SCIENTIFIC SECTION

ANALYSIS OF GINGER AND ITS PREPARATIONS.*

BY J. F. CLEVENGER.**

Examination in the Pharmacognosy Laboratory of many samples of fluidextract of ginger and ginger rhizomes found on the market showed that these products were often adulterated or inferior. As the Pharmacopœia contains no assay or standard for ginger and its preparations, a study was undertaken to develop one that would be acceptable to the trade and drug control officials alike.

METHOD OF ANALYSIS.

The following method of analysis was used in the study:

Place 50 cc. of fluidextract of ginger or the ether extract from 50 Gm. of moderately coarsely ground ginger rhizomes obtained with a continuous extractor[1] into a 100-cc. round-bottom flask and evaporate the alcohol, if fluidextract has been used, or the ether, if the ether extract of the rhizomes has been used, on a slowly simmering steam-bath until the odor of the solvent is no longer detected. Add 50 cc. of water to this residue and determine the amount of the volatile oil present, using the special apparatus described by Clevenger.[2] The number of cubic centimeters of volatile oil obtained multiplied by 2 gives the percentage of volatile oil. Finally, the volatile oil may be transferred to a test-tube (10 x 75 mm.) and allowed to stand until perfectly clear. (Over night is usually sufficient.) The specific gravity, the index of refraction and the optical rotation of the volatile oil thus obtained may be determined by the methods outlined.[2]

After extraction of the volatile oil, allow the flask containing the water and non-volatile residue to cool. When most of the non-volatile residue has settled to the bottom of the flask decant the water into a suitable separatory funnel and shake out repreatedly with ether until the ether solution is practically free from color. Extract the residue with ether, combine the ether extracts and filter through a dry filter paper into a tared beaker. Wash the filter paper with ether. Evaporate the solution to dryness on a steam-bath, using a current of air. Place the beaker containing the non-volatile ether-soluble extractive in a vacuum desiccator containing sulphuric acid. Let it stay for approximately 2 hours and then weigh. The non-volatile ether-soluble extractive, here designated G, is considered the active constituent of ginger. The weight in Gm. multiplied by 2 gives the percentage of G. Dissolve G in neutral 95% alcohol and make up to volume, so that 10 cc. contains approximately 0.5 Gm. of non-volatile ether-soluble extractive, using care to obtain a uniform solution. Determine the iodine and saponification values on 10-cc. portions of this solution by the following modifications of the U. S. Pharmacopœia methods.

---

* Scientific Section, A. PH. A., St. Louis meeting, 1927.

** Pharmacognosy Laboratory, Drug Control, Food, Drug and Insecticide Administration, Washington, D. C.

[1] Palkin, Murray and Watkins Automatic Extractor, Type B, *Ind. Eng. Chem.*, 17 (1925), 612, is satisfactory for this purpose.

[2] Clevenger, JOUR. A. PH. A., 17 (1928), 345.

IODINE VALUE.

Transfer 10 cc. of the alcoholic solution into a glass-stoppered 250-cc. bottle and evaporate to dryness on the steam-bath, using air current. Dissolve the residue in 10 cc. of chloroform. Add 15 cc. of iodobromide T. S. (U. S. P. X, page 489) measured from a burette. Stopper the bottle securely and allow the mixture to stand for half an hour in a cool dark place. Shake the mixture at 10-minute intervals. Then add, in the order named, 20 cc. of potassium iodide T. S., 75 cc. of distilled water, and tenth-normal thiosulphate in small successive portions, shaking thoroughly after each addition, until the color of the upper layer becomes pale. In order to recognize the approach of the end-point between successive shakings it is necessary to allow the mixture to stand until the layers are completely separated. Now add a few drops of starch T. S. and continue the addition of tenth-normal sodium thiosulphate until the blue color disappears.

Make a blank test by mixing exactly the same quantities of reagent and titrate the free iodine with tenth-normal sodium thiosulphate as directed above. The difference in the number of cubic centimeters of tenth-normal sodium thiosulphate consumed by the blank test and the actual test, multiplied by 1.269 and divided by the weight of G taken, gives the iodine value.

SAPONIFICATION VALUE.

Transfer 10 cc. of the alcoholic solution into an Erlenmeyer flask of approximately 200-cc. capacity, and add 10 cc. of alcoholic half-normal potassium hydroxide (U. S. P. X, page 501). Insert into the neck of the flask, by means of a perforated stopper, a glass tube from 70 to 80 centimeters in length and from 5 to 8 millimeters in diameter, and heat the flask on a water-bath for half an hour, frequently rotating the contents. Then add 2 cc. of phenolphthalein T. S. and titrate the excess of potassium hydroxide with half-normal hydrochloric acid. The natural color of solution G interferes with the determination of the true end-point, because the red color of the phenolphthalein grades off imperceptibly into the brown of G. The natural color of G varies, depending primarily upon the variety of ginger used. There are two distinct color changes during the titration, first when the red of the phenolphthalein disappears and second a change from dark brown to light brown. The end-point as determined by electrometric titration is indicated by the change from dark brown to light brown. It has been observed that under the conditions of the experiment the addition of approximately 0.4 cc. of alcoholic half-normal potassium hydroxide is necessary after the red of the phenolphthalein has disappeared.

Make a blank test, using exactly the same amount of alcoholic half-normal potassium hydroxide. The difference in the number of cubic centimeters of half-normal hydrochloric acid consumed in the actual test and in the blank, multiplied by 28.06 and divided by the weight of G taken, gives the saponification value.

It is generally accepted that the fluidextract of ginger contains the active constituents of the drug. Fluidextracts prepared by the U. S. P. method and ether extracts prepared in a continuous extraction apparatus were made from several specimens of moderately coarsely ground ginger rhizomes. The results obtained from analyses of these extracts are given in Table I.

TABLE I.—ANALYSIS OF GINGER EXTRACTS.

Ginger rhizomes.	Fluidextract, U. S. P.							Ether extract.						
	Volatile oil.				Non-volatile.		Ether-soluble extractive.	Volatile oil.				Non-volatile.		Ether-soluble Extractive.
	%	Sp. gr.	Op. rot. deg.	Ref. I.	%	I no.	Sapn. no.	%	Sp. gr.	Op. rot. deg.	Ref. I.	%	I no.	Sapn. no.
Cochin	1.7	0.877	−50	1.492	4.2	32.2	37.4	1.7	0.877	−50	1.492	4.2	36.5	37.2
African	2.55	0.885	−52	1.492	6.2	28.2	45.2	2.6	0.885	−52	1.492	6.3	28.1	44.8
African	2.55	0.877	−51.5	1.492	5.9	29.4	51.0	2.5	0.877	−52	1.492	5.7	29.6	52.0
Jamaican	1.5	0.877	−46	1.490	4.0	23.2	52.0	1.55	0.877	−46	1.490	4.1	23.1	54.1
African	2.3	0.876	−52	1.491	4.9	31.1	32.0	2.2	0.876	−52	1.4915	5.1	30.8	31.0

The results in Table I show that the analyses of the fluidextracts prepared from the rhizomes of several varieties of ginger are essentially the same as the analyses of the ether extracts prepared from equivalent quantities of the same rhizomes of ginger. The continuous ether extraction method was adopted for the analysis of ginger rhizomes because it is shorter and offers less opportunity for error.

ANALYSES OF SAMPLES.

Samples of Jamaican, African, Indian and Cochin ginger purchased on the open market and many samples of ginger rhizomes imported during the season of 1926–1927, as well as fluidextracts of ginger purchased on the open market and samples collected by inspectors of the Bureau of Prohibition of the Treasury Department, were analyzed. Representative results of these analyses are given in Table II.

TABLE II.—ANALYSIS OF RHIZOMES OF GINGER.

Source.	Volatile oil.			Non-volatile ether-soluble extractive.		
	%	Ref. index.	Op. rot.	%	I no.	Sapn. no.
Jamaica	1.2	1.493	−48°	3.5	36.6	63.8
Jamaica	1.8	1.491	−42°	3.9	44.5	60.9
Africa	2.6	1.493	−53°	6.2	34.8	61.7
Africa	3.1	1.492	−55°	7.1	38.7	50.0
Africa	2.4	1.490	−58°	5.7	36.7	58.0
Africa*	1.6	1.491	−27°	5.6	50.2	57.0
India	3.1	1.492	−50°	6.3	42.2	61.2
India	1.8	1.493	−55°	3.5	38.2	50.0
India	2.8	1.493	−51°	6.0	44.7	60.0
Cochin	2.0	1.490	...	5.0	44.7	75.0
Cochin	1.6	1.492	−45°	4.1	50.0	66.0

* Rhizome old and wormy.

TABLE III.—ANALYSIS OF FLUIDEXTRACT OF GINGER.

Source.	Volatile oil.			Non-volatile ether-soluble extractive.		
	%	Ref. index.	Op. rot.	%	I no.	Sapn. no.
Laboratory	2.8	1.490	−56°	7.0	29.2	45.8
Laboratory	1.9	1.492	−45°	4.48	44.5	75.0
Laboratory*	1.9	1.492	−45°	6.3	60.9	120.0
Trade	1.2	1.492	−55°	2.9	42.3	60.0
Trade	1.2	1.492	−35°	3.2	43.6	80.5
Trade	0.25	1.491	−27°	3.5	65.0	99.0
Trade	0.3	1.495	...	3.2	67.0	118.0
Trade	Trace	...	...	2.8	79.1	157.3

* Approximately 20% of castor oil was added.

The results in Table II show that: (*a*) The yield of volatile oil (1.2% to 3.1%) varies with the variety of ginger, African giving the highest yield; (*b*) the physical

constants of the volatile oils of all the varieties are essentially identical; (*c*) the non-volatile ether-soluble extractive varies from 3.5% to 7.1%, and gives an iodine value between 36 and 50 and a saponification value between 50 and 75, the African giving the highest yield.

Representative results of analysis of samples of fluidextracts of ginger are given in Table III.

The results in Table III show that the yield of volatile oil, together with the yield and the constants obtained on the non-volatile ether-soluble extractive of a fluidextract of ginger, can be used as an indicator in determining the character of ginger and ginger preparations.

DETECTION OF PRESENCE OF ADULTERANTS.

Because of a suspicion that some of the fluidextracts of ginger on the market are adulterated with fixed oils, experiments were carried on to determine the influence of certain types of adulterants when added to a given fluidextract. Results of the analyses made are given in Table IV.

TABLE IV.—ANALYSIS OF FLUIDEXTRACT OF AFRICAN GINGER WITH SEVERAL ADULTERANTS.

Adulterant added to 50 cc. of fluidextract.	Volatile oil.				Non-volatile ether-soluble extractive.		
	%	Spec. grav.	Op. rot.	Ref. index.	%	I no.	Sapn. no.
None	2.5	0.876	−55°	1.492	7.5	36.3	41.1
1.95 Gm. cotton-seed oil	2.5	0.876	−53°	1.492	11.32	47.1	85.4
1.5 Gm. castor oil	2.5	0.876	−53°	1.492	10.32	47.9	89.9
1.975 Gm. liquid petrolatum	2.5	0.876	−53°	1.491	11.6	26.0	32.7

The results in Table IV show that: (*a*) The presence of the adulterants does not materially influence the yield or physical constants of the volatile oil; (*b*) the added adulterants, being soluble in ether, appear approximately quantitatively in the yield of non-volatile ether-soluble extractives; (*c*) cottonseed and castor oils, giving high iodine and saponification values, are evidenced by the higher iodine and saponification values obtained for the non-volatile ether-soluble extractives containing these added oils; (*d*) liquid petrolatum, giving practically no iodine or saponification values, is evidenced by the distinctly lower iodine and saponification values obtained for the non-volatile ether-soluble extractive containing this added oil.

CONCLUSION.

The results reported in this paper indicate that fluidextracts and rhizomes of ginger should meet the following requirements:

Volatile oil:	
Proportion (per cent)	1.2 to 3.0
Specific gravity, 25° C.	0.876 to 0.885
Optical rotation, 25° C.	−40° to −56°
Index of refraction, 20° C.	1.490 to 1.493
Non-volatile ether-soluble extractive:	
Proportion (per cent)	3.5 to 7.1
Iodine value	36 to 50
Saponification value	45 to 70

Although the physical constants of the extractives from the different varieties of ginger vary considerably, the addition of appreciable quantities of an adulterant to a fluidextract of ginger may be readily detected by the method here described.

THE ACTIONS AND BIOLOGIC ASSAY OF EPHEDRINE.[1]

BY PAUL S. PITTENGER.

Ephedrine is an active alkaloid originally isolated in an impure form from the Asiatic drug, Ma Huang, by Yamanashi. It was first isolated in the pure form by Nagai.[2]

Ma Huang, identified as *Epheera vulgaris* **var.** *helvetica*, has been used in the practice of medicine in China for more than five thousand years but remained practically unknown until revived by the vast researches and publications of pharmacological and clinical studies by Chen and Schmidt and Chen[3] during 1924 to 1926.

The empirical formula for ephedrine is $C_{10}H_{15}ON$; its chemical structure most probably is 1-phenyl-2-methylaminopropanol-1 $C_6H_3.CHOH.CH(NH-CH_3)CH_3$.

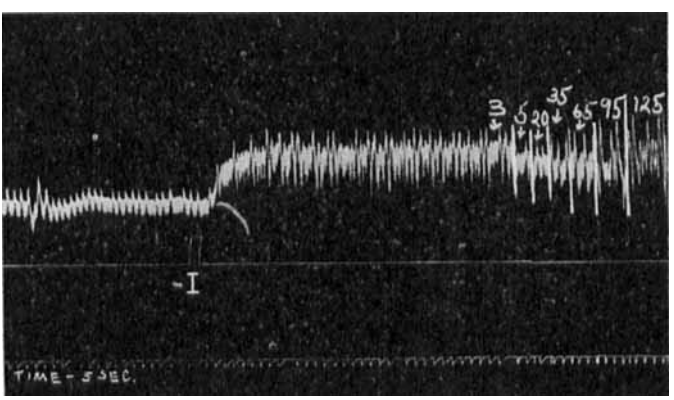

Fig. 1.—Effect of intravenous administration of ephedrine upon the circulation. 0.2 cc. of a 3 per cent solution of ephedrine sulphate intravenously injected at I. Figures above tracing indicate the number of minutes after injection.

It will be noted by the chemical composition of ephedrine that it is allied closely to epinephrine. In many ways it also simulates epinephrine in its physiologic action. Its effects on the circulation, smooth muscle and secretions are due to sympathetic stimulation and resemble qualitatively those of epinephrine. In addition it stimulates the central nervous system and depresses the heart, but these effects are elicited ordinarily only by toxic doses.

It produces a rise in blood pressure due to vasoconstriction and cardiac stimulation. It stimulates uterine muscle and relaxes the bronchial muscle. It also possesses mydriatic action.

---

[1] Read before the Scientific Section of the American Drug Manufacturers' Association, New York City, March 30, 1928.

[2] Nagai, *Pharm. Ztg.*, 32 (1887), 700.

[3] Chen and Schmidt, *Proc. Soc. Exptl. Biol. Med.*, 21 (1924), 351; *J. Pharmacol.*, 24 (1924), 339; *China Med. J.*, 39 (1925), 382; Chen, *Proc. Soc. Expti. Biol. Med.*, 22 (1924), 203; 22 (1925), 404; 22 (1925), 568; 22 (1925), 570; JOUR. A. PH. A., 14 (1925), 189; *J. Pharmacol.*, 26 (1925), 83; 27 (1926), 61; 28 (1926), 77; 27 (1926), 87; 27 (1926), 239.