1 This work was supported by CNR, Rome, in the framework of 'Progetto Finalizzato Chimica Fine e Secondaria'.
2 Amico, V., Oriente, G., Piattelli, M., Tringali, C., Fattorusso, E., Magno, S., and Mayol, L., Tetrahedron Lett. *1978*, 3593.
3 De Napoli, L., Fattorusso, E., Magno, S., and Mayol, L., Experientia *37* (1981) 1132.
4 Blackman, A.J., and Wells, R.J., Tetrahedron Lett. *1978*, 3063.
5 Sun, H.H., and Fenical, W., Tetrahedron Lett. *1979*, 685.

0014-4754/83/020141-03$1.50+0.20/0

Increase in micropore volume of N-containing activated carbon treated with methylol melamine urea solution

K. Boki[1], S. Tanada, T. Kita, T. Nakamura, H. Takahashi and R. Hamada

Faculty of Pharmaceutical Sciences, Tokushima University of Arts and Sciences, Yamashiro-cho, Tokushima 770 (Japan), and Faculty of Pharmaceutical Sciences, Faculty of Agriculture, Kinki University, Kowakae 3-4-1, Higashi-Osaka, Osaka 577 (Japan), February 26, 1982

Summary. The micropore volume of N-containing activated carbon was increased and the average radius of supermicropore was extended by treatment with methylol melamine urea solution.

The theory of volume filling of micropores (TVFM)[2] is applied for describing the physical adsorption of gas in micropores. The adsorption for micropores (radius < 5-6 Å) and supermicropores (5-6 < radius < 15-16 Å according to TVFM is expressed by the two-term equation[3]),

$$a = W_{01}/\mu * \exp[-(A/\beta E_{01})^2] + W_{02}/\mu * \exp[-(A/\beta E_{02})^2],$$

where a is the amount adsorbed; $\mu *$ is the molar volume of an adsorbate; W_{01} and W_{02} are the micropore and the supermicropore volumes, respectively; A is the decrease of free energy of adsorption; E_{01} and E_{02} designate the characteristic energies of adsorption in micropores and supermicropores, respectively; and β is the similarity coefficient.

In the previous paper[4] it was demonstrated that the N-containing activated carbon (N-CAC) prepared with methylol melamine urea (MMU) solution had the highest adsorption capacity for hydrogen sulfide at pressures up to about 400 Torr among the 20 kinds of N-CACs. N-CAC would be of great value for a large scale utilization because of the effects of its molecular sieving nature[5] and its surface polar nature[5]. The present investigation was undertaken to describe the difference in porous structure between the raw activated carbon and the N-CAC prepared with MMU solution on the basis of the results of application of the two-term equation to the experimental isotherms of hydrogen sulfide on them.

Materials and methods. The purity of hydrogen sulfide gas was indicated to be 99.9%. The physical properties of raw activated carbon (No. 1) and N-CAC prepared with MMU

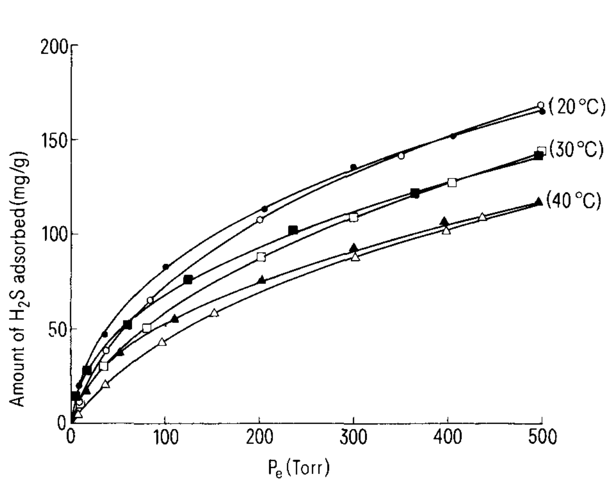

Figure 1. Adsorption isotherms of hydrogen sulfide on activated carbon. Open symbols and closed symbols denote the experimental data of adsorption on activated carbon Nos 1 and 2, respectively. The equilibrium amounts adsorbed at different equilibrium pressures were determined within an error of 0.5%. P_e is the equilibrium pressure of hydrogen sulfide.

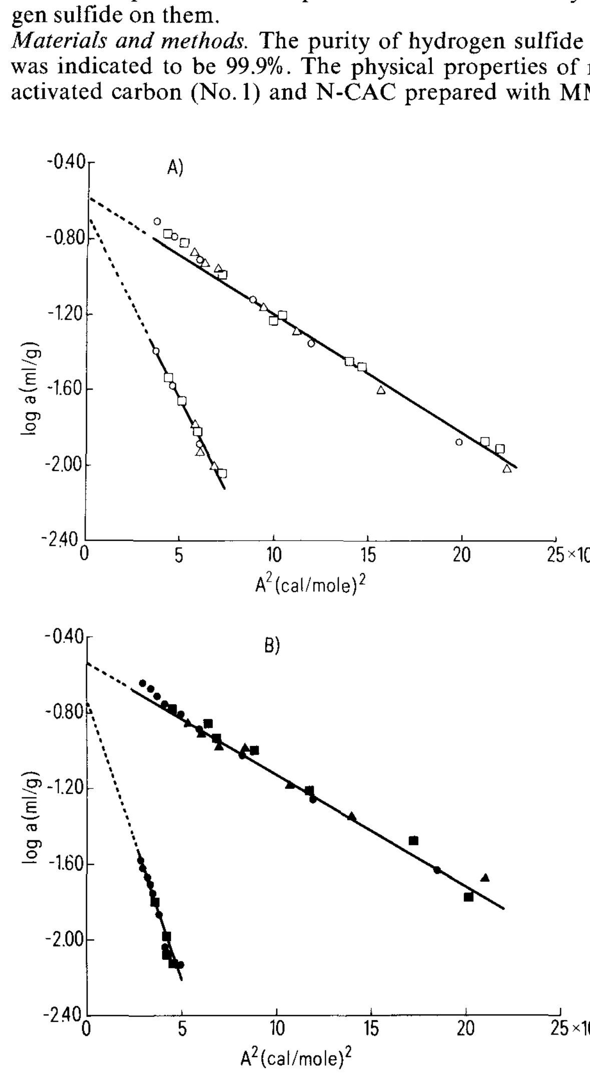

Figure 2. Application of the Dubinin-Radushkevich equation and the two-term equation to the experimental adsorption isotherms of hydrogen sulfide. *A* Activated carbon No. 1; *B* activated carbon No. 2; a, the amount of hydrogen sulfide adsorbed (ml/g); A, the decrease of free energy of adsorption.

Parameters of the two-term equation, structural constant, inertia radius, and characteristic size of micropores and supermicropores

Activated carbon No.	Micropores					Supermicropores				
	W_{01} (ml/g)	E_{01} (cal/mole)	B_1 (10^{-6} K^{-2})	R_{i1} (Å)	x_1 (Å)	W_{02} (ml/g)	E_{02} (cal/mole)	B_2 (10^{-6} K^{-2})	R_{i2} (Å)	x_2 (Å)
1	0.2642	6737	0.46	5.35	4.69	0.2108	3815	1.44	9.44	8.29
2	0.2923	6921	0.44	5.21	4.57	0.1780	3121	2.15	11.54	10.13

solution (No. 2) are as follows: specific surface area by N_2 gas, 949.6, 892.8 m^2/g; pore volume, 0.5186, 0.5039 ml/g; true specific gravity, 2.16, 2.18 g/ml; element analysis, H: 0.62%, C: 96.69%, N: 0.87%; H: 0.38%; C:87.82%. N: 4.31%; pH of an aqueous dispersion, 6.5, 6.7. The preparation of N-CAC with 25% (w/v) MMU solution and the procedures for adsorption were described in previous papers[4,6].

Results and discussion. The adsorption isotherms at 3 different temperatures (fig. 1) showed that the amounts adsorbed on No. 2 were larger than those on No. 1 over the whole range up to 400 Torr. The Dubinin-Radushkevich (D-R) equation[2]

$$a = W_0/\mu^* \exp[-B(T/\beta)^2 \log^2(p_s/p)]$$

and the two-term equation were applied to the adsorption isotherms (fig. 2), where B is the structural constant, p_s/p is the reciprocal number of the relative pressure, and T is the absolute temperature. The fact that the D-R plots showed a deviation from linearity at the ranges of $A^2 < 7 \times 10^6$ (No. 1) and $A^2 < 5 \times 10^6$ (No. 2) seems to indicate that these activated carbons possess heterogeneous pores, that is, micropores and supermicropores with a flattened shape as suggested by Huber et al.[7], Izotova and Dubinin[8], and Perret and Stoeckli[9]. The micropore volume (W_{01}) and the supermicropore volume (W_{02}) were estimated by extrapolation of the intercept to $A^2 = O$ of the upper line and the lower line, respectively, obtained by the least-squares method (fig. 2). E_{01}, B_1, E_{02}, and B_2 were calculated from the slopes of the straight lines in figure 2. Increase in the micropore volume and decrease in the supermicropore volume of No. 2 as compared to those of No. 1 (table) were produced by treatment with MMU solution. The inertia radius R_i of a flat-shaped pore is expressed[9] by $R_i = \sqrt{62B \times 10^6}$. The relationship between the inertia radii (R_i) of micropores and supermicropores and their characteristic sizes (x) is expressed by the equation[3] $x = 0.878\ R_i$. The characteristic size expresses the linear dimension which is of importance for the properties of micropores, and it is an average value of radii which correspond to the characteristic points of the adsorption isotherm[3]. The results that No. 2 was almost equal in x_1 to No. 1 and that No. 2 was longer than No. 1 by 1.84 Å in x_2 indicate that only the average radius of supermicropores was extended by treatment with MMU solution. It may be suggested that an increase of about 11% in micropore volume of No. 2 results not from an extension of micropore radius but from a numerical increase of micropores with the same radius as that of No. 1.

1 To whom reprint requests should be addressed.

2 Dubinin, M. M., Prog. Surf. Membrane Sci. *9* (1975) 1.
3 Dubinin, M. M., in: Characterisation of porous solids, pp. 1-12. Eds S. J. Gregg, K. S. W. Sing, and H. F. Stoeckli. Society of Chemical Industry, London 1979.
4 Tanada, S., Boki, K., Sakaguchi, K., Kitakouji, M., Matsumoto, K., and Yamada, Y., Chem. pharm. Bull. *29* (1981) 1736.
5 Tanada, S., and Boki, K., unpublished data.
6 Boki, K., and Tanada, S., Chem. pharm. Bull. *28* (1980) 1270.
7 Huber, U., Stoeckli, F., and Houriet, J. Ph., J. Colloid Interface Sci. *67* (1978) 195.
8 Izotova, T. I., and Dubinin, M. M., Zh. fiz. Khim. *39* (1965) 2796.
9 Perret, E. A., and Stoeckli, H. F., Helv. chim. Acta *58* (1975) 2318.

0014-4754/83/020143-02$1.50 + 0.20/0

Enhanced inhibitory effect of UV on cell-cycle progression in cultures of lymphocytes from malnourished children

P. Bala Krishna Murthy[1]

National Institute of Nutrition, Indian Council of Medical Research, Jamai-Osmania (P.O.), Hyderabad-500007 (A.P., India), May 25, 1982

Summary. Lymphocytes from malnourished children subjected to UV-irradiation were found to have a diminished entry into the proliferation pool and an increased cell-cycle duration in phytohaemagglutinin (PHA) treated cultures.

Protein energy malnutrition (PEM) is a disease due to inadequacy of proteins or calories in the diet and is known to cause a number of functional changes in children[2]. At the cellular level the disease is characterized by a prolongation of the cell-cycle duration and a diminished blast transformation and DNA synthesis in lymphocyte cultures treated with PHA[3,4]. Studies in our laboratory have been directed at understanding the possible presence of an increased 'spontaneous' and induced mutagenic environment in cells from children with severe PEM. We have recently reported that in lymphocytes from malnourished children UV induces more chromosome aberrations than it does in those from normal children controls[5]. In the present study, the inhibitory effect of UV on cell-cycle progression in PHA treated cultures of lymphocytes from malnourished children is reported.

Materials and methods. Six children suffering from severe PEM, diagnosed as having either kwashiorkor or kwashiorkor-marasmus, and 5 normal healthy children were investigated. The clinical and biochemical characteristics of symp-