

VITAMIN B<sub>6</sub> AS A YEAST NUTRILITE

Sir:

In corroboration of the findings of Schultz, Atkin and Frey [THIS JOURNAL 61, 1931 (1939)], we wish to indicate that we have independently found that vitamin B<sub>6</sub> is effective in yeast growth stimulation. A typical experiment is outlined below.

The basal medium was similar to that used in previous work [Williams and Saunders, *Biochem. J.*, 28, 1887 (1934)], but contained 0.1 g. of aspartic acid per liter instead of asparagin. It also contained 0.03 mg. of thiamine, 0.3 mg. of  $\beta$ -alanine, and 30 mg. of autolyzed liver extract per liter. The liver extract had been treated with charcoal and with fuller's earth. The yeast seeding was 0.03 mg. of a pure culture isolated from a Fleischmann cake per 12 ml. culture and the growth period was fourteen hours at 30°. The vitamin B<sub>6</sub> used had been generously furnished by Dr. Samuel Lepkovsky.

TABLE I

| Vitamin B <sub>6</sub> added<br>( $\gamma$ per culture) | Yeast crop<br>(mg. per 12 ml. culture) |
|---|--|
| 0   | 4.47                                   |
| 0   | 4.53                                   |
| 0.0005  | 4.44                                   |
| .001  | 4.95                                   |
| .005  | 6.29                                   |
| .01   | 6.82                                   |
| .05   | 8.01                                   |
| .1  | 8.58                                   |
| .5  | 7.94                                   |
| 1   | 8.27                                   |

This finding makes more emphatic the close relationship between "B" vitamins and substances effective for the stimulation of the growth of yeasts (as well as other microorganisms).

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RECEIVED JUNE 10, 1939

## VITAMIN K ACTIVITY OF SOME QUINONES

Sir:

In view of the recent note of Almquist and Klose [THIS JOURNAL, 61, 1611 (1939)] and their conclusion "that phthiocol is the simplest member of an homologous series of anti-hemorrhagic substances," we are submitting a report on the potencies of a rather extensive series of quinones.

As soon as our investigations on vitamin K indicated a quinone structure [THIS JOURNAL, 61, 1295 (1939)], we began a survey of the potencies of quinones.

Using the assay procedure previously described [*J. Soc. Exp. Biol. Med.*, 40, 478 (1939); 41, 199 (1939)] the following quinones were found to be inactive at a level of 5 mg.: anthraquinone  $\beta$ -sulfonic acid, thymoquinone, tolu-*p*-quinone, dihydro-anthraquinone diacetate, 1,2-naphthoquinone, phenanthraquinone, diamylhydroquinone, *p*-xyloquinone, 2-allyl-1,4-naphthoquinone (tested only at 2.0 mg.) and 1,4-benzoquinone.

With the exception of 2-allyl-1,4-naphthoquinone all of the derivatives of 1,4-naphthoquinone show vitamin K activity. Moreover, the diacetates of two of the dihydro-1,4-naphthoquinones show activity, perhaps due to hydrolysis in the gastro-intestinal tract. 2-Allyl-4-amino-1-naphthol hydrochloride in aqueous solution gives a positive reaction.

Our data are summarized in Table I. They show that the 2-methyl-1,4-naphthoquinone is the most active compound in this group; however, when compared with the natural vitamin K<sub>1</sub> (1000 units per mg.) or K<sub>2</sub> (660 units per mg.), the activity is relatively insignificant. Other more complex derivatives of 1,4-naphthoquinone are being prepared for a study of their physiological activity.

TABLE I

| Active compounds   | Our standard units<br>per milligram |
|--|-------------------------------------|
| 1,4-Naphthoquinone   | 1.0                                 |
| 2-Methyl-1,4-naphthoquinone                                    | 10.0                                |
| 2-Ethyl-1,4-naphthoquinone                                     | 8.0                                 |
| Phthiocol, 2-methyl-3-hydroxynaphthoquinone                    | 2.0                                 |
| 2-Bromo-3-methyl-1,4-naphthoquinone                            | > 0.10                              |
| 2,3 - Dibromo - 2 - methyl - 1,4 - dioxo-tetrahydronaphthalene | > 0.10                              |
| 1,4-Naphthalenediol diacetate                                  | 0.50                                |
| 2-Methyl-1,4-naphthalenediol diacetate                         | 5.00                                |

Our discovery of the activity of 1,4-naphthoquinones and the inactivity of other quinones has been of considerable assistance in developing the structure of vitamin K<sub>1</sub> [THIS JOURNAL, 61, 1928 (1939)].

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RECEIVED JUNE 19, 1939