acid, as a test for tin and antimony, and on the residue after volatilization, in connection with which "no appreciable residue" should be defined. Purified mercury of the market contains 0.02 to 0.05 per cent. of non-volatile matter.

HYDRARGYRUM AMMONIATUM.—It is not "wholly" volatilized by heat, but the residue should not exceed 0.05 per cent. Solution of the compound in diluted hydrochloric acid, precipitation and weighing of the mercury as sulphide has been found a satisfactory method of assay.

HYDRARGYRUM CUM CRETA.—The test for mercurous oxide should be made with the same proportions of materials as are directed in the test for mercuric oxide. A requirement of not less than 37 and not more than 39 per cent. of mercury should probably be made and a method of assay added. Dissolving in nitric acid, evaporating to dryness on a water-bath with a decided excess of nitric acid, then taking up in acidulated water and precipitating a mercuric sulphide, has been found a satisfactory method.

(To be continued.)

THE PRESERVATIVE ACTION OF ESSENTIAL OILS.

J. R. RIPPETOE, P. D. AND L. E. WISE, PH. D.

INTRODUCTION.

The present status of food preservatives in this country is a peculiar one. The past few years have shown that the addition of benzoate and salicylate of soda to food preparations is frowned upon, even if the chemicals themselves are not — in the opinion of some food experts — of a highly deleterious nature. Nor is the use of inorganic preservatives viewed with much favor. Copper salts, the sulphites, the fluorides, boric acid, all have had their detractors and all of them are gradually leaving the formulae of the manufacturers. Added preservatives of this type may, therefore, be considered (temporarily at least) under the ban.

And yet, foods, beverages and pharmaceutical products which act as culture media for various bacteria and which will permit the growth of mold must of necessity be preserved in order to make them articles of commerce. There is indeed one class of natural products which has for ages past been used perhaps unwittingly by house wives and manufacturers in the preservation of their food stuffs. We have reference to the spices, and especially to cinnamon, mustard and cloves, which, as a recent investigation by Hoffmann and Evans[1] has shown — are highly preservative in their action towards spore forming bacilli and the yeasts. It seems quite reasonable to assume that the preservative nature of these

[1] J. Industrial and Eng. Chemistry, Nov., 1911, 835.

spices may be directly traced to their specific and characteristic constituents, the essential oils, and it is an investigation of the action of these oils that has been set forth in this report.

The antiseptic action of many of the common (and not a few of the less well-known) essential oils has been made the subject of some extended researches,[2] although their preservative action has received little attention in the literature.

In 1895, Weinsche[3] mentioned the fact that menthol, the terpene-alcohol of peppermint, when in a dilution of 1 to 3000 arrested the growth of comma and cholera bacilli.

In 1902, Calvello[4] stated that a 7 to 8 per cent. emulsion of cinnamon oil and an 11 per cent. solution of oil of thyme had the same effect in sterilization as a one per cent. solution of corrosive sublimate, and that oil of cinnamon, in an emulsion carrying 9 per cent. of the oil, effected complete sterilization. Furthermore, the disagreeable, "secondary" effects of mercuric chloride were not apparent.

In 1903, Marx.,[5] continuing the previous work of Konradi examined terpineol, vanillin, heliotropin, and other substances of an aromatic nature, for the same purpose. The development of such pathogenic organisms as the resistant anthrax spores and staphylococci pyogenes aureus were arrested by the substances under investigation. A saponaceous emulsion of terpineol was found to be strongly antiseptic. Marx advanced the theory that the degree of bactericidal action was directly dependent on the oxygen-activating power of the aromatic examined — i. e. the alleged property that these substances have for rendering oxygen more active as a germicide.

The same year R. Kobert[6] in an article on the "Pharmaco—therapeutics of Aethereo-Oleosa. mentioned the anti-microbic properties of essential oils, and stated that the oil of turpentine when exposed to the air, prevented putrifaction, that limonene and methyl salicylate were both disinfectants and that menthol and thymol were of value as antiseptics in dental use.

Heller[7] investigated the toxic effect on plants of the vapor of certain essential oils. He found that in the liquid state or in aqueous solution, these oils were much less potent in their effect. Vandevelde[8] compared the poisonous character of different essential oils and their constiuents by means of plarmolysis, comparing their toxicity with that of ethyl alcohol (taken as 100). He found that

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[1]We wish at this point to state that many of the references to the bactericidal action of the essential oils have been found in the excellent physiological and pharmacological notes of Schimmel's Reports. For the earlier literature much information has been gained from Sternberg's *Text-book of Bacteriology*.

[2]Therapeut. Monatshefte, No. 9.

[3]Pharm. Ztg. 47, 759.

[4]Centralbl. fur Bacteriologie u Parasiten Krankeiten, 33, 1-74.

[5]Schimmel's Report, Oct., 1903.

[6]Thesis. Leipzig, 1903.

[7]Bull. de l' Assoc. Belg des chin 17, 269.

thymol, menthol, cinnamic aldehyde, oils of cassia, cloves, white thyme, cinnamon and red thyme were all more than one hundred times as powerful as the standard; that peppermint, nutmeg, and star anise were more than fifty times as toxic, and that carvone, benzaldehyde, oil of bitter almonds, caraway, terpeneless lemon, neroli, angelica, anise, (anethol) cognac and lemon were all more potent in their action than the alcohol itself.

In 1904, Liebreich[9] reported the germicidal action of oil of mustard. About the same time. Hall[10] published a research on the bactericidal and antiseptic action of the constituents of eucalyptus oils. He stated that cineol was the least active of the eucalyptus components and that aromadendral, piperitone and phellandrene were its most active bodies. B. coli communis was experimented upon. The author claimed that ozonized oils increased the antiseptic value of cineol — and he recommended their use in medicine.

In 1906, K. Kobert[11] and his co-worker Bruning[12] determined the relative antiseptic values of a large number of volatile oils, depending on the inhibitory action of these oils on the hydrogen sulphide generation which normally takes places through the action of bacteria in milk containing finely powdered sulphur. Their articles are well worthy of note, and we do not think it out of place to give a brief resume of their results.

Kobert found that oils of amber, anise, bergamot, calamus, cardamom, cedarwood, celery, copaiba, cubeb, cumin, cypress, erigeron, estragon, fennel, ginger, juniper, savin, turpentine (free from oxygen), valerian, and wintergreen — were all very feeble in their action; that angelica, citronella, geranium, jaborandi, lavender, patchouli, peppermint, peruvian balsam, pinus montana, rue, sandalwood, tansy, thyme, wild thyme and wormwood were feeble; that basil, eucalyptus, linaloe, niobe, orange blossom, palmrosa, pennyroyal, rosemary and sage oils were intermediate; that bay, cajuput, caraway, coriander, dill, double caraway, jasmine, pine needle, spearmint, spoonwort, *ozonized* turpentine, wormwood and ylang ylang oils were strong; and that bitter almond, cassia, cherry laurel, cinnamon, mustard and spike oils were very powerful antiseptics. Of the important constiuents of essential oils, and certain others Kobert found that ethyl alcohol and santalol, citral and heliotropin, muskone and thujone, anethol, apiol, isomyristicin, isosafrol, methyl chavicol and thymol, camphene, phellandrene and the terpenes of dill and rosemary oils all showed *very feeble* antispetic properties; that citronellol, geraniol, safrol, pinene, and the terpenes of bay and citronella oils all showed slight antiseptic value; that carvone, pulegone, menthyl-heptenone, myristicin, terpinene, were moderate bactericides; that furfuric alcohol, linalool, terpineol, fenchone, menthone, eugenol and limonene were strong in their action and that benzyl alcohol, anisic aldehyde, benzaldehyde, cinnamic aldehyde and isoeugenol were very *powerful* as inhibitory agents.

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[9]Ther. Monatshefts 18, 65.

[10]F. D. Chem. Industry XXIII (1904), 1233.

[11]Schimmel's Report, Oct., 1906.

[12]Centrbl. für un Medizin, 27, No. 14.

His work further shows that most esters such as amyl and methyl salicylate, bornyl acetate and valerianate and linalyl acetate are very poor, and that only benzyl acetate and methyl benzoate may be taken as moderate antiseptics. Cymene and cineol may be described as medium in their bactericidel value and $C_{10}H_{16}O_2$— the active principle of wormseed oil (known as "ascaridol"), is very powerful in its action.

There are several interesting differences between the observations of Kobert and those of Bruning. The latter placed bitter almond oil and terpinene among the very weak antiseptics, while the former stated that almond oil, was a very powerful and that terpinene was a mild antiseptic. Less striking differences are also to be noted in oils of turpentine (ozonized and free from ozygen) in dill, pine needle, and coriander oils and in linalool, spoonwort oil and terpineol. These variations may have been due to the bacteria-content of the milk; to change or decomposition of the substance tested or to the doubtful blackening of lead acetate paper. Both investigators noted the weak antiseptic character of the terpenes and both claim that terpeneless oils are useful in medicine.

In 1906, as well, we find the work of Kettenhofen[13] on the destructive influence of ylang-ylang oil on micro-organisms.

In 1907, Bruning[14] published an article on the potent active principle, of chenopodium oil—$C_{10}H_{16}O_2$ K. Kobert [15] also continued his noteworthy researches on the bactericidal value of essential oils — and investigated the differences between terpene and terpeneless oils of the same source. His results show that in general it can be assumed that terpeneless oils are at least as powerful in their action as those containing terpenes, and that in certain cases (such as oils of bergamot and citronella) the terpene free variety were the more powerful antiseptics. He also recorded the fact that the same influence was exerted by various oils on pure cultures, as on the normal milk bacteria, referred to in his former research.

1910 Gilmour[16] studied the relative germicidal values of essential oils used in dental surgery. Oils of cassia, cinnamon, cloves and bay (in the order named) head the list as valuable bactericides. These are followed by peppermint, eucalyptus, thyme and cajuput, while oil of gautheria is mentioned as being of insufficient value for the root canal dressing.

Martindale, [17] that same year published the outcome of a series of examinations of aqueous and saponaceous solutions of oils, compared with that solution phenol which represents the minimum strength necessary to destroy a specific organism. Assuming that *a* was the percentage of carbolic acid solution required for this purpose, that *b* was the percentage of oil required under similar conditions,

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[13]Thesis Boon, 1906.

[14]Deutsche Med. Wochen Schrift, 1907, No. 11; c. f. Thelen Thesis Rostock, 1907.

[15]Pharm. post 40, 627.

[16]Pharm. J. and Pharmacist, May, 1910, 844.

[17]Perfume and Ess. Oil Record, 1, 266.

he termed a/b the "phenol coefficient" and established this ratio for a large number of oils. The highest coefficient naturally indicates the highest antiseptic value. The following oils or constituents together with their respective coefficient have been listed:[18]

Origanum (W-25.76), thymol (S-25.29), carvacrol (S-21.32), thymol (W-19.41), thyme oil (S-14.85, W-13.38), geraniol (S-12.29), cinnamon leaf oil (S-9.66), cinnamon bark oil (S-8.91), clove oil (S-8.88), cinnamic aldehyde (S-8.0), citronellol (S-8.11), cinnamon oil (S-7.92, W-7.11), rosemary oil (S-5.94), otto of rose (S-5.94), cassia oil (S-5.35), wintergreen oil (S-4.64), eucalyptus (amygdalina) (S-4.35), lavender oil (Mitcham) (S-4.94), lemon oil (S-3.94), bitter almond oil (S-3.76), eucalyptol (S-3.76), eucalyptus-globulus (S-3.55), sandalwood (S-1.67), birch tar oil (S-1.67), cade oil, less than one.

The results (especially those involving cassia, which is apparently weaker than rosemary, and bitter almond oil which is even less potent than oil of lemon) are not entirely in accord with those of Kobert which have been summarized above.

OBJECT AND SCOPE OF INVESTIGATION.

The purpose of this report is to present in systematic form the preservation value which may be attached to a number of essential oils used in pharmaceutical practice, largely for flavoring purposes. The efficiency of the oil has been very roughly gauged by its power to arrest the growth of mold in a 50 per cent. glucose solution, (series A) and a 50 per cent. sugar solution containing extract of meat and peptone, (series B) within certain periods of time. All results of this work should be taken qualitatively. We have not undertaken to establish the comparative preservative value of our oils, excepting in a very general way. We have tried to show the inefficiency of certain oils as preservatives, and we have tried to show which oils preserve satisfactorily.

PROCEDURE.

Preliminary Examinations of Oils. The oils, with very few exceptions, were examined physically (gravity, optical rotation etc.) — and whenever possible the characteristic constituents were determined by reliable analytical methods. The appended list is a complete summary of this work. (The chief constituents are taken directly from Parry's Chemistry of Essential Oils and Artificial Perfumes 2nd. Ed.) Further than these, citral, menthol, thymol and terpineol have been included in our experiments.

[18]W indicates aqueous; S indicates saponaceous solution of the oil.

Oil	Source	Chief Constituents	S/G 25/25°C	Optical Rotation 25° C	Approximate Percentage of Characteristic Constituents	Other Tests
Almond, Bitter.....		Benzaldehyde; H C N.	1.0586		91% Benzaldehyde	
Almond, Bitter (no acid)		Benzaldehyde.	1.0453		99% Benzaldehyde	
Angelica	Schimmel	Phellandrene; methylethyl-acetic acid; oxypentadecylic acid.	.8607	+34.9°		
Anise		Methyl chavicol; anethol; aniseketone; anisic aldehyde and anisic acid.	.9745	very slightly+	77% Anethol	Congealed oil melts 16°-17° C.; B.P.(major portion) 225°-235° C.
Bergamot		Linalol; linalyl acetate; limonene; bergaptene.	.8746	+21.6°	34.9% {Linalyl Acetate	
Betula		Methyl salicylate.	1.1817	±0°		B. P. 218°-221°
Cajaput		Cineol; terpineol; terpinylesters; etc.	.9166	— 1.8°	68% Cineol	
Calamus	Schimmel	Terpenes; sesquiterpene; oxygenated bodies not identified	.9568			
Caraway Seed.....	Metzner & Otto	Limonene; carvone.	.9012	+78.7°	54% Carvone	Soluble in 1 part 90% alcohol
Cardamom	Schimmel (Ceylon)	Terpineol; dipentene; limonene; cineol; acetic esters.	.9289	+30.9°		
Cardamom	Prepared in this laboratory from Mangalore Cardamom		.9348	+38.5°		
Cassia		Cinnamic aldehyde; cinnamic acid ester; O-methyl cumaric aldehyde.	1.0672		75% Cinnamic Aldehyde	
Celery	Horner	Limonene; sedanolic acid; sedanolide; sedanonic acid, etc.	.8639	+76.6°		
Chenopodium			.9685	— 2.7°		
Cinnamon		Cinnamic aldehyde; eugenol; phellandrene.	1.0368		83% Cinnamic Aldehyde	
Cinnamon	Schimmel		1.0209	— 1.1°	74.5% Cinnamic Aldehyde	Soluble in 2½ parts 70% alcohol
Citronella		Geraniol; borneol; citronellol; camphene; dipentene; methyl heptenone.	.8979	—11.1°	Total Geraniol—27.7% Total Citronellol—28.3%	
Cloves		Eugenol; amyl methyl ketone; caryophyllene.	1.0417	— 0.4°	87.5% Eugenol	
Coriander	Metzner & Otto	Pinene; linalol.	.8686	+10.7°		Soluble in 3½ parts 70% alcohol
Coriander			.8721			
Cubeb (9199).....		Dipentene, cadinene, cubeb camphor.	.9192	—33.5°(?)		
Cubeb (9813).....			.9206	—25.1°		
Cumin	Schimmel	Cymene; cumic aldehyde.	.9076	+ 2.6°		
Dill	Schimmel	Limonene; carvone; dill apiol.	.9094	+69.7°	46% Carvone	
Eucalyptus		Cineol; other const. depending on source.	.9194	+ 1.7°	72% Cineol	
Fennel		Pinene; phellandrene; dipentene; limonene; fenchone.	.9668	+18.1°		
Geranium, Rose (Algerian)	Schimmel		.8927	— 8.1°	22.6% Geraniol tiglate 75.2% Geraniol (total)	

Oil	Source	Chief Constituents	S/G 25/25°C	Optical Rotation 25° C	Approximate Percentage of Characteristic Constituents	Other Tests
Geranium, Rose	Bertrand	Geraniol citronellol; and tiglic acid esters.	.8976	+ 0.8°	{15.6% Geraniol tiglate {48.2% Geraniol (total)	
Ginger	Schimmel	Camphene; phellandrene; sesquiterpene.	.8773	—45.1°		
Hedeoma		Hedeomol; pulegone.	.9322	+17.6°	Pulegone 62%	
Horsemint	Schimmel	Dextro-limonene; cymene; thymol.	.9206		Phenolic bodies 46.8%	
Juniper berries	Metzner & Otto	Pinene; cadinene.	.8700	— 7.8°		
Lavender flowers	Schimmel No. 1	Linalyl acetate; geraniol; sesquiterpene, pinene; limonene.	.8872	— 4.4°	26.8% Linalyl acetate	
Lavender flowers	Motlet (French)		.9092	— 1.6°	29.6% Linalyl acetate	
Lavender flowers	D. & O.		.9193	— 3.1°	26.9% Linalyl acetate	
Lavender flowers	"Mitcham" (English)	Constituents as above and also cineol.	.8983	— 6.8°	12% Linalyl acetate	
Lemon (9469)		Citral; citronellol; limonene.	.8524	+58.7°	4.25% Citral (average)	
Lemongrass		Citral; citronellol; geraniol; methyl heptonone.	.9112		69% Citral	Not completely soluble in 7 to 8 parts of 70% alcohol
Mace	Schimmel	Pinene; myristicin; dipentene; myristical.	.9057	+20.3°		
Marjoram	Schimmel		.9017	+15°		
Mustard (artificial)	Schimmel	Allylisothiocyanate.	1.0144		100% Allylisothiocyanate	
Neroli		Limonene; linalol; linalyl acetate.	.8790	+11.6°	{18.7% Linalyl acetate} {56.1% Linalol }	Slight fluoresence in alcohol
Nutmeg	Metzner & Otto	Myristicol; terpenes.	.8893	+21.4°		Soluble in 1 part 95% alcohol, also in 5 parts 90% alcohol
Origanum (Red Imitation)	Schimmel		.8657		10.5% Phenols	
Orange Peel	Messina	Limonene; citral; citronellol.	.8450	+95.8°		
Pepper (black)	Schimmel	Terpenes; sesquiterpenes.	.9016	— 1.1°		
Peppermint		Menthol; menthyl acetate etc.	.9105	—25.5°	{11.2% Menthyl acetate {63.8% Menthol total	
Pimenta		Eugenol; sesquiterpene.	1.0416		85% Eugenol	
Pine	Schimmel (from abies pectinata)	Pinene; sylvestrine bornylacetate.	.8567	—68.2°	Ester cont. 3.4%	
Pine	Schimmel (from Pinus Pumilio)		.8604	— 9.3°	5.2 Bornyl acetate	
Pinus Palustra (Oil of Tar)			1.0118			
Rose	(Damascena)	Geraniol; citronellol.				
Rosemary		Borneol; bornyl acetate.	.8988	+ 5.1°	{ 2.70% Bornyl acetate {10.4 % Borneol	
Sassafras		Safrol; eugenol; pinene; phellandrene; cadinene.	1.0732	+ 2.9°		
Santal	East Indian	Santalol.	.9730	—16.8°	96% Santalol	
Spearmint		Carvone.	.9318	—47.2°		
Tansy		Thujone; camphor; borneol.	.9218	+35.7°		
Thyme		Thymol; pinene; cymene; linalol, bornyl acetate; carvacrol.	.9086	— 1.4°	21% Phenols	
Turpentine	(rectified by Schieffelin)	Pinene, etc.	.8655	+12.5°		0.79% residue on evaporation

METHODS OF MANIPULATION.

Sterilization, Series A:—Eight ounce bottles, to which 8 grams of purified talc had been added, and empty 2 ounce bottles — both series loosely stoppered with corks) were heated in an air bath for 2-3 hours, at a temperature of about 130°-140°. This procedure was followed, not to insure *absolute, final sterility* but to obtain *nearly uniform* conditions within the bottles (which had simply been taken from clean stock in our bottling department), i. e. to warrant sterilization before the bottles were actually exposed to the air of the laboratory.

Series B: — No sterilization precautions were taken.

Solutions, Series A:—A solution made up of 1500 grams of *good* commercial glucose (containing traces of H_2SO_4) in three liters of aqueous solution (i. e. enough water to bring the volume to 3000 cc.) was prepared and shaken mechanically to insure homogeniety. The same mixing bottle and cork were used throughout the set of experiments.

Series B: — The solution was prepared by dissolving 18 gm. ext. of beef, 36 gm. peptone and 1800 gm. sugar in sufficient water to make 3600 cc.

Saturated Oil Solutions, Series A: — These were prepared by adding 200 cc. of the glucose solution to each cooled eight oz. bottle (containing the talc.) shaking (on a mechanical shaker for 1 hour) and finally filtering through filter papers taken from two packages kept in the same drawer, under similar conditions and through funnels which had previously been heated and cooled—into the 2 oz. bottles (referred to above). The latter were in all cases (with exceptions which have been recorded) "well filled" — (filled somewhat above the shoulder of the bottle.) One lot of saturated-oil-solution served to fill two 2 oz. bottles — and these were in every case taken as duplicate experiments, bottles marked 1 and 2.

Series B: — Prepared same as series A excepting that no sterilization precautions were observed. Bottles marked 4 and 5.

CONTROLS.

Control tests (employing the methods outlined above and simply omitting the addition of essential oils) were run for each lot and also in series B controls with benzoic acid, the acid being added in excess and the undissolved portion filtered out.

TIME FACTOR IN SETTING UP EXPERIMENTS AND FURTHER PRECAUTIONS.

It was found convenient to run about eleven oils a day, thus making a total of twenty-three bottles, (including the control)and on successive days whenever possible until the series had been completed. In series A the bottles were kept out of direct sunlight — ordinarily in a dark closet. In series B the bottles were placed on a shelf in the laboratory in diffused sunlight.

EXAMINAION OF SOLUTIONS.

The solutions were examined for mold growth, cloudiness, gas formation or other evidence of spoiling at frequent intervals. In several cases the saturated oil solutions showed a slight amount of floating matter — filter paper or traces

of talc that had passed into the filtrate. These could however be generally distinguished from mold growth or cloudiness without much difficulty. In series B many of the solutions showed turbidity without any other signs of spoiling. Believing this to be due to chemical reaction between the oils and the constituents of the solution we have recorded there as negative.

Positive growth of mold or gas formation has been recorded *giving the time elapsing* between date of preparation of test and date when the solution had positively spoiled. Negative results are recorded as (——).

In series A the second bottle (bottle 2) of each test after standing for 30 days was inoculated with a postive growth from a blank that had fermented and had mold growth. In case of positive results the time recorded, in column 3, is that which has elapsed after inoculation.

At the time of the tabulation of results series A has stood for 24 weeks and series B for 8 weeks.

TABULATION OF RESULTS.

OILS, ETC.	SOLUTIONS.				
	SERIES A.			SERIES B.	
	1	2	3	4	5
Almond Bitter	—	—	—	—	—
Almond Bitter, no acid	—	—	—	—	—
Angelica	1 week	2 weeks		2 weeks	2 weeks
Anise	—	—	3 weeks	2 weeks	2 weeks
Bergamot	—	—	3 weeks	4 weeks	4 weeks
Betula	—	—	—	—	—
Caluput	—	—	—	—	—
Calamus	1 week	1 week		2 weeks	4 weeks
Caraway Seed	2 weeks	—	3 weeks	—	—
Cardamom S	—	—	—	—	—
Cardamom Mang.	—	—	—		
Cassia	—	—	—	—	—
Celery	1 week	1 week		2 weeks	2 weeks
Chenopodium	—	—	—	—	—
Cinnamon	—	—	—	—	—
Cinnamon S	—	—	—		
Citral	—	—	20 weeks	—	—
Citronella	—	—	—	—	—
Cloves	—	—	—	—	—
Coriander	—	—	—	—	—
Coriander M. & O.	—	—	—		
Cubeb 9199	3 weeks	4 weeks		2 weeks	2 weeks
Cubeb 9813	1 week	4 weeks			
Cumin	—	—	—	—	—
Dill	1 week	—	3 weeks	—	—
Eucalyptus	—	—	—	—	—
Fennel	—	—	3 weeks	—	—
Geranium B	—	—	—	—	—
Geranium S	—	—	—		
Ginger	—	—	3 weeks	2 weeks	2 weeks
Hedeoma	—	—	20 weeks	—	—
Horsemint	—	—	—	—	—
Juniper Berries	1 week	—	3 weeks	—	—
Lavender Flowers S No. 1	—	—	—	—	—
Lavender Flowers M	—	—	—		
Lavender Flowers D & O	—	—	—		
Lavender Flowers M. Eng.	—	—	—		
Lemon 9469	1 week	1 week		2 weeks	4 weeks
Lemongrass	—	—	3 weeks	—	—
Mace	—	—	—	—	—

TABULATION OF RESULTS—*Continued.*

OILS, ETC.	SOLUTIONS.				
	SERIES A.			SERIES B.	
	1	2	3	4	5
Marjoram	—	—	—	—	—
Menthol	—	—	—	—	—
Mustard Art.	—	—	—	—	—
Neroli	—	—	—	—	—
Nutmeg	—	—	3 weeks	—	—
Orange Peel	1 week	1 week		2 weeks	2 weeks
Origanum	—	—	—	—	—
Pepper Blk.	1 week	1 week		2 weeks	2 weeks
Peppermint	—	—	—	—	—
Pimenta	—	—	—	—	—
Pine (*Pin. pum.*)	2 weeks	—	3 weeks	2 weeks	2 weeks
Pine (*Abies pect.*)	1 week	2 weeks		—	—
Pine Tar	—	—	—	—	—
Rose	—	—	—		
Rosemary	—	—	—	—	—
Sassafras	—	—	—	—	—
Santal	1week	3 weeks		2 weeks	2 weeks
Spearmint	—	—	3 weeks	—	—
Tansy	—	—	—	2 weeks	—
Terpineol	—	—	—		
Thyme	—	—	—	—	—
Thymol	—	—	—	—	—
Turpentine	1 week	2 weeks		2 weeks	2 weeks

Conclusions: — The following act as preservatives; oils of bitter almond, bitter almond no acid, betula, cajuput, cardamom, cassia, chenopodium, cinnamon, citronella, cloves, coriander, cumin, eucalyptus, rose geranium, horsemint, lavender, mace, marjoram, mustard art., neroli, origanum, peppermint, pimenta, tar, rose, rosemary, sassafras and thyme and menthol, terpineol and thymol.

Oils of angelica, calamus, celery, cubeb, lemon, orange peel, black pepper, pinus, pumilio, santal and turpentine do not act as preservatives.

The preservative action of ths following is questionable: oils of anise, bergamot, caraway seed, dill, fennel, ginger, hedeoma, juniper berries, lemongrass, nutmeg, pine (abies pectinata), spearmint and tansy and citral.

At this writing series B has not been standing sufficiently long to arrive at any definite conclusions as to comparison of results of the two series.

We would take this opportunity of acknowledging the willing and valuable assistance of Dr. Roddie Minor in preparing the solutions.

RESEARCH DEPARTMENT, SCHIEFFELIN & Co., New York, August 10, 1912.

MORE TROUBLE FOR THE DRUGGIST.

One would think that with cut rate, chain store and department store competition, pure food and drugs legislation, drastic city health board ordinances, the Richardson Bill, the Owen Bill, and other restrictive measures in prospect, the retail druggist had troubles enough for one poor mortal.

But it seems that, like Job's boils, trouble no sooner is overcome in one place