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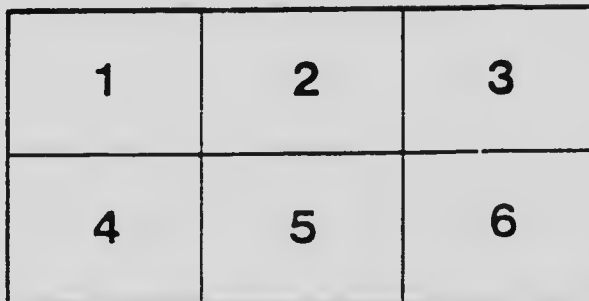
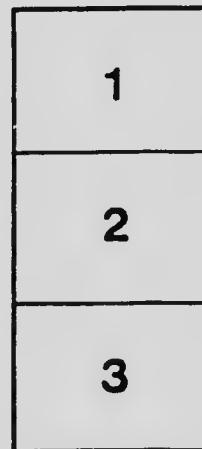
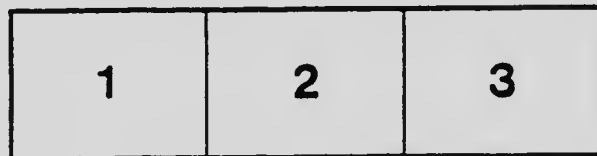
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LABORATORY
OF THE
INLAND REVENUE DEPARTMENT
OTTAWA, CANADA.

BULLETIN No. 349

M A C E

NOTES AND COMMENTS.

Under this heading, as occasion arises, the Bulletins issued by this Department will contain, as an appendix, such comment as may seem necessary or advisable upon matters relating to the work of the Department in connection with the administration of the Adulteration Act, the Fertilizers Act, the Feeding Stuffs Act or the Proprietary Medicines Act.

It frequently happens that correspondents ask information regarding the above Acts, of such a nature that the matter in question possesses general interest, and comment upon it would prove acceptable and useful to others than the immediate questioner. In such cases the reply may find a place in these columns. For convenience of reference these notes will be numbered in series.

*L,
of Analyst.*

LABORATORY
OF THE
INLAND REVENUE DEPARTMENT
OTTAWA, CANADA

BULLETIN No. 349.

MACE

OTTAWA, October 18, 1916.

J. U. VINCENT, Esq.,
Deputy Minister of Inland Revenue,

SIR,—I beg to hand you herein a report upon the spice known as Mace. This is the first occasion upon which we have dealt with the article named, and owing to the facts that comparatively little investigatory work is on record regarding this spice; that no accepted standards for it exist, and that even importers of the article are imperfectly informed as to its source and character, the report now placed in your hands must be considered rather as a study of the subject, than as a record of official inspection.

The attention of the Department has been called to the matter by several interested parties, from one of whose letters I quote the following:

"Has your Department ever made a collection of this spice? The reason we ask is this. A good Amboyna or Penang costs at the present time (April, 1914) about 61½ cents per pound, while Bombay, which is a wild mace, can be purchased for 2½ cents a pound. In order to reduce the cost per pound, the spice-grinders generally blend either of the first two with the latter. While Bombay is truly mace, yet it does not contain any essential oil, and has no flavouring power, and therefore really acts as a filler."

Mace is the arillus, or outer coating of the nutmeg, the seed of *Myristica fragrans* (British Pharmacopocia.) "This tree is indigenous to the Molucca Islands, and is cultivated in Penang, Sumatra, the West Indies, etc. Penang nutmegs, which are the most esteemed, are very aromatic. Singapore nutmegs closely resemble them. Wild nutmegs are longer, narrower, and less aromatic. Bombay nutmegs, (*M. Malabarica*) are devoid of aroma. Of species of *Myristica* other than *M. fragrans*, only one, viz.: *M. Argentea*, the Papua nutmeg, yields aromatic seeds. Mace is the dried arillus. Considerable quantities of valueless Bombay mace are imported." B. P. Codex, p. 652.

Mace, like the nutmeg, owes its value as a spice to its content of volatile oil, and according to Allen (Com. Org. Analysis, IV, 359) this oil is practically identical in nutmeg and mace. The *Oleum Myristicæ* of the pharmacopocia is stated by Allen

to be a fraction only of the natural oil. Specifications for this oil, are somewhat changed in the 1914 edition of the B. P.

	1898	1914.
Specific gravity.	0.870 to 0.910.....	0.870 to 0.925.
Optical rotation.....	Not given.....	+13° to +30°.
Refractive index.....	".....	(25 C) 1.474 to 1.484.
Solubility.....	In 1 vol. mixture equal parts absolute and 90% alcohol.....	In 3 volumes of 90% alcohol.
Residue at temp. of boiling water..	No crystalline residue.....	Not to exceed 5%.

That Bombay mace must be regarded as of no value for the purposes of a spice, follows from the above quotation from the B. P. Codex. In addition I may quote Kraemer. (Pharmacognosy, 1915, p. 256.) "Bombay mace is very largely used to adulterate genuine mace." Also Bailey (Food Products, 1914, p. 451.) "Bombay mace, which is often used to adulterate Penang and other true maces, has practically no flavour, and is of little more value than so much inert material."

Leach (Food Inspection, etc., 1909, p. 467) says: "Bombay mace, is almost entirely devoid of odour or taste, being nearly as inert as so much starch. It is most properly regarded as an adulterant from its lack of pungency, even though in a sense, it is a variety of mace."

U. S. A. standards for Mace, are as follows: (Circular 19, Dept. of Agriculture, Washington.) "Mace is the dried arillus of *Myristica fragrans*, and contains not less than 20, nor more than 30 per cent. of non-volatile ether extract; not more than 3 per cent. of total ash, and not more than 0.5 per cent. of ash insoluble in hydrochloric acid; and not more than 10 per cent. of crude fibre."

"Macassar mace, Papua mace, is the dried arillus of *Myristica Argentea*." "Bombay mace is the dried arillus of *Myristica Malabarica*."

Leach (Food Inspection and Analysis, 2nd edition, p. 466) quotes the following analytical results, obtained by Winton, Ogden and Mitchell upon samples of the three kinds of mace specified in the above standards:

1. True mace (means of 4 samples.)
2. Macassar mace.
3. Bombay mace.

	1	2	3
Moisture.....	11.05	4.18	0.32
Ash total.....	2.01	2.01	1.98
Ether extract, volatile.....	7.58	5.89	4.65
" non-volatile.....	22.48	53.54	59.81
" total.....	30.06	59.43	64.46
Alcohol extract.....	23.11	32.89	44.27
Reducing matters by acid conversion, as starch.....	31.73	10.39	16.20
Starch, by diastase.....	27.87	8.78	14.51
Crude fibre.....	3.20	4.57	3.21
Nitrogen x 6.25.....	6.47	7.00	5.06

It will be noted that true mace is sharply distinguished from the other maces by its non-volatile ether extractive, which is much less than that yielded either by Macassar or by Bombay mace.

With regard to Macassar mace, Leach (op. cit.) says: "Macassar mace is sometimes designated as wild mace, but it is by no means as inert as the Bombay variety, and possesses a wintergreen like odour. Its taste, while distinctive, is not that of true Penang mace. It is distinctly an inferior article."

The value of the ethyl ether extractive as indicating the presence of Bombay mace is greatly enhanced if the sample be extracted with petroleic ether before applying the ethyl ether. (Parry, Food and Drugs, Vol. 1, p. 237.) Under these conditions, genuine mace yields only from 2 to 3.5 per cent. extractive to ethyl ether, while Bombay mace yields up to 33 per cent.

Macassar mace, however, behaves like Banda mace in this respect.

QUALITATIVE TESTS FOR BOMBAY MACE.

The microscopical characters of these various maces are not such as to satisfactorily distinguish them. Nevertheless, the oil glands in Bombay mace are so much redder than those of true mace, as to afford fairly good evidence of its presence.

Mr. Dawson suggests the possibility of utilizing the brilliant red produced in Bombay mace by treatment with dilute potassium hydroxide, as a means of quantitative determination in admixture.

Mr. A. T. Collins, Chemist to the Colburn Company, Philadelphia, has shown that, when mace is mounted in Canada Balsam, reduced by benzol, the cellular structures come out clearly under the microscope; and he claims that very small percentages of Bombay mace, in admixture with true mace, can easily be detected.

The Hefelmann and Schindler tests depend upon the fact that alcoholic extracts from Bombay mace differ from similar extracts of true mace, in yielding a decided red colour to paper through which they are filtered; and in giving a precipitate of reddish tint with acetate of lead. (Parry, op. cit., p. 237.) Waage's test consists in adding potassium chromate to the alcoholic solution, when the solution becomes red, and the precipitate at first yellow, becomes red on standing, if Bombay mace is present. True mace gives a yellow solution and the precipitate does not turn red. (Leach, op. cit., p. 463.) The refractive index of the fixed oil of Bombay mace (at 35° c.) is somewhat lower than that of the fixed oil from other maces. Lythgæ finds as follows:

For Banda mace oil.	1.4747 to 4848
" Batavia mace oil.	1.4893 to 1.4975
" Papua mace oil.	1.4795 to 1.4816
" West Indian mace oil.	1.4766
" Bombay mace oil.	1.4615 to 1.4633

E. Spaeth (Leffmann and Bean, Food Analysis, 2nd ed., p. 309-10) extracted a number of samples of mace with petroleum spirit and determined the constants of the material obtained. The figures obtained from mace from Banda, Menado, Penang, Macassar, and Zanzibar closely agreed with each other:—

	True Mace.	Bombay Mace.
Melting Point in open tube	25-26	31-31.5
Saponification Number.	169.9-173	189.4-191.4
Iodine Number	75.6-80.8	50.4-53.5
Zeiss Refractometer at 40°	76-85	48-49
Index of Refraction.	1.480-1.487	1.463-1.464
Meissl Number (Banda Mace).	4.1-4.2	1.0-1.1

In June of last year I was fortunate enough to secure, through the kindness of the late Mr. Grigg, Canadian Commissioner of Commerce, three samples of mace from Mr. E. H. S. Hood, Canadian Trade Commissioner of Barbados. These represent the qualities of mace exported from Grenada, B.W.I., and are described as:

- No. 1. First quality.
No. 2. Second quality.
No. 3. Third quality.

The Superintendent of Agriculture for Grenada states that "he does not think there is any adulteration in the No. 3 sample, other than what may accidentally occur in the process of sweeping up the fragments from the curing floors or boxes. The differences in quality are mainly of colour, and strength of the aromatic oil as affected by the action of mildews during drying, and the length of time, and methods used in the curing process."

The three samples referred to were submitted to analysis by Mr. J. A. Dawson of this staff, who reports as follows:

Sample No. 1. Marked "Best Estates and Buyers" consisted of the clean arillus in whole condition, of a dull yellow colour, with reddish brown to pink along the edges. Weighed 465 grams.

Sample No. 2. Marked "2nd Best Estates and Buyers" was made up of mostly broken arillus of dull reddish to blackish brown colour, with few yellow pieces. One or two fragments of grass or bark. Weighed 493 grams.

Sample No. 3. Marked "Mace Siftings, Estates and Buyers" included small broken fragments of arillns of yellow, red and black or brown colours. Pieces of grass, bark, leaves and chips of wood, with a few whole seeds like peas or coffee beans. Several short pieces of thread, possibly from jute bags, and two dead insects. Weight, 487 grams.

In sampling, the whole contents of each package were spread out on a sheet of paper and thoroughly mixed. About 100 grams were weighed out and ground to pass a sieve of 1 sq. mm. Figures given are in all cases the mean of two determinations.

	No. 1.	No. 2.	No. 3.
Total ash	1.50	1.70	2.10
Ash insol. in 10% HCl	0.05	0.05	0.09
Non-volatile petrolic ether extractive	29.85	29.02	26.43
Non-vol. ether extractive after petrolic	1.14	1.43	1.55
Total ether extracts	30.99	30.45	27.98
Crude fibre	2.87	3.14	3.80
Refractive index of non-vol. petrolic ether extract	1.4791	1.4788	1.4821
Microscopic examination for Bombay mace	None.	None.	None.
Starch (iodine test)	Absent.	Absent.	Absent.

Two samples of mace obtained direct from Bombay, through the kindness of A. H. Ley, Esq., gave the following results:

Sample A. Known as "Chap" cost 1s. 10d. per lb.

" B. " " Ful " " 1s. 8d. "

	A	B
Total ash	1.94	1.96
Insoluble ash	0.044	0.012
Crude fibre	3.80	3.60
Petrolic ether extract	20.95	20.94
Sulph.	0.87	0.54
Total extractive	21.82	21.48

It is quite apparent that these samples are true mace, and not the Bombay or wild mace.

Two samples of Bombay mace supplied by a friend in Toronto, gave the following results:

	C	D
Petrolie ether extractive.....	34.32	28.44
Sulph. ether ".....	25.04	27.56
Total extractive.....	59.36	56.00

These samples gave positive reactions with the *Biuret* and *Schindler* tests for Bombay mace.

The following work was done by Mr. Dawson upon a sample of commercial mace containing Bombay mace; and upon the components of this sample, separated as completely as possible, under the microscope.

	The Sample.	True mace.	Bombay mace.
	%	%	%
Non-volatile petrolie ether extract.....	20.96	24.07	22.43
" " ethyl " after petrolie.....	7.24	1.83	42.30
Total non-volatile ether extracts.....	28.20	25.90	64.73
Ash.....	1.75	1.70	1.37
Ash insoluble in HCl.....	0.10	0.07	0.07
Crude fibre.....	2.91	3.00	4.80

It must be borne in mind that separation of the components is only approximately exact. The sample contained adulterants, cereal starches, olive stones and turmeric, in addition to wild mace. The analytical results, especially as regards the ether extractive after petrolie ether, are sufficiently marked.

The percentage of Bombay mace present in a mixture with genuine mace may be determined from the formula,—

$$X \text{ equals } \left\{ \frac{E - G(100 - X)}{100} \right\} \times \frac{100}{B} \quad (1)$$

X is the desired percentage of Bombay mace.

E is the per cent of non-volatile ethyl ether extract after petrolie in mixture.

G " " " " for genuine mace.

B " " " " for Bombay mace.

If the maximum values of 5% for G and 35% for B, assumed as constants, then the formula becomes,—

$$X \text{ equals } \frac{10(E - 5)}{3} \quad (2)$$

In the majority of cases this formula will give results considerably too low. Applied to the above mentioned mixture, 7.5 per cent is indicated by formula (2), whereas 10 to 15 per cent was found by actual separation. However, if as found the value of 1.83 be given to G, and 42.30 to B, and E for the mixture is 7.24 using formula (1), then 13.3 per cent is indicated which is in good agreement with the results obtained by separation.

It is of course, necessary that the solvents employed should be entirely volatile at the temperature of the water bath. In a comparison of results obtained on the same sample with.

a = ether, redistilled below 40° C.

b = " containing 4 per cent. alcohol.

c = petrolic ether, redistilled below 40° C.

d = " " distilled between 40° C. and 75° C.

Mr. Dawson obtained the following results:

NON-VOLATILE EXTRACTIVE.

A	B	C	D
28.28	28.54	29.51	29.91
28.50	28.48	21.03	21.01
Mean . . . 28.39	28.51	29.77	29.96

The results prove that slight differences in the quality of the solvent do not greatly affect the extractive.

TABLE 1.

It is of interest to place on record the following analytical results obtained in these laboratories upon 30 commercial samples of mace which appear to be genuine or to contain traces only of foreign material.

Number.	Ash.		Non volatile extraction.			
	Total.	Insoluble.	Petrol ether.	Ethyl ether.	Total.	Crude Fib.
2686	2.40	0.20	26.67	1.82	28.49	4.45
41871	3.30	1.05	24.00	3.91	27.91	4.90
41872	1.90	0.15	21.50	4.04	25.54	3.95
41873	3.65	0.35	28.66	4.92	33.58	6.75
53683	2.40	0.35	23.08	2.32	25.40	4.00
55022	2.25	0.20	26.82	2.34	29.16	3.95
56277	3.80	1.00	30.10	1.88	31.98	4.75
58388	1.75	0.10	28.74	1.76	30.50	3.66
59532	2.65	0.15	26.96	4.26	31.22	5.20
59535	3.55	0.35	29.22	4.66	33.88	6.00
61636	2.90	0.25	26.02	3.06	29.08	4.50
62361	2.00	0.05	26.06	2.18	28.24	4.10
63426	1.95	0.15	25.86	2.50	28.36	3.00
63429	1.85	0.02	25.86	2.24	28.10	3.80
66162	1.66	0.12	27.60	3.32	30.92	.....
60373	2.33	0.37	25.06	3.68	28.74	.....
64218	2.32	0.20	26.00	4.72	30.72	.....
64220	2.32	0.22	28.74	3.82	32.56	.....
58401	.....	.....	23.60	2.60	26.20	.....
58403	.....	.....	30.04	1.84	31.88	.....
58404	.....	.....	31.30	1.60	32.90	.....
70598	.....	.....	26.56	0.72	27.28	.....
70521	.....	.....	31.06	0.80	31.86	.....
70523	.....	.....	26.64	1.92	28.56	.....
70522	.....	.....	30.62	0.80	31.42	.....
69965	.....	.....	31.80	1.20	33.00	.....
54681	.....	.....	28.08	6.62	34.70	.....
54692	.....	.....	28.96	3.68	32.64	.....
58470	.....	.....	22.72	1.08	23.80	.....
61415	1.84	6.10	27.20	2.90	30.10	2.85
means	2.46	0.28	27.18	2.77	29.96	4.39

TABLE 2.

In the following table I have brought together data obtained upon 95 samples of commercial ground mace which were found practically free from added starchy material, and whose principal foreign content is presumably Bombay mace.

Number.	Ash.		Non-volatile Extractive.				
	Total.	Insol.	Petrol. ether.	Ethyl ether.	Total.	Cr. Fib.	X.
52266	2.00	0.25	26.04	33.36	59.40	3.85	...
52267	3.90	0.60	17.62	20.56	38.18	7.65	66
52268	2.65	0.30	26.62	23.36	49.98	5.60	76
52269	1.50	0.15	24.84	34.42	59.26	4.05	...
52270	2.10	0.25	23.72	32.32	56.04	4.05	...
55372	2.55	0.30	22.02	29.08	51.10	5.20	96
55373	2.50	0.75	23.44	29.70	53.14	4.40	99
61888	2.45	0.20	26.06	26.82	52.88	5.20	88
66630	2.85	0.30	23.68	26.26	49.94	5.90	85
66636	2.55	0.35	24.64	28.02	52.66	5.55	93
66637	2.05	0.25	22.44	26.08	48.52	3.80	86
2135	2.10	0.30	26.58	17.76	44.34	3.80	56
2136	1.80	0.40	27.78	28.44	56.22	4.15	94
2137	2.15	0.15	26.12	22.48	48.60	4.25	73
2607	1.55	0.15	36.96	9.14	46.10	3.90	25
2844	3.90	0.75	22.30	23.06	45.36	6.75	75
41874	2.40	0.25	24.54	20.84	45.38	4.58	67
41875	2.10	0.15	26.84	9.92	36.76	3.80	28
51991	3.09	0.45	24.90	27.86	52.76	3.85	92
51992	3.15	0.45	24.18	25.92	50.10	6.85	85
51993	1.80	0.15	22.50	32.18	54.68	4.50	...
51994	1.90	0.30	27.54	34.46	62.00	4.10	...
51995	1.70	0.25	29.04	34.06	63.10	4.25	...
53685	1.90	0.20	21.54	26.36	47.90	5.45	87
55018	2.30	0.35	21.28	23.89	45.17	3.90	78
55020	2.90	0.45	25.78	27.10	52.88	6.90	89
56276	1.75	0.10	25.88	17.64	43.52	3.80	55
56278	1.85	0.40	26.50	32.78	59.28	5.00	...
56279	2.30	0.35	28.86	19.56	48.42	5.35	62
56280	2.00	0.15	23.82	15.78	39.60	5.80	49
59531	2.10	0.15	27.54	6.42	33.96	3.35	15
59534	2.00	0.20	23.72	24.98	48.70	4.35	77
61141	2.35	0.35	23.64	14.98	38.62	5.40	46
61142	2.45	0.25	27.44	27.26	54.70	5.60	90
61143	2.70	0.30	24.20	30.54	54.74	5.35	...
61144	2.20	0.20	22.50	15.16	37.66	4.50	47
61145	2.30	0.40	22.70	22.72	45.42	4.50	74
61531	2.20	0.25	20.20	27.42	47.62	4.20	90
61532	2.90	0.65	27.86	11.70	39.56	4.40	34
61533	2.50	0.25	26.38	24.24	50.62	4.45	79
61534	1.85	0.15	28.06	23.80	51.86	4.20	77
61535	1.95	0.15	26.34	18.44	44.78	4.20	53
61649	2.85	0.35	24.96	27.36	52.32	5.60	90
61926	3.05	0.50	20.38	34.46	54.84	6.30	...
61940	2.60	0.45	23.68	16.18	39.86	4.40	50
61942	2.75	0.45	29.36	10.53	39.94	4.90	30
62360	2.25	0.20	28.88	10.08	38.96	4.85	28
62363	2.55	0.40	21.96	18.44	40.40	5.15	58
63252	2.45	0.20	24.62	21.28	45.90	4.85	63
63254	2.35	0.45	24.60	32.02	56.62	4.95	...
63254	1.95	0.20	26.02	29.32	55.34	4.70	97
63256	2.05	0.15	24.54	20.66	45.20	4.05	66
63294	1.90	0.20	25.36	29.88	55.24	4.00	99
63295	1.95	0.15	25.82	19.66	45.48	4.95	63
63297	2.50	0.20	21.42	20.06	41.48	5.15	64
63298	2.50	0.25	24.28	25.08	49.36	4.90	82
63427	2.00	0.15	28.40	22.12	50.52	3.90	71
63428	2.60	0.15	26.14	7.18	33.32	4.45	18
63430	1.85	0.25	33.26	23.44	56.70	4.20	76
63751	3.00	0.15	26.84	17.96	44.80	8.05	57
63757	2.35	0.40	21.32	28.02	49.34	5.05	92
63760	1.90	0.15	27.16	23.66	50.82	4.60	77

TABLE 2—Concluded.

Number.	Ash.		Non-volatile Extractive.				
	Total.	Insol.	Petrol. ether.	Ethyl ether.	Total.	Cr. Fib.	X.
63764	3 10	0 15	27 70	20 78	48 48	8 25	67
63901	2 15	0 15	20 68	19 78	40 46	5 30	63
63903	1 75	0 20	24 00	32 66	56 66	4 05	...
63906	2 85	0 65	21 56	22 28	43 84	4 55	72
64006	1 75	0 15	28 80	19 60	48 40	3 80	62
64017	2 05	0 20	21 72	28 98	50 70	4 65	96
64024	1 90	0 25	22 06	37 90	59 96	4 65	...
56531	1 97	0 28	27 86	24 26	52 12	...	79
56532	1 62	0 15	27 88	33 88	61 76	...	...
56533	1 81	0 17	25 04	21 89	46 93	...	71
56534	1 80	0 10	41 07	17 79	58 86	...	56
56535	1 78	0 15	28 55	28 86	57 41	...	95
66161	2 06	0 26	27 12	28 56	55 68	...	94
66163	2 03	0 19	28 40	8 99	37 39	...	24
66165	1 66	0 15	28 92	23 17	52 09	...	75
60374	1 90	0 22	25 86	24 42	50 28	...	80
60375	2 20	0 18	29 94	10 11	40 05	...	23
64219	1 65	0 14	26 60	28 59	55 19	...	94
64221	2 76	0 39	31 11	8 75	39 86	...	24
61412	2 90	0 20	21 34	19 90	41 24	3 65	63
61413	2 40	0 22	18 28	31 98	50 26	4 95	...
61431	2 36	0 30	24 28	9 96	34 24	4 10	23
69966	...	...	24 32	24 00	48 32	...	78
69967	...	...	29 44	22 18	41 62	...	72
69968	...	...	27 44	11 24	38 58	...	33
69969	...	...	26 10	16 00	42 10	...	50
70535	...	...	25 70	10 76	36 46	...	31
54504	...	...	24 68	10 54	35 22	...	30
54505	...	...	20 58	20 36	40 94	...	65
54088	...	...	25 70	23 40	49 10	...	76
70262	...	...	22 00	9 68	31 68	...	27
58469	...	...	26 60	24 06	50 66	...	73
58471	...	...	24 00	8 66	32 66	...	23

The trustworthiness of any formula employed to calculate the percentage of Bombay mace present in a mixture of this mace with the genuine, is dependent upon the accuracy of the constants involved. If we use as a basis of judgment the amount of extractive to ethyl-ether after petroleic, it is necessary to define the solvents, as well as the manner in which they are used; and also to determine the normal extractive by this method, for true mace and for Bombay mace respectively.

The samples enumerated in Table 2 were extracted in a Knorr apparatus, for 16 hours with petroleic ether (redistilled between 25° and 70° C.); then for a similar length of time with ethyl-ether (redistilled 35° to 37° C.) The extractive was dried to constant weight, at 110° C. The quantity operated on was 5 grams.

We have the following data for the extractive yielded by true mace:

Sample No.	Per cent.	
Sample No. 1	1 14	Dawson.
" " 2	1 43	"
" " 3	1 55	"
" " 2606	1 82	"
" A	0 87	Valin.
" B	0 54	"
Sample separated from a mixture	1 83	Dawson.
Mean of 30 samples (see Table 1)	2 77	Various.
Penang mace	2 68	Parry.
Pale West Indian mace	2 04	"
Red " "	3 90	"
Sample No. 4	3 67	Valin.
" " 6	5 05	"
Mean value	2 25	

Data for extractive yielded by Bombay mace, under conditions above described:—

	Per cent.
Sample C	25.04
" D	27.55
Parry, Food & Drugs, page 237	29.11
Sample No. 5	32.69
Mean value	28.60

It will be noted that 14 samples of Table 2, yielded more than 30 per cent, extractive to ethyl-ether after petroleic. The mean extractive for these 14 samples is 33.35 per cent. Since these samples were found on careful qualitative examination to consist essentially of mace, it follows that some samples of Bombay, or other wild mace, must yield much more than the above average of 28.60 per cent. extractive. It is to be regretted that, at the time of writing this, I am unable to avail myself of fuller data for Bombay mace.

If we accept 30 per cent. as an approximate value for this mace, and take 2 as the corresponding number for genuine mace, the percentage of Bombay mace (x) in a mixture of the two maces, may be calculated from the formula,

$$x = \frac{100 (e - 2)}{28}$$

where (e) is the extractive found for the sample.

The resultant values are given in the last column of Table 2. It must be understood that they are merely approximations to the actual percentage amounts of Bombay mace in these samples.

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TABLE 3.

In this table I have arranged the results of analysis for 43 samples of commercial ground mace, found to contain other material than Bombay mace. In most cases this foreign matter is cereal or nutmeg starch, with turmeric.

Number.	Ash.		Extractive.			Crude Fibre.	Remarks based on microscopic examination.
	Total.	Insol.	Petrol.	Ethyl.	Total.		
55371.	1.45	0.15	18.65	24.88	43.53	3.15	Bombay mace and maize starch in large amount.
55374.	2.15	0.35	21.72	26.56	48.28	4.20	Much Bombay mace and small amount of starch.
55375.	1.85	0.15	20.06	25.10	45.16	3.95	Much Bombay mace and starch.
61893	2.45	0.25	20.70	3.34	29.04	3.80	Small amount Bombay mace with much starch.
61895.	1.85	0.15	18.58	26.22	44.80	3.70	Much Bombay mace. Considerable starch.
68103.	2.65	0.25	19.28	22.54	41.82	3.80	" " " "
68106.	2.85	0.20	18.88	10.28	29.16	4.80	Bombay mace small, much starch.
66619.	2.40	0.20	26.60	16.68	43.28	5.25	Bombay mace large amount and considerable starch.
66627.	1.75	0.15	23.66	25.48	48.54	3.10	Bombay mace much; also starch.
2698.	1.65	0.15	22.24	1.44	23.68	2.30	Much starch with turmeric.
55019.	2.00	0.25	19.47	27.72	47.19	4.80	Small amount starch much Bombay mace.
55021.	2.30	0.35	22.28	23.02	45.30	5.35	" " " "
58386.	3.25	0.25	27.16	6.64	33.80	9.80	Bombay mace little, much starch.
58387.	1.55	0.10	24.12	0.74	24.86	2.25	Large amount starch, with turmeric.
58389.	3.20	0.30	26.78	6.38	33.16	7.85	Little Bombay mace and starch.
58390.	1.55	0.10	25.02	0.74	25.76	2.30	Much starch and turmeric.
59533.	3.30	0.70	24.20	10.32	34.52	5.05	Considerable Bombay mace traces of starch.
61620.	2.20	0.45	21.84	25.58	47.42	4.65	Much Bombay mace
61625.	1.90	0.25	19.08	21.24	40.32	3.50	" " little starch.
61641.	1.45	0.15	17.56	18.92	36.48	3.05	" " some starch.
61935.	2.05	0.10	27.66	17.44	45.10	3.65	Considerable Bombay mace and starch.
61938.	2.30	0.45	22.12	24.00	46.12	4.70	Much Bombay mace, little starch.
62362.	2.05	0.10	25.56	0.58	26.14	3.20	Much starch and turmeric.
63253.	2.45	0.15	20.08	10.52	30.60	4.35	Considerable Bombay mace and starch.
63296.	2.70	0.35	23.08	21.60	44.68	4.95	Much Bombay mace, little starch.
63709.	1.95	0.20	19.06	28.76	47.82	4.35	Much Bombay mace and starch.
64021.	2.45	0.30	20.88	1.92	22.80	3.35	No Bombay mace much starch.
64023.	2.40	0.45	16.60	19.48	36.08	4.35	Much Bombay mace and starch.
66164.	1.81	0.17	26.78	17.50	44.28	.....	" " and some starch.
61414.	2.12	0.20	23.70	9.32	33.02	3.35	Some Bombay mace and starch.
58402.	.....	.....	24.48	1.16	25.64	.....	15 to 20% wheat starch.
58405.	.....	.....	23.80	1.68	25.48	.....	" " " "
70261.	.....	.....	20.92	12.50	32.52	.....	20 to 30% Bombay mace and starch.
70263.	.....	.....	23.04	26.68	49.72	.....	60 to 35% " " "
70264.	.....	.....	18.96	25.62	44.64	.....	" " " "
70265.	.....	.....	29.54	2.84	32.38	.....	No Bombay mace. 25 to 30% starch.
58467.	.....	.....	27.50	24.00	51.50	.....	50 to 60% Bombay mace and starch.
58468.	.....	.....	27.66	1.92	29.58	.....	No Bombay mace, 25 to 30% " "
67466.	.....	.....	25.42	0.66	26.08	.....	" " 10 to 15% " "
67467.	.....	.....	25.58	2.20	27.78	.....	" " " 20% " "
67468.	.....	.....	20.18	0.36	20.54	.....	" " " " "
67469.	.....	.....	26.66	0.64	27.30	.....	" " " " "
67470.	.....	.....	40.64	0.65	41.29	.....	Is ground nutmeg.

A study of the numerical results in Table III, taken in connection with the results noted from microscopic observation, leads to the conclusion that very definite inference as to the composition of these mixtures may be drawn from the extractive.

The presence of starch decidedly lowers the total extractive; while the ethyl-ether extractive plainly indicates the presence of Bombay mace. Where this is less than about 2 per cent. the absence of any considerable amount of Bombay mace is evident; and when in excess of 2 per cent. a close approximation to the actual amount present may be derived from a comparison of the ethyl-ether extractive with the total extractive.

The refractive index of the fixed oil from Bombay mace is given by Lythgæ as varying from 1.4615 to 1.4633 at 35° C., while that from other maces varies from 1.4747 to 1.4975. The refractive indices for the fixed oils obtained from the samples included in Table 1, were read by Mr. Dawson at 35° C. and are found to be uniformly higher than the maximum limit quoted for Bombay mace oil. Unfortunately this is also true for most of the samples recorded in Table 2, many of these, even when containing very

high percentages of Bombay mace, (as judged from the ethyl-ether extractive) giving refractive indices of 1.4300 or higher. It would hence appear that, while the existence of a refractive index below 1.4700, points to the presence of Bombay mace, the finding of a higher reading than this cannot be regarded as evidence of the absence of Bombay mace.

The most conclusive chemical evidence of this adulteration of mace appears to be afforded by the ethyl-ether extract. In the case of Bombay mace, the resins seem to be less readily dissolved by petrolic ether than the fats. When these last are removed by petrolic ether, the subsequent extraction by ethyl-ether gives a number which is highly characteristic. It may be that alcohol, on account of its great solvent power for resins, might take the place of ethyl-ether, and effect a saving of time. This point may be investigated later.

Investigatory work done by Mr. Valin, since the above was written, has demonstrated certain points of importance in regard to details of operating. These are briefly:

1. The inadvisability of drying the sample at 100°—110° C. before extracting the fat and resins. Such treatment tends to make the extraction difficult.
2. The extractive matter is difficult to dry to constant weight, and an exposure of from 24 to 48 hours at 110° C. is required.
3. Extraction with petrolic ether is not usually complete in less than 16 hours.
4. The use of alcohol instead of ethyl ether, gives a somewhat higher extractive; but shows less characteristic difference between genuine and Bombay mace than does ether. For this reason it is not recommended.

The report now placed in your hands deals with 175 samples of mace, which are classified as follows:

Samples of known origin	7
" essentially true mace	30
" mixed with true and wild mace	95
" variously adulterated	43
Total	175

Their study would appear to justify the following standards for mace.

1. True mace is the dried arillus of *Myristica fragrans* (Houttyn.) It contains not more than three (3) per cent. of total ash, and not more than half of one per cent. (0.5) of ash insoluble in hydrochloric acid. Its crude fiber content does not exceed seven (7) per cent.

After extraction with petrolic ether, the ethyl-ether extractive does not exceed five (5) per cent. The total extractive by both solvents, does not exceed thirty three (33) per cent.

2. Macassar mace is the dried arillus of *myristica argentea* (Warb.)

3. Bombay Mace, is the dried arillus of *myristica malabarica* (Lamarok.) This mace must not be present in admixture with true mace, under the label, or other mark clearly declares its presence, and approximate percentage content.

It is recognized that the limited number of samples of certified origin included in this report, leaves much to be desired in the way of assured knowledge of the limits of variation which may obtain in different samples of the maces studied, where these are the production of different soils and localities. At the same time, I am convinced that no injustice will be done to importers by official adoption of the very liberal standards suggested; while a very much needed protection will thereby be afforded to the consumer.

I would respectfully recommend publication of this report as Bulletin No. 349.

I have the honour to be, Sir,

Your obedient servant,

A. MCGILL,

Chief Analyst.

