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QUANTITATIVE ANALYSIS OF LETTUCE ASH

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HISTORICAL

As early as 1864 Wolff brought out the need for a systematic tabulation of plant ash analyses and in his book [1] published the best data available at that time. He reported CaO, MgO, K_2O, Na_2O, Fe_2O_3, PO_3, SO_3, SiO_2 and Cl. But he gave neither the number of analyses nor the source of the samples. Similar data are given by both Leach [2] and Sherman.[3]

While but very little systematic work has been done on the complete analyses of plant ashes, a large amount of work has been done on isolated elements, such as manganese and copper, by Lindow and Peterson,[4] Tilden,[5] and Remington and Shriver.[6] Miller and Mitchell [7] reported ash analyses of spinach juice both fresh and canned. Ajon Guido [8] reported on the analysis of the ash of lemons.

Most of the data that are available are from the standpoint of the effect of the different elements on nutrition and have but little to do with the ash content of the plants themselves. During the last few years a large amount of work has been done on the effect of small amounts of such elements as copper, manganese and aluminum on the nutrition of plants and animals.

It is the purpose of this laboratory to analyze representative samples of different edible plants, qualitatively by the precedures outlined by Noyes and Bray,[9] to determine the presence or absence of all of the rare and common elements. These methods will usually show as small amount as a milligram which with a five gram sample will indicate as small an amount as 0.02% in the ash. After the qualitative analysis has been made, appropriate quantitative methods are developed. The first plant whose ash has been examined is lettuce and the results are given in this paper.

1 Wolff, Aschen-Analysen von Landwirthschaftlichen Producten, Fabrick-abfallen und Wildwachensenden Planzen.
2 Leach, Food Inspection and Analysis.
3 Sherman, Chemistry of Food and Nutrition.
4 Lindow and Peterson, J. Biol. Chem. 75, 165 (1927).
5 Tilden, Soil Science 26, 149 (1928).
6 Remington and Shriver, Assoc. Agr. Chem. J. 13, 129 (1930).
7 Mitchell and Miller, J. Biol. Chem. 85, 355 (1929).
8 Ajon Guido, Riv. ital. essence profumi 11, 107 (1929).
9 Noyes and Bray, Qualitative Analysis for the Rare Elements (1927).

EXPERIMENTAL

Three samples of lettuce were examined, two of the varieties Big Boston and Grand Rapids, were grown locally and the third was a head lettuce as shipped from Salinar, California. Fifteen pounds of each were cleaned by washing in running water, brushing with a fine brush, rinsing with distilled water and drying with a soft cloth. The whole plant as received, without the roots, was analyzed except that any decayed material was first removed. The samples were dried in an over at 80°C in a current of air and small portions of the dry material ashed in platinum dishes in a muffle furnace at as low a temperature as possible. The whole ash was then ground in an agate mortar to get a homogenous sample. On one sample the ash was found to be 0.796% which agrees very well with the usual values which are given as from 0.8 to 0.9%. The percent of moisture in this same sample was 94.3%.

ANALYSES

The qualitative analysis showed the following ions only present in each of the samples: aluminum, calcium, copper, iron, manganese magnesium, phosphorus, potassium, silicon, sodium, titanium, chlorine, sulfate and carbonate. The iron, silicon and phosphorus were determined in separate samples as were the chloride and sulfate. The other elements were determined from the precipitates as they were separated in the scheme of qualitative analysis. Copper was determined by the iodometric method, manganese by the oxidation with bismuthate and titration with ferrous sulfate, titanium colormetrically with hydrogen peroxide. The rest of the elements were determined gravimetrically. The results of the analyses are given in the following table.

Analysis of Lettuce Ash

SAMPLE	I	II	III
VARIETY	HEAD LETTUCE	BIG BOSTON	GRAND RAPIDS
Potassium	35.0%	26.60%	32.60%
Sodium	4.93	3.65	1.95
Calcium	3.01	5.86	5.16
Magnesium	1.40	1.40	1.60
Iron	0.34	0.18	0.18
Aluminum	0.185	0.54	0.58
Manganese	0.11	0.28	0.11
Copper	0.049	0.022	0.024
Titanium	0.016	0.009	0.008
Silicon	0.329	0.745	0.515
Phosphorus	6.34	3.71	4.07
Chloride	16.18	2.03	2.93
Sulfate	3.44	3.23	4.11

The samples were each tested for the presence of iodine by the method of McClennon [10] using phosphoric acid, potassium nitrite and carbon tetrachloride. In every case the amount was less than ten parts per million.

Discussion of Results

The only element found that has not been usually reported in plant ash analyses was titanium, however, almost any inorganic material which has both silicon and aluminium present in it, has some titanium present also.

There are about as great differences between the analyses of two samples of lettuce grown locally as there are between them and the sample of California material. The chief exception to this statement is the percent of chloride which is about five times as great in the California sample as in the two Iowa samples.

The other noticeable differences are the higher percents of iron, copper and titanium in the sample I. The latter in spite of the smaller amounts of both silicon and aluminium.

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10 McClennon, Jour. Am. Chem. Soc. 51, 392 (1929).