III.—*Analysis of the Ash of Lemon-Juice.*

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The following analysis, having for its object the determination of the mineral constituents in the juice of lemons, was made during the early part of last summer, in the laboratory of the Royal College of Chemistry, under the superintendence of Dr. Hofmann, and at the request of Dr. Bence Jones.

Preparation of the Ash.—The lemons (200 in number) were peeled with a bright steel knife, care being taken in so doing to avoid as much as possible cutting into the juicy endocarp, and thus bringing the acid in contact with the steel knife; the juice was then expressed by a hand-squeezer of wood (without any metallic hinges), and filtered through flannel into a porcelain dish, in which it was evaporated to the condition of a black carbonaceous mass, then transferred, a portion at a time, into a platinum dish, and ignited until perfectly white.

A *qualitative examination* was first made, which indicated the presence of potassa, soda, lime, magnesia, and sesquioxide of iron; of silicic, phosphoric, sulphuric, hydrochloric, and carbonic acids. A separate and very careful examination was made for alumina, but it was not detected; manganese was also separately tested for, but not found.

As regards the plan followed in performing the *quantitative analysis*, it differed in no respect from that generally adopted.

Without entering into details, it may be stated that the part insoluble in hydrochloric acid consisted of silica and carbonaceous matter. In one portion of the hydrochloric solution, the phosphate of iron, the lime, magnesia, and phosphoric acid, were determined; whilst separate portions of the solution were employed for the alkalies and for sulphuric acid; a nitric acid solution being used for the determination of hydrochloric acid; and, lastly, a distinct portion of the ash was reserved for estimating the carbonic acid.

The phosphoric acid was determined as ammonio-magnesian-phosphate in the dilute solution, to which acetate of potassa had been added, after separation of the lime by oxalic acid.

The following are details of the results obtained.

1. Determination of silica.

Weight of ash employed.	Silica obtained.	Percentage.
I. 59·3835 grns.	0·355 grn.	0·5986
II. 23·6165 „	0·128 „	0·542

2. Determination of carbon.

Weight of ash employed.	Carbon obtained.	Percentage.
I. 59·3835 grns.	0·0615 grn.	0·1035

3. Determination of phosphate of iron.

Weight of ash employed.	Phosphate of iron obtained.	Percentage.
I. 24·5077 grns.	0·230 grn.	0·9385
II. 18·276 „	0·219 „	1·198

4. Determination of lime.

Weight of ash employed.	Carbonate of lime obtained.	Percentage of lime.
I. 24·5077 grns.	3·354 grns.	7·6631
II. 18·276 „	1·353 „	7·4059

5. Determination of magnesia.

Weight of ash employed.	Pyrophosphate of magnesia obtained.	Percentage of magnesia.
I. 18·276 grns.	1·644 grns.	3·2124
II. 23·6165 „	2·2385 „	3·385

6. Determination of phosphoric acid.

α. In combination with lime :

Weight of ash employed.	Pyrophosphate of magnesia obtained.	Percentage of phosphoric acid.
I. 18·276 grns.	0·402 grns.	1·4146
II. 16·242 „	0·520 „	2·0582

β. In combination with magnesia :

Weight of ash employed.	Pyrophosphate of magnesia.	Percentage of phosphoric acid.
I. 18·276 grns.	1·644 grns.	5·7825
II. 23·616 „	2·2385 „	5·7106

7. Determination of the alkalies.

	I.	II.
Weight of ash employed	10·84 grns.	11·948 grns.
Weight of mixed chlorides obtained	7·970 „	9·04 „
Corresponding to per cent of mixed alkalies (KO and NaO)	45·9355	45·9446
Weight of potassium platinum-salt (KCl, PtCl ₂) obtained	25·077 „	26·700 „

hence :

Percentage of potassa	44·251 „	43·545
„ soda	1·6845 „	2·3996

8. Determination of sulphuric acid.

Weight of ash employed.	Sulphate of baryta obtained.	Percentage of sulphuric acid.
I. 8·7795 grns.	3·159 grns.	12·354
II. 6·018 „	2·069 „	11·802

9. Determination of carbonic acid.

Weight of ash employed.	Carbonic acid evolved.	Percentage.
I. 15·517 grns.	3·02 grns.	19·462

10. Determination of chlorine.

Weight of ash employed.	Chloride of silver obtained.	Percentage.
I. 8·7795 grns.	0·429 grns.	1·2079 grns.
II. 6·018 „	0·295 „	1·2090 „

The following table is a synopsis of the preceding results :

	I.	II.	mean.
Alkalies (KO and NaO)	45·9355	45·9446	45·9400
Potassa . . .	44·251	43·545	43·8984
Soda . . .	1·6845	2·3996	2·1416
Lime . . .	7·6631	7·4059	7·5345
Magnesia . . .	3·2124	3·385	3·2987
Sulphuric acid . . .	12·3540	—	12·3540
Chlorine . . .	1·209	1·2079	1·2084
Carbonic acid . . .	19·462	—	19·4620
Phosphoric acid . . .	7·1971	7·7691	7·4829
Phosphate of iron . . .	0·9385	1·198	1·0682
Silica . . .	0·5986	0·542	0·5700
Carbon . . .	0·1035	—	0·1035
Alumina	} absent.		
Manganese			
			99·1222

The preceding numbers, after deducting the charcoal, give the following as the percentage composition of the ash :

Potassa	44·34
Soda	2·16
Lime	7·61
Magnesia	3·34
Sulphuric acid	12·47
Carbonic acid	19·66
Chlorine	1·23
Phosphoric acid	7·56
Phosphate of iron	1·06
Silica	0·57
	100·00

These constituents may be assumed to be thus arranged :

Carbonate of potassa	57·725
Carbonate of soda	2·265
Sulphate of potassa	9·293
Chloride of sodium	2·026
Sulphate of lime	13·935
(Tribasic) Phosphate of lime . .	3·687
Phosphate of magnesia	9·086
Phosphate of iron	1·060
Silica	0·570
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	99·647

In order to ascertain the proportion of ash in the juice, a known weight was carefully incinerated in a platinum dish, with the following results :

	Weight of juice employed.	Ash obtained.	Percentage.
I.	587·96 grns.	3·11 grns.	0·52
II.	1020·695 „	2·055 „	0·20
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		Mean	0·36

Hence by calculation, the following was obtained as the proportion of the several *inorganic constituents of the juice* :

	Inorganic constituents of 1000 grains of the juice.	Inorganic constituents of an ounce Troy (480 grns.) of the juice.
Potassa . . .	1·597 grns.	0·767 grns.
Soda . . .	0·077 „	0·038 „
Lime . . .	0·274 „	0·131 „
Magnesia . .	0·120 „	0·058 „
Sulphuric acid .	0·448 „	9·215 „
Chlorine . .	0·045 „	0·022 „
Carbonic acid .	0·707 „	0·339 „
Phosphoric acid .	0·273 „	0·130 „
Phosphate of iron	0·038 „	0·018 „
Silica . . .	0·021 „	0·010 „
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Total	3·600	1·728

On reviewing the above-mentioned results, it was felt that the objection might be raised, that either the whole or at least a portion

of the iron found, might have been derived from the knife employed in cutting the lemons (notwithstanding the precautions taken to avoid contamination from this source); consequently, to remove all doubt on this rather important point, a fresh portion of juice was incinerated, the lemons whence it was obtained having been cut with a silver knife, and every possible care taken to avoid the extraneous introduction of iron. In the ash thus obtained the determination of the ferruginous phosphate was repeated with the following result :

Weight of ash employed.	Phosphate of iron obtained.	Percentage.
8.225 grns.	0.12 grn.	1.458

which, on comparison with the preceding, lead to the conclusion that none of the iron had been derived from the knife, since this last determination indicates a still larger proportion of the phosphate than either of the former determinations.