

A T H E S I S  
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T H E P O T A S H C O N T A I N E D  
I N L E A V E S

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## DISCUSSION.

In the vegetable kingdom potassium is universally found, principally in the liquid contents of the cells and vessels, chiefly combined with organic acids. On burning, it appears in the ashes as carbonate, together with more or less sulphate, chloride, phosphate, and silicate. It is unnecessary to say that all this potassium is derived from the soil on which the plants grown; but for many centuries, indeed, apart from salt petre and kelp, nearly up to the middle of the last century, wood ashes formed practically the only source of potassium compounds employed for technical purposes.

In the mineral kingdom potassium occurs as sylvine or sylvite  $KCl$ , and as carnallite  $KCl \cdot MgCl_2 \cdot 6H_2O$  especially in the layers overlaying the great salt deposits of Strassfurt. As the nitrate it is found as an efflorescence on the soil usually together with sodium salt in Peru, Chile, etc., and as important constituent of many mineral waters such as those of Harrowgate and Vichy. As the double sulphate of aluminum and potassium it occurs in alumstone or alumnite.  $3 KAl_2SO_6 \cdot K_2SO_4 \cdot 6H_2O$  principally in trachyte and other rocks subjected to the action of sulphurous gases. The main sources of potassium from the mineral kingdom are the primitive rocks, in which it occurs, such as, orthoclase,  $Al_2O_3 \cdot K_2O \cdot 6SiO_2$ ; muscovite

$K_2O3Al_2O_34SiO_2$ ; apophyllite  $4(CaO2SiO_2H_2O)KF$  and other zeolites and silicates.

A source similar to the one under consideration is that of kelp or sea weeds. The most favorable fields are along the coasts of Scotland, Normandy and lower California. The potassium here occurs as the chloride sulphate and carbonate, as which it is taken from the sea water. It has been estimated that 1 liter of the water contains from 5 to 7 grams of the element.

In the process of obtaining the potassium from the kelp, the weeds are collected, dried and burned. The liquid obtained by lixiviating the ashes is concentrated by evaporation in several stages, and thus yields several crops of crystals. The first crop, called plate sulphate, is a mixture of potassium sulphate with some sodium sulphate and common salt; the mother-liquor yields on evaporation, while hot, a mixture of common salt with alkaline sulphates and carbonates, which is fished out from pans and sold as kelp salt; on cooling, a crop of potassium chloride is obtained. The latter can be brought up to upwards of 90%; and formerly about 2500 or 3000 tons of it was made per annum; but the development of the Strassfurt industry has mostly compelled the kelp workers to give up the manufacture of the potassium salts for technical purposes, and to use their products for agriculture almost exclusively. It is obvious that the process

is one of purely mechanical crystallization, and the product is obtained as the readily water-soluble potassium chloride.

The beet sugar residue molasses offers quite a promising source of potash, and in fact it is used considerably in suitable form as a fertilizer, principally for its potash content.

It now becomes of interest to investigate leaves as a possible source of essential plant food.

#### METHOD AND PROCEDURE.

The leaves for this investigation were taken from the dried leaves of the Washington and Lee Campus, just as they fell from the trees in early November. They were dried in grain sacks by the side of a chimney flue, from that time until the latter part of April.

Two samples of 900 grams each were taken, after the whole had been cleaned of sticks and pieces of bark. The samples were ignited in a muffle furnace at a temperature just high enough to burn all the carbon out; a dull red heat. For this purpose was used a shallow iron pan, just the size of the muffle. The back of the muffle was closed to prevent, as much as possible, any loss from volatilization, while the front of the muffle was kept open in order to effect as complete oxidation as possible. The burning was carried far enough to produce a light gray ash.

Sample One yielded 110.58 grams ash.

Sample Two yielded 104.76 grams ash.

After these had cooled to room temperature they were thoroughly mixed and from each were taken two samples of 10 grams each, for analysis.

These were leached five times with 50 c.c. boiling distilled water. The leach water was evaporated to dryness and the water soluble residue remaining was determined.

The ash residue was leached five times with dilute hydrochloric acid, the solution being continually made stronger until the last washing was almost concentrated.

The residue which remained appeared to be unburned carbon. It was washed onto a filter-paper, and washed free from soluble material. After drying the residue was ignited in nickel crucibles, and then fused with an equal volume of sodium carbonate, for ten minutes.

The fusions were put in solution in dilute hydrochloric acid, and also the water soluble residues were dissolved in dilute hydrochloric acid. These two solutions were combined with the acid leachings, and the whole solution evaporated to almost dryness twice, to drive off most of the free HCl.

A few drops of  $\text{HNO}_3$  were added to oxidize up any ferrous iron present and then ammonia was added to precipitate the iron and aluminum. From two samples the percentage of the precipitate were determined.

The filtrate was evaporated to dryness and heated to about  $300^\circ \text{C}$  to volatilize the hulky mass of ammonium chloride, -crystals. The heating required about 50 hours, and a residue resulted which exhibited a deliquescent appearance.

This residue was dissolved in 100 c.c. boiling water, and filtered to remove some insoluble matter, probably silica.

The solution was kept at boiling and ammonium oxalate added to precipitate the calcium. The precipitate was filtered from a boiling solution.

The filtrate were evaporated to dryness and then heated, as above described to remove the  $\text{NH}_4\text{Cl}$ . The residue, consisting of a grayish powder, was fused in a platinum dish to insure the freedom of the ammonium chloride.

After cooling the fusion was dissolved in 150 c.c. boiling water and allowed to cool. To each solution was added 1 c.c.  $\text{H}_2\text{PtCl}_6$ , and after standing over night a precipitate of crystalline potassium chloride platinate was found deposited on the bottom and sides of the beaker.

This precipitate was filtered onto a gooch filter, washed three times with a 60% solution of alcohol and water, and dried in a drying closet at 150° C.

From the weight of the  $K_2PtCl_6$  the potassium content could be easily calculated as  $K_2O$ .

	I		II	
	900		900	
	110.58		104.76	
	A	B	C	D
Grams in Sample	10	10	10	10
Water-soluble material:	.5848	.5635	.5740	.5921
Percent. of ash.	5.84%	5.64%	5.74%	5.92%
$Fe_2O_3$ in gms.	1.2990			1.2881
Percent. of ash	12.99%			12.88%
$K_2PtCl_6$ per 10 gms ash:	.6661	.6714	.5983	
$K_2O$ in total ash	1.427	1.439	1.215	
Percent $K_2O$ of ash	1.29%	1.30%	1.16%	
Percent. $K_2O$ of leaves:	.16%	.16%	.14%	

#### CONCLUSION.

We see then that in 100 pounds of leaves there is .16 pounds of potash. Further, 100 pounds of leaves, thoroughly dry, will constitute a volume of about 21 bushels. Hence in the large volume of 21 bushels of leaves there is only .16 pounds of potash available as  $K_2O$ . If we consider potash as worth 4 cents per pound we see that 100 bushels of leaves are worth only .0064 cents while one bushel will have a value of only .0003

cents. We are forced, therefore, to conclude that, for the potash value alone, leaves would not be worth the trouble and in convenience required to convert them to available use.

Respectfully submitted.

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