SHORT COMMUNICATIONS

The Viscosity of Cottonseed Oil, Fractionation Solvents and Their Solutions

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Cold fractionation of cottonseed oil is made difficult by the high viscosity of the oil. This study was aimed at demonstrating the effect of solvents on the viscosity of mixtures between 0°C and 25°C with a view to facilitating the fractionation of refined cottonseed oil. The solvents used were acetone, methylethylketone, methylisobutylketone, hexane and heptane. Measurements of viscosity were carried out by means of a capillary viscometer. The ratio of the viscosity of cottonseed oil to that of pure solvents is of the order of 300. The viscosities of solutions of various ratios of solvent to oil (1/3, 1/1, 3/1) are between those of cottonseed oil and the pure solvents. The effect of the solvent/oil ratio overrides that of solvent nature. The effect of solvent in reducing the viscosity of cottonseed oil is by descending order: acetone, hexane, methylethylketone, heptane, methylisobutylketone.

KEY WORDS: Acetone, cottonseed oil, cottonseed oil solutions, heptane, hexane, methylethylketone, methylisobutylketone, solvent, viscosity.

Viscosity is one of the physico-chemical properties which are important practically. The efficiency of fractionation of cottonseed oil in the presence of solvent depends on the viscosity of the solution. Several studies (1-4) have been carried out on the viscosity of oils and fats. As far as cottonseed oil is concerned, very little has been published (5) on the influence of solvent on the viscosity of the oil solutions. The purpose of this investigation is to determine the viscosities of refined cottonseed oil, fractionation solvents and their solutions.

MATERIALS AND METHODS

The sample of refined cottonseed oil (HCR) was supplied by the Société de Développement de Coton (Sodecoton) du Nord Cameroun, Africa.

The solvents coming from Société de Documentation et de Synthèse, France, were all of analytical grade: acetone > 99.7%, methylethylketone (MEK) > 99%, methylisobutylketone (MIBK) > 99%, hexane > 99% and heptane > 99%.

An Ubbelohde-type capillary viscometer as well as several capped bottles were placed in a thermostated bath of precision 0.1°C. The cottonseed oil, the oil solutions of solvent to oil weight ratios, 1:3, 1:1, 3:1 and the pure solvents were placed in the bottles held in the thermostat at a predetermined temperature. The bottles were shaken periodically to ensure thermal equilibrium, and the temperature read with a thermometer of precision 0.1°C. When the temperature of a sample reached that of the bath, the sample was quickly transferred to the viscometer in the thermostat, and the viscosity was measured. These measurements were performed at various temperatures from 0°C to 25°C. The measurements were carried out quickly and in all cases before any cloudiness appeared in the oil solutions.

RESULTS AND DISCUSSION

The variation of viscosity with temperature, of oil solutions in different solvents at various solvent/oil ratios is presented in Figures 1 to 5.

The viscosity is expressed on a logarithmic scale in Figure 1 for the polar solvents (MIBK, MEK, acetone) and in Figure 2 for the nonpolar solvents (heptane, hexane). The measured viscosity of pure solvents is in very good accordance with the values recently compiled (6): the mean relative departure between the measured and the compiled values is of 2.1%. It can be seen that the viscosity of oil is greater than that of the solvents and the oil solutions. With respect to pure solvents, the viscosity of the oil is higher by a factor of about 300. Thus addition of solvent causes a considerable decrease in the viscosity of the oil. This is confirmed by the fact that in going from solvent/oil ratio of 1/3 to 3/1, the viscosity is decreased by a factor of 30. It is notable that at a given solvent/oil ratio the change in viscosity upon changing solvent is of the order of 1.5 to 2. Hence, the effect of the solvent/oil ratio by far overrides the effect of the nature of the solvent, in reducing the viscosity of the oil.

The variation of viscosity with temperature is represented on a linear scale in Figure 3 for the cottonseed oil, in Figure 4 for the pure solvents and in Figure 5 for solutions of the oil at solvent/oil ratios of 1/3 and 1/1. Figure 3 shows that the viscosity of cottonseed oil increases rapidly as temperature is decreased.

From Figure 4 it is seen that the viscosity of the pure solvents is very low and decreases by about 20% in going

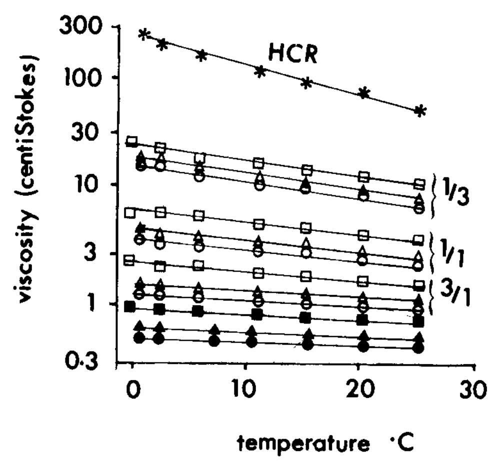

FIG. 1. The variation of viscosity (logarithmic scale) as a function of temperature for cottonseed oil(*), acetone (●), MEK (▲), MIBK (■) and solutions in acetone (○), MEK (△), and MIBK (□) at various solvent/oil ratios.

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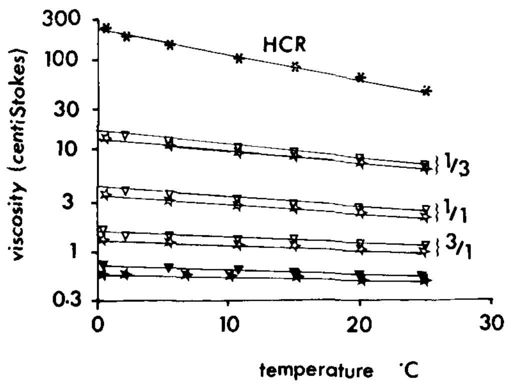

FIG. 2. The variation of viscosity (logarithmic scale) as a function of temperature for cottonseed oil (*), hexane (★), heptane (▼) and solutions in hexane (★), heptane (▽) at various solvent/oil ratios.

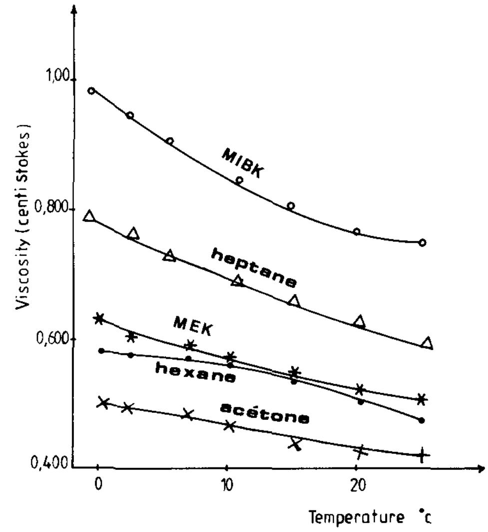

FIG. 4. Variation of the viscosity with temperature for acetone (x), hexane (•), MEK (*), heptane (△), MIBK (○).

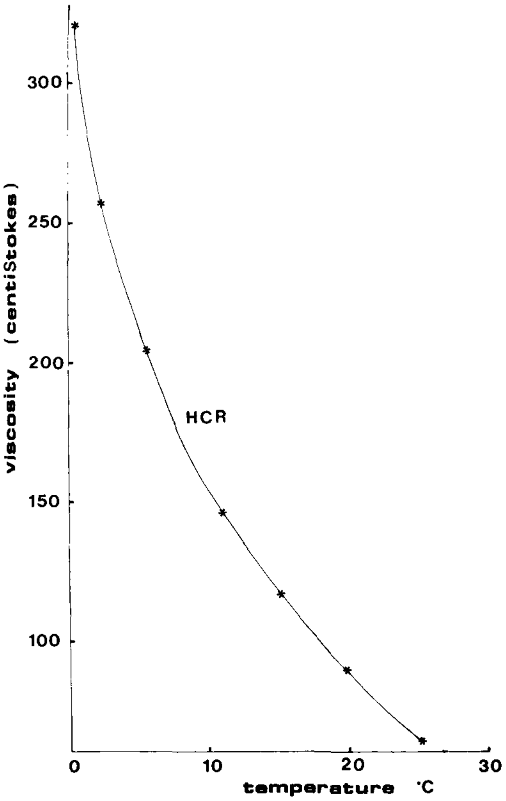

FIG. 3. Variation of the viscosity of cottonseed oil with temperature.

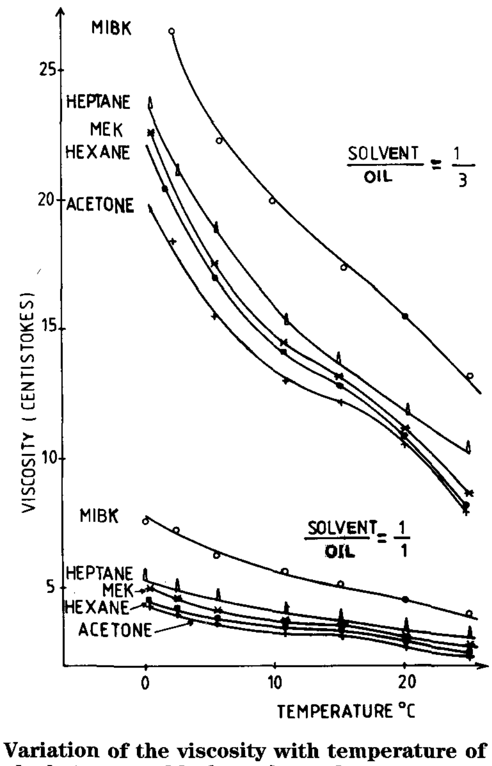

FIG. 5. Variation of the viscosity with temperature of oil solutions in the ketones and hydrocarbons shown.

from 0°C to 25°C, whereas in Figure 3 the viscosity of cottonseed oil decreases by a factor of 50 times, between 0°C and 25°C. Thus it is evident that cold fractionation of cottonseed oil in the absence of solvent will pose serious difficulties of separation and these could be considerably mitigated by carrying out the fractionation in the presence of solvent. For cold fractionation of cottonseed oil with solvent, oil is mixed with solvent and the mixture is cooled; separation of solid and liquid phase is easy for the viscosity of liquid is less than without solvent.

Figure 4 shows that the viscosity of the solvents increases in the order: acetone, hexane, MEK, heptane, MIBK. The viscosities of solutions of cottonseed oil in these solvents also follow the same trend, as can be seen in Figure 5. Given the boiling points of the solvents — acetone (56.5°C), hexane (69.0°C), MEK (79.6°C), heptane (98.4°C), MIBK (115.9°C), and the results of viscosity measurements presented here, the solvents of interest for cold fractionation of cottonseed are in decreasing order: acetone, hexane and MEK. It is worth noting that hexane is used to extract cottonseed oil, and acetone and MEK (methylethylketone) have been used in the cold fractionation of other edible oils.

ACKNOWLEDGMENTS

We are thankful to the Sodecoton of Cameroon for the cottonseed oil. The financial support of the Departement de Coopération et des Echanges Internationaux of Institut National Polytechnique de Lorraine, Nancy, France and the University Center of Ngaoundere, Cameroon, is gratefully acknowledged.

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[Received February 7, 1990; accepted October 30, 1990]