referred to as powdered rhizome in text.
V. album	1.12–1.25	LaWall[8]	1897	5 powdered commercial samples.
V. album	1.75	LaWall[8]	1897	Origin not stated.
V. album	0.56–1.01	Bredemann[1]	1906	3 commercial samples.
	Veratrum viride			
V. viride	0.08	Wright[35]	1879	Referred to as roots in text.
V. viride	0.6612	Bullock[2]	1879	
V. viride	0.08	Pehkschen[12]	1890	Commercial sample. Referred to as powdered rhizome in text.
V. viride	0.8015	Bredemann[1]	1906	Commercial sample.
V. viride	0.14–0.712	Bredemann[1]	1906	9 powdered commercial samples.
V. viride	1.21	Roberts[18]	1915	
V. viride	1.32	Vanderkleed[25]	1915	
V. viride	0.9, 1.04, 1.41	Patch[11]	1916	Referred to as powdered (1 lot).

The variation observed may be due, as Bredemann[1] suggests, to the fact that the drugs were collected at different seasons. It may be due also, as we have found in the case of hydrastis,[26] to the fact that the proportion of roots present, which contain different amounts of alkaloid, varies greatly. Furthermore, the disagreement of results may also be due to failure to determine the botanical identity and purity of the Veratrum species examined. It must finally be kept in mind that different authors have used different methods of assay.

After studying the methods proposed for the estimation of alkaloids in Veratrum, we adopted essentially the one suggested by Bredemann,[1] shortening materially, however, the time of contact of the solvent with the drug. The time used by Bredemann for the extraction (3 hours) seemed unnecessarily long.* Some authors used NH_4OH, others NaOH to liberate the alkaloid from the drug or acid solutions. To ascertain the influence of time of extraction and the use of different alkalies upon yield, a few experiments were made. The details and results of these experiments are given in Table III.

TABLE III.

EFFECT UPON YIELD OF VARIATION OF TIME OF EXTRACTION AND USE OF DIFFERENT ALKALOIDS.

Species.	Part Used.	Time of Extraction.	Alkali Used.	Total Alkaloids.	Analyst.
V. album	Rhizome and roots	30 min.	NaOH	1.53	J. F. Clevenger
V. album	Rhizome and roots	30 min.	NH_4OH	1.50	J. F. Clevenger
V. album	Rhizome and roots	1 hour	NaOH	1.44	J. F. Clevenger
V. album	Rhizome and roots	3 hours	NaOH	1.52	J. F. Clevenger
V. album	Rhizome and roots	3 hours	NH_4OH	1.47	J. F. Clevenger

[a] Analysis made upon the same commercial sample.

From these data, even a 30-minute extraction appears sufficient. The same results were obtained whether NaOH or NH_4OH was used.

The details of the procedure are as follows:

Method for the Estimation of Veratrum Alkaloids.—A 15-gram sample (No. 40 powder**) was placed in a 250-cc flask; 150 cc of chloroform-ether (equal parts) was added and allowed to act upon the sample for 10 minutes. Then 10 cc of 10% ammonia was added to the flask. The mixture was shaken at frequent intervals during the entire time of extraction. At the end of 60 minutes 10 cc of water was added. After a thorough shaking the crude material was allowed to settle and the liquid was decanted through a pledget of cotton into a flask containing about 1/4 Gm. of calcined magnesia. After shaking, the mixture was filtered into a 100-cc graduated cylinder, and 80 cc of the filtrate (considered equivalent to 8 Gm. of drug) was transferred to a separatory funnel. During the entire operation, of course, care was taken to avoid any loss of the liquid by evaporation. The filtrate in the separatory funnel was then shaken out with 20-20-10-10 cc of 10% acetic acid.†

* The U. S. Pharmacopoeial directions for the extraction of different alkaloidal drugs require 1-3 hours' extraction, with frequent shaking, and subsequent standing up to 10 hours. The fineness of the different powders extracted varies from No. 40 to No. 80. The entire time of contact of the crude alkaloidal drugs with the solvents, during shaking and subsequent standing, probably can be materially shortened, especially when a powder of a high degree of fineness is used. Further experimental work, of course, is necessary to establish this presumption as a definite fact.

** A few exceptions are noted in Table IV.

† An additional shake-out should show complete extraction when tested with Mayer's reagent. Acetic acid is used, inasmuch as the acetate of jervine, occurring in predominating amounts, is more soluble in water than the salts of mineral acids.

These "shake-outs" were collected in a separatory funnel, made alkaline with 10 percent ammonia, and in turn shaken out with 20-20-10-10 cc of chloroform-ether. The "shake-outs" were collected in a tared beaker, evaporated by passing a slow current of air over the liquid, and dried to practically constant weight at 100° C. (weights made at 30-minute intervals).

This method was used in a survey covering the examination of samples of domestic and imported Veratrum, mainly collected in import or interstate trade. A few authentic specimens were also included in the work. In addition to the estimation of the alkaloids, the condition of the samples as to proportion of rhizomes and roots present, as to purity (total and acid-insoluble ash), and as to fineness of powder was determined. The data are given in Table IV.

CONDITION OF SAMPLES.

The relative amounts of roots and rhizomes present vary decidedly. Sometimes the roots are prevalent, sometimes the rhizomes. The rejections consisted mainly of adhering soil. The fineness of the powder was determined, using a set of sieves in order to ascertain the degree of uniformity in size of the particles of the various samples. There is no uniformity, even in those cases where the samples had evidently been put through the same milling process. As a result of this examination it appears advisable, if not necessary, always to verify the size of the powder, should a definite size of powder be required in an assay.

Discussion.

ALKALOIDAL CONTENT.

From a critical review of the literature and the data given in Tables II and IV, it appears that no differentiation of the species *V. album* and *V. viride* can be based on the alkaloidal content. It is evident that *Veratrum viride* contains as much alkaloid as *Veratrum album*. Of interest is the difference in alkaloidal content found in the roots and rhizomes of other drugs, *e. g.*, hydrastis, the roots of which usually contain a smaller amount than the rhizomes. From the amounts of alkaloid found it appears that the minimum limit of tolerance of 0.45 percent and 0.60 percent alkaloid, as suggested by Gordon,[6] is too low. We are inclined to believe that a limit of 1 percent, as suggested by LaWall[8] and adopted by the Swiss Pharmacopoeia for *Veratrum album*, should prove to be a satisfactory pharmacopoeial alkaloid standard for both *Veratrum album* and *Veratrum viride*.

ASH CONTENT.

The amount of total and acid-insoluble ash varies greatly, the following range being evident from the results in Table IV: Total ash, from 2.9 to 19.0%; acid-insoluble ash from 0.5 to 15.2%.

Interesting also in this connection are the data which indicate clearly the cause for the high total and acid-insoluble ash, namely, the excessive amounts of dirt. Where this dirt (rejections) had been removed from the drug the amounts of total ash and acid-insoluble ash were very low. In our former work on American crude drugs,[5] on hydrastis,[26] and on aletris,[22, 27] we reached the same conclusion.

A limit of 8 percent total ash and 4 percent acid-insoluble ash appears to be a feasible pharmacopoeial standard and will indeed be a liberal limit for adequately cleaned, washed samples of the crude medicinal drug.

MICROSUBLIMATION.

Rosenthaler,[19] who reports sublimation experiments with *Veratrum album*,

TABLE IV.

EXAMINATION OF DOMESTIC AND IMPORTED VERATRUM.

No.	Identity.	Part.*	Alkaloid. Percent.	Alkaloid. Detd. %	Alkaloid. Computed. %	Ash. Determined. Total. %	Ash. Determined. Insol. %	Ash. Computed. Total. %	Ash. Computed. Insol. %	Fineness of Powder. Portion Separated in Set of Sieves. Below No. 40. %	No. 40. %	No. 60. %	No. 80. %	Origin of Sample.
						Veratrum album.								
3131	*V. album*	Roots	39.0	1.42	2.04	3.5	0.6	2.9	0.5	45.0	23.0	15.0	17.0	Coml. Imp.
	V. album	Rhiz.	61.0	2.45		2.5	0.5			15.5	32.0	16.0	36.5	
3160	*V. album*	Roots	38.0	1.05	1.19	6.6	3.2	4.4	1.9	..	13.0	31.0	56.0	Coml.
	V. album	Rhiz.	60.0	1.28		3.2	1.0			..	16.0	35.0	46.0	Coml.
		Rej.	2.0											
3164	*V. album*	Roots	33.0	0.98	1.07	6.2	3.1	4.5	1.8	..	13.0	33.0	54.0	Coml.
	V. album	Rhiz.	65.0	1.12		3.6	1.2			..	15.0	41.0	44.0	Imp.
		Rej.	2.0											
3165	*V. album*	Rt. *e* Rh.	..	2.11	..	5.3	1.9	..	..	..	0.5	24.5	75.0	Coml. Imp.
3130	*V. album*	Rt. *e* Rh.	..	2.15	..	4.8	2.0	..	..	..	4.0	13.0	83.0	Coml. Imp.
3124	*V. album*	Rt. *e* Rh.	..	1.11	..	8.4	5.0	..	..	..	2.0	4.0	94.0	Coml. Imp.
3073	*V. album*	Rt. *e* Rh.	..	1.29	..	10.5	5.4	..	..	..	2.5	31.0	66.5	
3159	*V. album*	Rt. *e* Rh.	..	1.09	..	10.3	6.1	..	..	7.0	27.0	47.0	19.0	Coml.
3134	*V. album*	Rt. *e* Rh.	..	1.00	..	10.8	7.0	..	..	..	5.0	30.0	65.0	Coml. Imp.
3136	*V. album*	Rt. *e* Rh.	..	1.32	..	10.7	7.0	..	..	..	8.5	15.5	76.0	Coml. Imp.
3128	*V. album*	Rt. *e* Rh.	..	1.11	..	12.0	8.0	..	..	..	2.0	4.0	94.0	Coml. Imp.
3123	*V. album*	Rt. *e* Rh.	..	1.08	..	12.4	8.5	..	..	..	5.0	5.5	89.5	Coml. Imp.
3129	*V. album*	Rt. *e* Rh.	..	1.20	..	13.3	8.9	..	..	1.0	38.5	34.5	26.0	Coml. Imp.
3167	*V. album*	Rt. *e* Rh.	..	1.09	..	19.0	15.0	..	..	..	6.0	7.0	87.0	Coml. Imp.
						Veratrum viride.								
3141	*V. viride*	Rt. *e* Rh.	..	1.30	..	4.8	1.2	..	..	2.5	10.0	15.0	72.5	Coml. Dom.
3132	*V. viride*	Roots	66.0	1.33	1.28	6.2	1.8	5.2	1.4	4.0	12.0	30.0	54.0	New York[2]
	V viride	Rhiz.	28.0	1.18		2.9	0.6			..	13.0	37.0	50.0	New York[2]
		Rej.	6.0											
3117	*V. viride*	Roots	42.0	0.95	1.03	5.0	2.5	4.9	2.0	..	13.5	23.0	63.5	N. Carolina[3]
	V. viride	Rhiz.	48.0	1.11		4.8	1.5			..	40.0	33.0	27.0	N. Carolina[3]
		Rej.	10.0											
3106	*V. viride*	Roots	52.0	1.34	1.53	9.1	2.4	7.8	2.1	2.0	15.5	36.0	46.5	Coml. Dom.
	V. viride	Rhiz.	43.0	1.76		6.2	1.9			..	22.0	39.0	39.0	
		Rej.	5.0											
3163	*V. viride*	Roots	55.0	1.58	1.61	9.2	3.7	6.7	2.3	11.0	38.0	18.5	32.5	Coml. Dom.
	V. viride	Rhiz.	42.0	1.76		3.5	0.5			11.0	30.0	22.0	37.0	Coml. Dom.
		Rej.	3.0											
3121	*V. viride*	Rt. *e* Rh.	..	1.17	..	5.5	2.7	..	..	1.0	10.0	24.0	65.0	Coml. Dom.
3122	*V. viride*	Roots	45.0	1.07	1.27	8.5	5.1	5.9	3.0	6.0	6.0	24.0	62.0	Coml. Dom.
		Rhiz.	53.0	1.45		3.7	1.3			..	14.0	33.5	52.5	Coml. Dom.
		Rej.	2.0											
3113	*V. viride*	Roots	42.0	1.22	1.39	9.5	5.0	6.8	3.2	1.0	16.0	30.0	53.0	W. Virginia[4]
	V. viride	Rhiz.	52.0	1.70		4.7	1.7			..	11.5	35.0	53.5	W. Virginia[4]
		Rej.	6.0											
3140	*V. viride*	Rt. *e* Rh.	..	1.22	..	6.1	3.6	..	..	..	9.0	28.0	63.0	Coml. Dom.
3135	*V. viride*	Rt. *e* Rh.	..	1.11	..	13.0	9.0	..	..	..	20.0	11.0	69.0	Coml. Dom.
3139	*V. viride*	Rt. *e* Rh.	..	1.04	..	16.5	12.7	..	..	..	19.0	1.0	80.0	Coml. Dom.
3166	*V. viride*	Rt. *e* Rh.	..	1.15	..	19.0	15.2	..	..	trace	4.0	20.0	76.0	Coml. Dom.

*Abbreviations—Roots and Rhizomes: Rt. *e* Rh. Rejections: Rej.

[1] Abbreviations—Commercial: Coml. Imported: Imp. Domestic: Dom.

[2] Collected in low lands, not swampy, at Machias, N. Y.

[3] Slightly moist plateau, North Carolina.

[4] Collected on dry mountain, West Virginia.

obtained a sublimate which gave the typical color reactions** with sulphuric acid as well as precipitates with alkaloidal reagents. Extending these experiments to

**See the authors' previous paper, Part I, JOUR. A. PH. A., 10, 590, 1921.

viride and *californicum*, the authors have obtained amorphous and sometimes crystalline sublimates. Upon dissolving the amorphous sublimate in organic solvents, such as alcohol, crystallization was induced, most of the crystals observed being needle-shaped and featherlike. Both green and red color reactions were observed, suggesting the presence of such alkaloids as pseudojervine and jervine, rubijervine and protoveratrine, respectively.[1] The experiments were not extended further, since it appeared that this method could not readily be used for the differentiation of the Veratrum species examined.

PHARMACOLOGICAL CHARACTERISTICS.

Many authors have given some attention to the pharmacological characteristics of either *Veratrum album* or *Veratrum viride*. Some authors have even made comparative studies. No report of pharmacological work for *Veratrum californicum* and *Veratrum nigrum*, however, has been found in the literature.

The discussion of this subject by Cramer,[39] Casseday,[36] and Wood[42] may be of interest.

Wood states: "In a study of the comparative effect of the two rhizomes, in 1899 the conclusion was reached that, although, as a rule, the white hellebore was somewhat the more toxic of the two, the differences between them were no greater than might exist between individual specimens of *Veratrum viride*. I believe, however, that the recognition of the two plants as identical was progressing backward." Hewlett[40] states: "The effect of *Veratrum album* on the pulse rate and the blood pressure of man has been recently studied by Collins[37] who found that large therapeutic doses reduced both the pulse rate and the blood pressure, and that these reductions may occur in certain cases without unpleasant gastro-intestinal symptoms. We have repeated these observations, using the hospital tincture of the fluidextract of *Veratrum viride*, and were able to confirm Collins' observations. The effective dose, however, was considerably larger than that used by Collins, and it is evident that some method of standardization will be necessary if veratrum is to be employed in general practice." Collins[38] and Hanzlik state: "It appeared also that the preparations of *Veratrum album* were more toxic than the preparation of *V. viride* examined by Pilcher." Pilcher[41] states: "But one tincture of *Veratrum album* was obtainable, so that, while it was more toxic than any of the viride solutions, conclusions cannot be drawn relative to the activity of the two species of veratrum until further samples are on hand."

It is evident, therefore, that further work should be done by pharmacologists on both of these forms. It is hoped that in such investigation definitely identified samples will be used and that the study of the alkaloids isolated therefrom will be included.

Summary.

(1) The character of the alkaloids of *Veratrum album* does not appear to differ much from that of the alkaloids of *Veratrum viride*. The alkaloid content in both species varies within the same limits, so that no differentiation of species is possible on the basis of alkaloidal content. Microsublimation indicates close chemical relationship but does not permit of ready differentiation.

(2) The close relationship of *Veratrum viride* and *Veratrum album* demonstrated in Part I and the close chemical relationship indicated by the chemical findings here reported seem to justify the adoption of the same standards for the medicinal material obtained from both species. The standards suggested for the medicinal drugs are at least 1 percent for alkaloids and not more than 8 percent total nor more than 4 percent acid-insoluble ash.

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DISTRIBUTION OF CERTAIN DRUGS BETWEEN IMMISCIBLE SOLVENTS.*

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Of the many medicinal preparations examined by this laboratory, those containing analgesic and antipyretic agents have been fruitful fields for various lines of investigation. In the isolation of these substances preliminary to their quantitative determination, recourse was frequently had to the use of immiscible solvents such as aqueous solutions and chloroform, the latter preferably on account of its physical properties and consequent ease of separation and recovery. During the earlier stages of the work, the relative volumes of the solvents, as well as the number of extractions deemed necessary or expedient for complete isolation of the substance sought, were governed largely by empirical considerations, care being taken, however, that any error of commission should involve an excess rather than a deficiency in organic solvent. In operations with caffeine and antipyrine, for example, substances possessing about equal solubility in chloroform but differing widely in this respect toward water (1 Gm. of caffeine is soluble in 46 cc, 1 Gm. of antipyrine, on the other hand, in less than 1 cc of water), it was assumed that, given like volumes, antipyrine would require a greater number of extractions than caffeine. From preliminary experiments on controls, carried out in the usual way with the

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