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Germination and Morphine Content of *Papaver somniferum* Plants Produced from Commercially Available Poppy Seed

Keyphrases □ *Papaver somniferum*—germination and cultivation from commercial poppy seeds, morphine content, TLC, column chromatography, IR and mass spectra □ Morphine—isolated from *Papaver somniferum* germinated and cultivated from commercial poppy seeds, TLC, column chromatography, IR and mass spectra □ Narcotics—morphine, isolated from *Papaver somniferum* germinated and cultivated from commercial poppy seeds, TLC, column chromatography, IR and mass spectra

To the Editor:

There are no legal constraints to the possession of seeds of *Papaver somniferum,* the opium poppy. However, it is illegal to cultivate this plant in the United States. This paradox is interesting since *Cannabis sativa* (marijuana) seeds must be sterilized prior to sale. The narcotic regulations do not require sterilization of *P. somniferum* seeds.

Because *P. somniferum* could be illicitly cultivated in the United States as a source of codeine and morphine, the present study was carried out to answer the following questions. What is the botanical identification of commercially available poppy seeds? What is the germination rate of such seeds? And will plants produced from commercial poppy seeds grow and produce morphine in a temperate climate such as we have in the United States?

Poppy seeds (100-g samples) were obtained from two commercial bakeries in Chicago as well as from three supermarkets in the area. The seeds were soaked for 2 min in a dilute solution of sodium hypochlorite, washed thoroughly with water, and germinated on wet vermiculite. Approximately 60% of the seeds from each of five lots germinated.

After the seedlings developed well-expanded cotyledons, they were transplanted to potting soil. The plants were grown in a greenhouse in 10.2-cm (4-in.) diameter clay pots. Flowering occurred about 8 weeks after germination. Greenhouse plants were similar in appearance to fieldgrown plants, although they were smaller[1].

Immature capsules of one seed lot (I-9786) were pierced with a suitable needle daily, and the dried latex was scraped from the capsules and accumulated. A total of 24 mg of dried latex was collected in this manner from several capsules.

When the plants were fully mature, the entire plants were dried and then subjected to alkaloid extraction. The latex (24 mg), which had been scraped from the immature capsules, was dissolved in 15 ml of 1% HCl and filtered. After the filtrate was made alkaline with ammonium hydroxide, it was extracted three times with 15-ml volumes of chloroform. The combined chloroform extracts were taken to dryness to yield a 10-mg residue, which was used in the TLC analyses.

TLC of the extract on silica gel G plates, when compared with an authentic morphine sample, indicated morphine to be present in the alkaloid extract in addition to several other alkaloids.

Chromatography of the alkaloid extract over a small column (disposable pipet) containing 1.5 g of silica gel PF_{254}, using chloroform–methanol–ammonium hydroxide (90:10:1) as the eluent, resulted in the isolation of a compound (2 mg) whose R_f on silica gel PF_{254} plates, using the same solvent system, was 0.71.

The mass spectrum of the compound indicated a molecular ion M^+ at m/e 285 nm, and the fragmentation pattern was consistent with that reported for morphine (1).

To confirm this identification, additional capsules and foliage (8.38 g) were processed for alkaloids as already described. We wanted to determine if a larger quantity of the compound, tentatively identified as morphine, could be isolated and more definitively identified. TLC analysis of the resulting alkaloid extract indicated the same pattern as was observed for the alkaloid extract prepared from the latex.

Column chromatography of this extract, using 10 g of silica gel PF_{254}, resulted in the isolation of 7.6 mg of the compound. The UV spectrum of the sample (in ethanol) showed a maximum absorption at 284 nm,

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[1] The plants were identified as *Papaver somniferum* L. (Papaveraceae) by F. A. Crane, and herbarium specimens (I-9786–I-9790) were deposited at the Department of Pharmacognosy and Pharmacology, College of Pharmacy, University of Illinois at the Medical Center, Chicago, IL 60612

which was consistent for the morphine chromophore (2).

The remaining 6.6 mg of the compound was converted to the sulfate salt by dissolving the sample in ether and adding ether saturated with sulfuric acid. A white crystalline material (2.0 mg) was obtained and dried. Its IR spectrum (potassium bromide) was superimposable with that of an authentic morphine sulfate sample.

These data served to confirm the presence of morphine in poppy plants grown from seeds obtained at a local supermarket.

(1) H. Audier, M. Fetizon, D. Ginsburg, A. Mandelbaum, and T. Rull, *Tetrahedron Lett.*, **1965**, 13.

(2) A. Q. Sangster and K. L. Stuart, *Chem. Rev.*, **65**, 84(1965).

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Thermodynamics of Gaseous Anesthesia of Mice

To the Editor:

Evidence was presented recently indicating that the gaseous anesthesia of mice is largely a gas–biophase equilibrium process (1). This evidence consists principally of the observations that gaseous anesthetic potencies can be correlated against gas–oil distribution coefficients (1) but not against oil–water or 1-octanol–water partition coefficients (2). Since gaseous anesthesia has the characteristics of an equilibrium process, it is appropriate to establish the apparent thermodynamic variables pertaining to the anesthetic process in mice. This report presents such an attempt. The results indicate that the Ferguson principle (3), as presently formulated, is in error. A revised expression of the Ferguson principle is a direct outcome of this study.

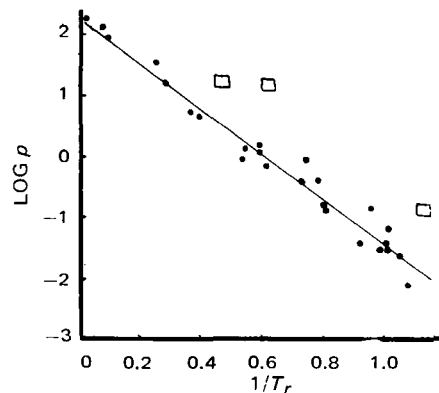The Clausius–Clapeyron equation for the distribu-

Figure 1—*Graph of anesthetic pressure against the reciprocal of the physiological reduced temperature. Compounds not following the relationship (fluoromethane, perfluoromethane, and perfluoroethane) are identified by the symbol □.*

tion of a gas with a condensed phase is given by:

$$\left(\frac{\partial \ln a_2}{\partial T}\right)_P = \left(\frac{\partial \ln p}{\partial T}\right)_P = \frac{\Delta H_v}{RT^2} = \frac{\Delta S_v}{RT} \quad (\text{Eq. 1})$$

where p is the partial pressure of the gas (presumed ideal) at an absolute temperature, T, and pressure, P, and a_2 is the thermodynamic activity of the gas solubilized in the condensed phase.

Equation 1 is appropriate for the determination of the apparent enthalpy and entropy of vaporization, ΔH_v and ΔS_v, at each temperature T from the slopes of graphs of log p against $1/T$ or log T, respectively. However, if the distribution of a number of gases with a condensed phase is of interest, one must either determine the partial pressure variation with temperature for each gas or, following the Principle of Corresponding States, approach the problem in terms of reduced thermodynamic variables so that the same equation of state will apply to each gas.

The reduced thermodynamic variables, P_r, V_r, and T_r, for a substance are obtained by dividing the critical values, P_c, V_c, and T_c, for the substance into the corresponding thermodynamic variables, P, V, and T. Critical values define the point where a gas can no longer be condensed into a liquid phase. When con-
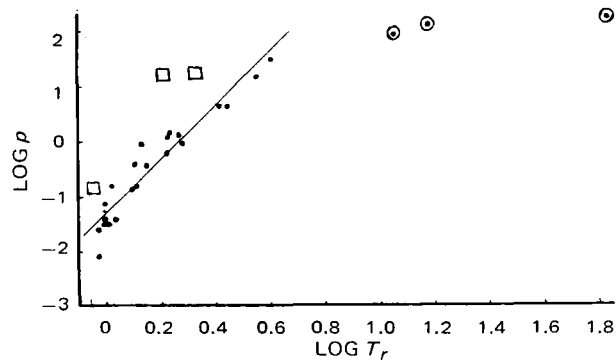

Figure 2—*Graph of anesthetic pressure against the logarithm of the physiological reduced temperature. Compounds not following the relationship (fluoromethane, perfluoromethane, and perfluoroethane) are identified by the symbol □. Anesthetics whose boiling points are near 0°K (helium, hydrogen, and neon) and which may be expected to depart from general trends are identified using the symbol ⊙.*