cane juice and its incipient slight germicidal action are due to the action of the oxidases of the juice upon naturally occurring polyphenols of a tannin nature with production of quinone-like substances. The discoloration is more evident when freshly cut sections of the sugar-cane are exposed to the air and this leads to the suggestion that this reaction may serve a useful purpose in protecting living plants to a certain extent against the invasion of micro-organisms when their inner tissues are exposed to the air as a result of injury. The antibacterial activity of quinones was very likely known before the year 1906, but I am unable at the moment to refer to previous observations recorded in the literature.

C. A. BROWNE

BUREAU OF AGRICULTURAL AND
INDUSTRIAL CHEMISTRY,
U. S. DEPARTMENT OF AGRICULTURE

GREEN COLOR OF PLANT ASH DUE TO MANGANESE, NOT TO COBALT

IN 1932, Bishop and Lawrenz[1] published a note on the presence of cobalt in plant ash. Their attention was called to the problem by the color of the ash which was white from some plants but of various shades of green from others. Iron, chromium, manganese, cobalt, nickel and copper were considered as possible causes of this green color. Using the magneto-optical method of analysis it was concluded that cobalt was responsible for the green color of the ash. This has been widely quoted as evidence of cobalt in plants.[2]

In general plants contain but a fraction of a part per million (dry weight basis) of cobalt. The manganese content, however, is commonly over fifty parts per million and may reach as high as 4,300 parts per million manganese in tree leaves growing on acid soil.

From the evidence adduced from the color and composition of the ash from several thousand of plant ash analyses, and from the color of ignited soil extract residues we can state quite positively that the cause of the green color of plant ash is due to manganese. However, to develop this color it is necessary that the ash be thoroughly oxidized, heated at a fairly high temperature and that the ash be relatively high in potassium (or sodium) carbonate. Under these conditions green potassium manganate is formed. The green color developed is the classical and time-honored qualitative test for manganese by fusion with sodium or potassium carbonate under oxidizing conditions. It is a very sensitive qualitative test. Plant ash frequently contains enough manganese to develop the colors, when treated with water, which are characteristic of chameleon mineral.

If green plant ash is leached with water, a green solution is obtained. This solution turns pink when neutralized with hydrochloric acid, as Bishop and Lawrenz state. This is characteristic of manganese and not of cobalt. The cobalt of plants is far too low to yield these colors. Further, it is doubtful if any cobalt would go into solution in a water extract of plant ash because cobalt is not dissolved by a slight excess of alkali except under unusual conditions such as in the presence of ammonia. The large excess of phosphate in plant ash would also tend to prevent the cobalt from dissolving in water.

The addition of quantities of cobalt up to five parts per million, the highest quantity plants seem to contain, has no noticeable effect on the color except in the case of plants high in aluminum such as the sweet leaf. In this case the change in color is the development of a faint shade of blue rather than green.

W. O. ROBINSON

DIVISION OF SOIL AND FERTILIZER
INVESTIGATIONS,
BUREAU OF PLANT INDUSTRY,
BELTSVILLE, MD.

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[1] SCIENCE, 75: 1940, 264–5.

[2] L. G. Willis, "Bibliography of the Minor Elements," third edition, p. 281, 1939.

THE COLOR REACTION OF VITAMIN A ON ACID EARTHS

A BRIGHT blue color reaction of vitamin A upon adsorption on a commercial adsorbent made from Montmorillonite was lately described by Lowman[1] and, in a recent issue of this journal, Zechmeister and Sandoval[2] point out that a similar observation had been previously reported by Meunier.[3] However, this observation goes further back; in 1939 Emmerie and Engel[4] discovered that vitamin A gives a dark blue color, and carotenoids a bluish green color, when adsorbed on Floridin SX used for the removal of vitamin A and carotenoids from serum extracts prior to the reductometric colorimetry of tocopherol. When adapting the method of Emmerie and Engel to a photoelectric procedure, we confirmed their observation and described[5] that a clear yellow benzene solution containing, besides tocopherol, vitamin A and carotenoids caused a column of floridin earth to assume a dark greenish blue color.

GERDA GERNSHEIM MAYER
HARRY SOBOTKA

CHEMICAL LABORATORIES,
THE MOUNT SINAI HOSPITAL,
NEW YORK, N. Y.

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[1] A. Lowman, SCIENCE, 101: 183, 1945.

[2] L. Zechmeister and A. Sandoval, *ibid.*, 101: 585, 1945.

[3] P. Meunier, *Comptes rendus de l'Acad. Franc.*, 215: 470, 1942.

[4] A. Emmerie and C. Engel, *Rec. trav. chim. Pays-Bas,* 58: 283, 1939.

[5] G. Gernsheim Mayer and H. Sobotka, *Jour. Biol. Chem.*, 143: 695, 1942.