Regeneration of Silicic Acid Following Adsorption of Soybean Oil Pigments

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The effectiveness of sequential washes (isopropanol/hexane) of increasing polarity for desorbing soybean oil pigment (lutein) from silica was studied. Increasing the polarity promoted desorption of pigment, as the amount of adsorbed pigment increased. The evidence suggests that silicic acid has adsorption sites of variable accessibility. Lutein adsorption isotherms show that much of the adsorption capacity was regained after desorption.

During the refining of crude soybean oil, absorbent bleaching clays are used to remove pigments to produce a light-colored oil acceptable to consumers. The adsorbent is disposed of. Recycling the adsorbent and using it for bleaching vegetable oil would be a more economical use of materials. Furthermore, reuse of adsorbent would relieve a problem of disposing of the spent adsorbent. Regeneration of bleaching clay that has been exposed to cottonseed oil in hexane has been studied (1). When the clay was exposed to polar solvents much of the adsorbent capacity was restored.

This investigation studied the ability of isopropanol (IPA)/hexane mixtures to regenerate silicic acid that had previously been used to adsorb soybean oil pigments from a crude soybean oil miscella. The adsorption of soybean oil pigments on silicic acid has been studied with respect to sorption isotherms for lutein and triglyceride (2) and with respect to kinetics of adsorption (3).

MATERIALS AND METHODS

Oil, solvents and adsorbent. Crude soybean oil, obtained commercially and stored at 4°C, was used throughout, and all solvents were high performance liquid chromatography (HPLC) grade. Bio-Sil A (100-200 mesh silicic acid, Bio Rad Laboratories, Richmond, CA) was the adsorbent used and will be referred to as "silica."

Pigment (lutein) measurement. Pigment was measured according to the method of Proctor and Snyder (2), based on absorbance at 445 nm.

Silica regeneration. One-g quantities of silica were mixed with 200-ml volumes of 5%, 10%, 20%, 30% or 40% w/v oil in hexane miscellas. The amount of lutein adsorbed was measured. The silica was recovered and was subjected to a series of 200 ml IPA/hexane washes of increasing polarity as follows: 0.75%, 2.0%, 4.0% and 8.0% IPA with consecutive 100-ml volumes. During each wash the silica was stirred with solvent for 15 min. The amount of lutein desorbed was measured after each elution, and the data were plotted as a percentage of adsorbed pigment eluted after each wash. A lutein isotherm was prepared using 1-g quantities of recycled silica that had been mixed with 200 ml of a 20% miscella for 15 min and subsequently washed with 100 ml of 25% IPA/hexane, according to the method of Proctor and Snyder (3). A control isotherm was prepared using fresh silica.

RESULTS AND DISCUSSIONS

Figure 1 shows the effectiveness of sequential washes of solvent systems of increasing polarity in promoting desorption of lutein from silica previously exposed to miscellas of varying concentrations. For each elution sequence, the percentage of lutein desorbed decreased as the miscella concentration used for adsorption increased. This was probably because more pigment was adsorbed from the more concentrated miscellas. Increasing the

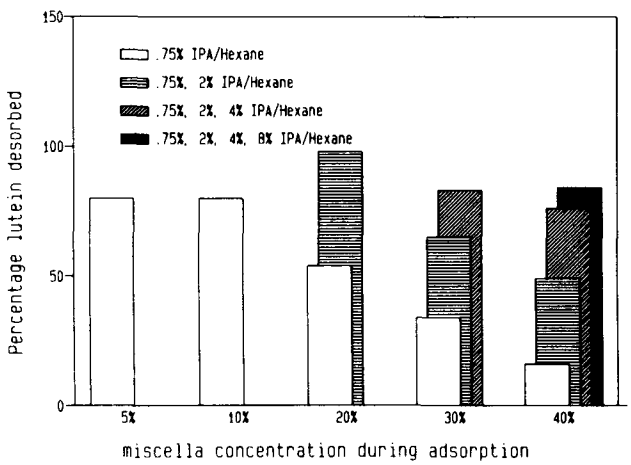

FIG. 1

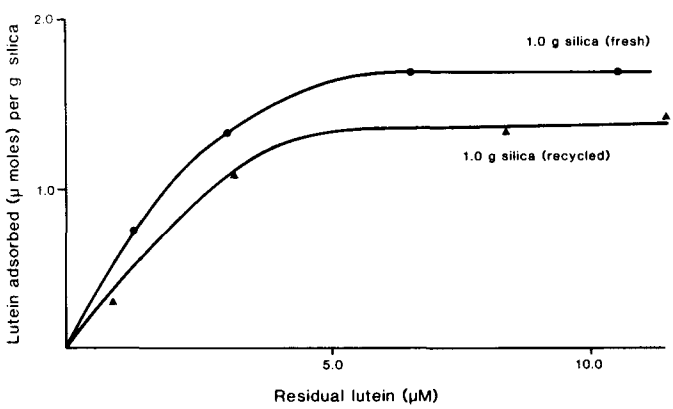

FIG. 2.

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polarity of the solvent system was necessary to desorb large percentages of pigment when large amounts were adsorbed. The need for increased polarity to desorb large amounts of pigment may have been because adsorption sites differed in their ability to adsorb and desorb pigment. Possibly, there were sites that were easily accessible, and these were occupied and desorbed first. Sites that were less accessible may have been within crevices and less readily occupied by pigment or IPA. Alternatively, there may have been chemical differences between the sites.

In a bleaching system using regenerated adsorbent there are two important factors to consider: 1) obtaining maximum adsorption of pigment per g of adsorbent and 2) obtaining maximum desorption as simply as possible, i.e., with a single, low-polarity wash. In Figure 1, a 20% miscella represents the best compromise between these two factors.

Figure 2 shows that although the adsorption of pigment by recycled silica is less than that of fresh adsorbent, the recycled silica retains much of its ability to bind lutein. The decreased adsorption may be due to bound triglyceride or IPA inhibiting lutein binding (2). Feuge and Janssen (1), studying the regeneration of bleaching earth by exposure to acetone, also found reduced adsorption by recycled adsorbent.

REFERENCES

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