tion was hampered by lack of powers to deal with persons unwilling to submit to treatment and known to infect others. This difficult problem is engaging attention.

At the end of April, 1939, the number of state-registered nurses was 94,200. In April, 1942, the number had risen to 103,700. But there is still a shortage, and 12,000 more are required. The tuberculosis service in particular has exceptional difficulties in securing adequate numbers. Fear of contracting the disease in sanatoriums appears to be a factor, though the authorities hold that there is no greater risk than in other hospitals.

The demand for doctors in the fighting forces has entailed a shortage for civilian purposes. The government has asked the public to recognize the difficulty and do what it can to limit calls to what is essential.

SPECIAL ARTICLES

ABSORPTION OF SELENIUM BY CORN FROM ASTRAGALUS EXTRACTS AND SOLUTIONS CONTAINING PROTEINS

BESIDES being highly toxic to livestock, selenium indicator plants serve as converters of selenium. They absorb selenium from the soil, change it into water-soluble compounds, and through decay return it to the soil in forms readily available for absorption by all types of plants, including farm crops. Soil-plot experiments by Beath and his associates[1] have shown that selenium derived from a water extract of an indicator plant is much more readily accumulated than selenium from an inorganic compound such as sodium selenite.

We have recently made a quantitative comparison of a water extract of *Astragalus bisulcatus* and sodium selenite (Na_2SeO_3) as sources of selenium for absorption and accumulation by young corn plants growing in solution cultures. Another phase of our study dealt with the possible influence of proteins and their derivatives on the absorption of inorganic sodium selenite.

Pioneer hybrid corn no. 307 was germinated in quartz sand. When the seedlings were about 8 cm high they were transferred to a mineral culture solution of the usual composition[2] to which either *Astragalus* extract or sodium selenite had been added. The culture solutions were renewed twice a week, and after the plants had grown for three weeks they were dried, weighed and analyzed for selenium. The extract was prepared by soaking finely ground seleniferous *Astragalus bisulcatus* in culture solution for 16 hours at room temperature and then filtering with suction; about 75 per cent. of the selenium in the *Astragalus* powder was removed, and the extract contained approximately 40 ppm of selenium.

The curves in Fig. 1 show far greater absorption and accumulation of selenium from a water extract of *Astragalus* than from sodium selenite. The selenium content of the corn seedlings receiving the *Astragalus* extract was from 12 to 20 times as high as that of the seedlings receiving sodium selenite. Maximum accumulation was 3,150 ppm[3] in the *Astragalus* extract series as compared with only 235 ppm in the sodium selenite series. Although reduction in growth was

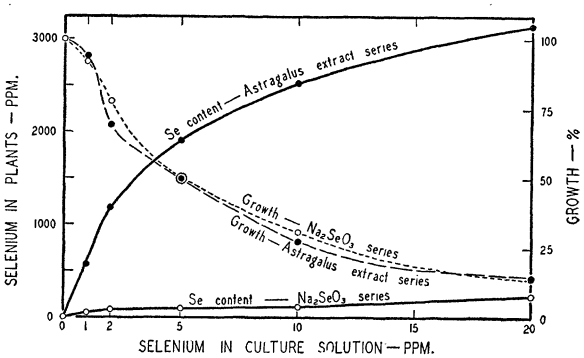

FIG. 1

about the same in both series for equivalent concentrations of selenium in the culture solution, it is evident that, per unit of selenium accumulated, the selenium in the *Astragalus* extract was much less toxic than the inorganic sodium selenite.

The selenium occurs in the extract as part of an organic compound—not as the selenite or selenate ion. Dialysis has shown that the selenium is present in molecules sufficiently small to diffuse readily through a Cellophane membrane (Du Pont or Visking), since it became equally distributed on both sides of the membrane within 48 hours at 5° C. The dialyzed selenium and the selenium in the original extract exhibited the same toxicity, and they were accumulated to the same degree by young corn plants.

In view of the much greater accumulation of selenium from an *Astragalus* extract than from sodium selenite, it seemed of interest to determine whether the addition of an organic substance to the culture solution would increase the absorption of inorganic sodium selenite. Various proteins, protein derivatives and

[1] O. A. Beath, H. F. Eppson and C. S. Gilbert, *Wyo. Agr. Exp. Sta. Bull.*, 206, 1935.

[2] S. F. Trelease and H. M. Trelease, *Am. Jour. Bot.*, 26: 530–535, 1939.

[3] This is one hundred times the maximum reported for lethal corn from naturally seleniferous soils. See: S. F. Trelease, *Scientific Monthly*, 54: 12–28, January, 1942.

amino acids (Difco) were added, each in a concentration of 50 ppm, to a culture solution containing 5 ppm of selenium as sodium selenite. Table I shows that at least four of these substances—bactotryptone, neopeptone, sodium caseinate and proteose peptone—approximately doubled the accumulation of selenium, and smaller increases were obtained with the other substances tested. It may be noted also that water extracts of alfalfa hay and of string beans had a marked effect in increasing selenium absorption.

TABLE I

INFLUENCE OF VARIOUS PROTEINS AND AMINO ACIDS IN THE CULTURE SOLUTION ON THE ACCUMULATION BY CORN SEEDLINGS OF SELENIUM SUPPLIED AS SODIUM SELENITE

Protein or amino acid in culture solution, 50 ppm.	Selenium series (5 ppm. Se as Na_2SeO_3)		Control series* (No selenium)
	Se content of plants, ppm.	Ave. dry wt. of tops, g.	Ave. dry wt. of tops, g.
Bactotryptone	471	0.90	2.23
Neopeptone	420	0.87	2.10
Sodium caseinate	413	0.92	2.26
Proteose peptone	396	0.95	3.37
Alanine	324	0.78	2.27
Tyrosine	264	1.02	2.63
Cystine	253	1.00	2.87
Tryptophane	205	1.12	2.20
Control	192	1.14	2.47
Alfalfa hay extract ..	319	0.80	1.17
Control	143	1.27	2.20
String-bean extract ..	285	0.84	0.83
Control	132	0.66	1.04

* Analysis showed that these plants contained no selenium.

Fig. 2 shows that increasing the concentration of sodium caseinate in a solution containing 5 ppm of selenium as sodium selenite brought about a progressive increase in the accumulation of selenium by the corn plants. With 200 ppm of sodium caseinate, the corn plants stored 830 ppm of selenium, or four times the concentration accumulated in the absence of the protein. It is of interest in this connection to note that the toxicity of selenium to rats has been found to be markedly reduced by a high proportion of protein, particularly casein, in the diet.[4]

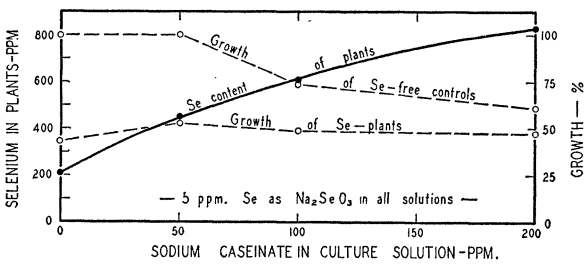

FIG. 2

In conclusion, it may be suggested that soils naturally high in nitrogenous organic substances may allow greater selenium accumulation by crop plants and native grasses than soils low in such substances. It would be expected that preparation of a grain field in a seleniferous area by plowing under a leguminous crop might markedly increase the absorption of selenium by the grain. Corn, other cultivated grains and native grasses, though unable to rival the true indicator plants, might nevertheless be capable of significant activity as selenium accumulators and converters in a soil rich in organic material.

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[4] R. A. Gortner, Jr., *Jour. Nutrit.*, 19: 105–112, 1940.

FACTORS INFLUENCING CAPILLARY PERMEABILITY IN THE VITAMIN E DEFICIENT CHICK[1]

INCREASED permeability of capillaries resulting in diffuse hemorrhage and exudation of plasma, as well as in increased migration of intravenously injected colloidal dyes into the tissues, was found by us to be an outstanding feature of vitamin E deficiency in chicks.[2, 3, 4, 5]

A further study of this condition has shown that it is possible to influence the intensity of this symptom very much by certain modifications of the diet which do not affect the vitamin E content.

Thus the appearance of exudates can be delayed and the incidence and severity of the symptom reduced by lowering of the concentration of soluble salts in the diet, whereas a high concentration of such salts—phosphates or sodium chloride—has the opposite effect. By suddenly raising the content of soluble salts considerably, exudates in the pericardium and the peritoneum and edema of muscle tissue can be produced as a regular symptom, whereas such exudates are rare on the same diet with low salt content. This observation affords some explanation as to why Bird and Culton[6] found the symptoms to be more severe on their diet (which contained 54 per cent. of dried skim milk and 1 per cent. of sodium chloride) than on our previously used diet, which has a lower salt content.

Acceleration of the onset of exudates can also be obtained by incorporating a trace of histamine in the

[1] Acknowledgement is made to the Josiah Macy Jr. Foundation for aid in conducting this work. Thanks are due to Hoffman LaRoche, Nutley, N. J., for furnishing synthetic alpha-tocopherol acetate (Ephynal acetate) and to Dr. L. R. Dragstedt, of the University of Chicago, and The Lilly Research Laboratories, Indianapolis, Ind., for lipocaic.

[2] H. Dam and J. Glavind, *Nature*, 142: 1077, 1938.

[3] *Idem, Nature*, 143: 810, 1939.

[4] *Idem, Skandinavisches Archiv f. Physiologie*, 82: 299, 1939.

[5] *Idem, Die Naturwissenschaften*, 28: 207, 1940.

[6] H. R. Bird and Th. G. Culton, *Proc. Soc. Exp. Biol. and Med.*, 44: 543, 1940.