

On Aluminium in the Ashes of Flowering Plants.

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It has long been known that lycopodium contains aluminium (as acetate) dissolved in its juices, and quite recently the presence of much alumina in the ash of another cryptogamous plant has been announced, though the evidence does not seem quite satisfactory. But the occurrence of this element in the ashes of phanerogamous plants has hitherto been attributed to particles of soil adhering to the plants submitted to calcination. Accordingly, in ash analyses, even when elaborate, no mention is found of its presence as a constituent of the real ash, and A. H. Allen's statement, in his *Commercial Organic Analysis*, Vol. I. page 38, that "flowering plants do not contain aluminium as a normal constituent," appears to express the current opinion of chemists.

There have been published, however, at least two exceptions to the supposed non-occurrence of aluminium in phanerogamous plants, one by myself (*Journ. Chem. Soc.* **43**, 481), and the other quite recently by M. L'Hôte (*Comptes rendus* **104**, 853). In the aqueous part of the latex of *Rhus vernicifera*, the lacquer tree of Japan, aluminium is present in solution, apparently as arabate, for on treating the latex with absolute alcohol, boiling the precipitate thus formed with water, filtering and evaporating the aqueous extract, a residue

of gum was obtained, which when burnt left 5 per cent. ash, containing 7.8 per cent of its weight of alumina.*

L'Hôte's recognition of aluminium as a normal component of a flowering plant was made in the juice of the grape, all samples of the fresh fruit and of wine, except one, examined by him, having yielded alumina in small quantity.

There being little or no evidence, except my own, as to whether aluminium is or is not to be ranked among the mineral constituents of flowering plants, I undertook, at the suggestion of my respected colleague, Dr. Divers, to make a few careful examinations of some beans and grains, in order, if possible, to decide the matter. These were completed two or three months ago, and before the notice in the *Chemical News* of L'Hôte's interesting observations, or the *Comptes rendus* had come to hand.

The fact that the soil of the plain of Musashi, in which Tōkyō is situated, and which is of volcanic origin, is remarkable for the large proportion of alumina in it soluble in hydrochloric acid, gave promise that, if anywhere, then certainly here would aluminium be found in flowering plants.

The samples examined, for which I have to thank Dr. O. Kellner, had been grown on the farm lands of the Imperial College of Agriculture, at Komaba, near Tōkyō. Each one was carefully picked over, and all imperfect and visibly soiled grains rejected.

The peas and beans were soaked and well washed in water. Some of these were rubbed with cloths, and left to dry in the air and sun. The rest were, in their soddened state, broken up by hand in

* Aa recorded by me at the time in the *Journ. Chem. Soc.* Since then, however, I have determined the phosphoric acid, which I had regarded as present in too small quantity to need estimation, and as I now find it to be more considerable than I thought, I believe that 6.3 per cent. more closely expresses the proportion of alumina than 7.8 per cent. as formerly stated. At the first opportunity I shall redetermine it.

water into hull and cotyledons, the two carefully separated and then dried on filter paper in the sun. The rice (hulled),* barley, millet, and buckwheat were also picked over and were then bruised in an iron mortar, winnowed, washed and rubbed on a sieve until the water passing through showed scarcely any turbidity, and then dried on sheets of paper in the sun.

The calcination was carried out in large platinum dishes, one hundred grams at a time, and in most cases several hundred grams of the prepared sample were burnt, and the ashes mixed and ground together in an agate mortar.

The peas, beans, and buckwheat were calcined from first to last over the lamp. Rice, wheat, and the rest, being more difficult to calcine, the samples were charred and partially burned over the lamp, and then the dish transferred to a capacious blind muffle to complete the calcination. The muffle was kept nearly closed and at as a low temperature as possible. It was of clay, but well seasoned by work, and the dishes were always removed when charcoal had to be added to the fire, or when the muffle was heating in the morning and cooling at night, and every other care and watchfulness taken that no contamination with clay or charcoal ash should occur. Generally the calcination was effected with but little fusion of the ash. The prepared ash was boiled with dilute hydrochloric acid and evaporated to full dryness, again treated with dilute hydrochloric acid and filtered through ashless paper. The residue washed and calcined was weighed.

The filtrate nearly neutralised and mixed with sodium acetate, was boiled and filtered through ashless paper and the precipitate

* Even the best hulled rice of commerce, has in this country, adhering to it some of the dust which had been employed in polishing the grains after hulling, and rendering them translucent. This dust or powder is Bôshû sand, a white tufa containing 10—12 per cent. of alumina.

washed. The latter was transferred to a platinum dish, and digested with sodium hydroxide which I had prepared myself from sodium in a platinum dish. The filtered solution was acidified with hydrochloric acid and precipitated with ammonia. The precipitate was washed, dried and ignited, and regarded as aluminium phosphate. In one or two cases, its composition was verified by determining the phosphoric acid in it. In another part of the ash, the total phosphoric acid was estimated by precipitation as ammonium phosphomolybdate and weighing as magnesium pyrophosphate.

In the following table, there are included the numbers for percentage of ash in the grains, and of phosphoric acid and silica in the ash, because they serve to show the normal character of the samples and of my analyses.

Sample.	Ash per cent of air-dried	Per cent. of Ash of.		
		Alumina.	Phosph. acid.	Silica etc.
Pea, whole. <i>Soja hispida</i> .	—	0.053	33.48	—
Pea, cotyledons.	4.22	0.000	—	0.50
Pea, hull or skin.	4.31	0.268	5.66	3.60
Red bean (Azuki), <i>Phaseolus radiatus</i> .	2.60	0.096	32.89	0.25
Rice. (Hill).	0.87	0.161	51.33	9.36
Rice. (Paddy).	0.56	0.189	52.79	10.99
Wheat.	2.62	0.106	65.55	1.31
Barley.	1.09	0.140	33.19	1.19
Millet (Awa), <i>Panicum italicum</i> .	1.68	0.272	40.43	8.91
Millet (Hiye). <i>P. crus corvi</i> .	0.94	0.185	39.87	8.62
Buckwheat.	1.72	0.113	1.94	0.81

From this table it will be seen that I have found alumina in every case except in that of the cotyledons of the pea, while in the hull or skin of the pea, one of the largest amounts of alumina occurs.

The result here recorded may at least serve to indicate the propriety of reconsidering the accuracy of the dictum that aluminium is not a constituent of flowering plants.

