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NOTE

Adsorption bleaching of soyabean oil in presence of small amount of solvents

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Abstract : The presence of small amounts of solvents from 1.0 to 5.0% enhanced the adsorption bleaching efficiency of soyabean oil. The solvents used were ethanol, benzene and acetone. Among the solvents acetone gave the best results. The temperature maintained during the process ranged from 70–75 °C. The process is convenient and simple and can be practiced in a commercial scale. The process temperature being low, oil quality could be better retained.

Keywords : Soyabean oil, adsorption.

The commonly used decolorisation technique of vegetable oils is adsorption bleaching using suitable clay minerals and activated carbon[1,2]. The nature and characteristics of clays used in adsorption bleaching of such oils have been extensively studied[3–6]. The outstanding feature of the clay (montmorillonite) structure is that, water and other polar molecules can enter between the unit layers. This causes the lattice of the clay to expand and such expansion varies with the nature and geometry of the molecules entering the clay moiety[2] expansion in lattice of the clay material facilitates adsorption of color bodies during bleaching operation. Interlayer water of the clay plays an important role, and removal of such water reduces bleaching efficiency of the clay[6]. Polar organic compounds and non-ionic compounds having polar character, form complexes with montmorillonite clays through water bridges. The degree of adsorption of a particular organic molecule on montmorillonite also depends on the nature of the associated solvent[7,8]. In case of non-polar molecules or groups only the van der Walls forces of attraction between them and the clay sheets is considered. Since this force is non-directional, the question of orientation does not arise and only a single molecular layer could be held in common by two neighboring clay mineral sheets. Polar molecules could from a two layer structure and less polar molecules single layer structure. Some polar groups are necessary for adsorption, as saturated hydrocarbons do not form complexes[2]. The necessity of polar groups for adsorption is due to the fact that the clay mineral sheets are charged and held together by positive ions between the sheets. The energy of formation of a purely van der Walls adsorption complex is insufficient for the break-up of the charged sheet-ion-charged sheet complex[2].

In the present study, the solvents ethanol, benzene and acetone were chosen because of their class difference and dissimilar polarity. All these solvents form two-layer structure with clay mineral (montmorillonite), saturated hydrocarbons (e.g. *n*-hexane) are incapable of forming layers with clay minerals[2].

Results and discussion

Results of bleaching of soyabean oil are presented in Table 1. The bleaching efficiency improved with added ethanol, benzene and acetone (1–5%) in comparison to that using the adsorbents alone.

The dominant clay-mineral component of bentonites is montmorillonite. The formation of complexes by the solvents with water in the clay material causes expansion of the lattice of the adsorbent and thereby more area is exposed for the adsorption of the pigments present in the oil. With polar solvents the spacing of the montmorillonite layers (C-axis) decreases with increasing number of carbon atoms as the number of layers is determined by the energy of adsorption, which decreases as the non-polar part of the molecule becomes larger. Saturated hydrocarbons (*n*-hexane, *n*-heptane, etc.) do not form layers with montmorillonite. Benzene, ethanol and acetone form two layer complexes[2].

Results indicate that benzene and ethanol have similar effects, whereas use of acetone improved the efficiency further. The complex forming ability of acetones with water in the clay mineral is superior to ethanol and benzene due to its greater polar character, causes the clay to expand more and this accommodates more pigment molecules. Hence acetone is found to be the most effective additive in adsorption bleaching of the oil. The bleaching efficiency is maximum at 5% (w/v) level of acetone.

Table 1. Adsorption bleaching of soyabean oil in presence of solvents

Solvent	Amount of solvent (% w/v)	Color of bleached oil (Lovibond 2 inch cell)		Reduction in color (%)	
		Y	R	Y	R
None	Nil	15	3.2	62.5	60.0
Ethanol	1.0	13	2.8	67.5	65.0
	3.0	13	2.6	67.5	67.5
	5.0	13	2.6	67.5	67.5
Benzene	1.0	13	2.7	67.5	66.3
	3.0	13	2.5	67.5	68.5
	5.0	13	2.5	67.5	68.8
Acetone	1.0	12	2.6	70.0	67.5
	3.0	10	2.2	75.0	72.5
	5.0	9	2.2	77.5	72.5

Experimental

Acid activated bentonite clay (activity 60%, moisture 15.6%) and activated carbon (activity 30%, moisture 16.4%) were used as adsorbents (D.C.M. Chemicals). Benzene and acetone (AnalaR, B.D.H.) and absolute alcohol (Fluka) were used. Activity of the adsorbents was determined by the method prescribed by Bureau of Indian Standards[9]. Color of the oil was evaluated by a Lovibond Tintometer (Model E No. 83064).

A combination of 1% (w/w) each of the acid activated bentonite clay and activated carbon was used as adsorbent for bleaching soyabean oil. The adsorbents were soaked separately with ethanol, benzene and acetone (at 1, 3 and 5% w/v level with respect to oil) in the reaction flask. For each experiment neutralized and washed soyabean oil at 70 °C was poured into the flask. Flask was connected to the vacuum pump and place over a heater with magnetic stirrer. Temperature of the mixture was maintained at 70–75 °C and vacuum at 20 in of Hg. The mass was stirred for 30 min. It was then filtered and color was evaluated in Lovibond Tintometer. Experiments using benzene were conducted in a fume cupboard.

Neutralised and washed soyabean oil (Hindusthan Lever Ltd.) had the following characteristics : Free fatty acids – 0.04%, color 40Y, 8R (Lovibond 2" cell).

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